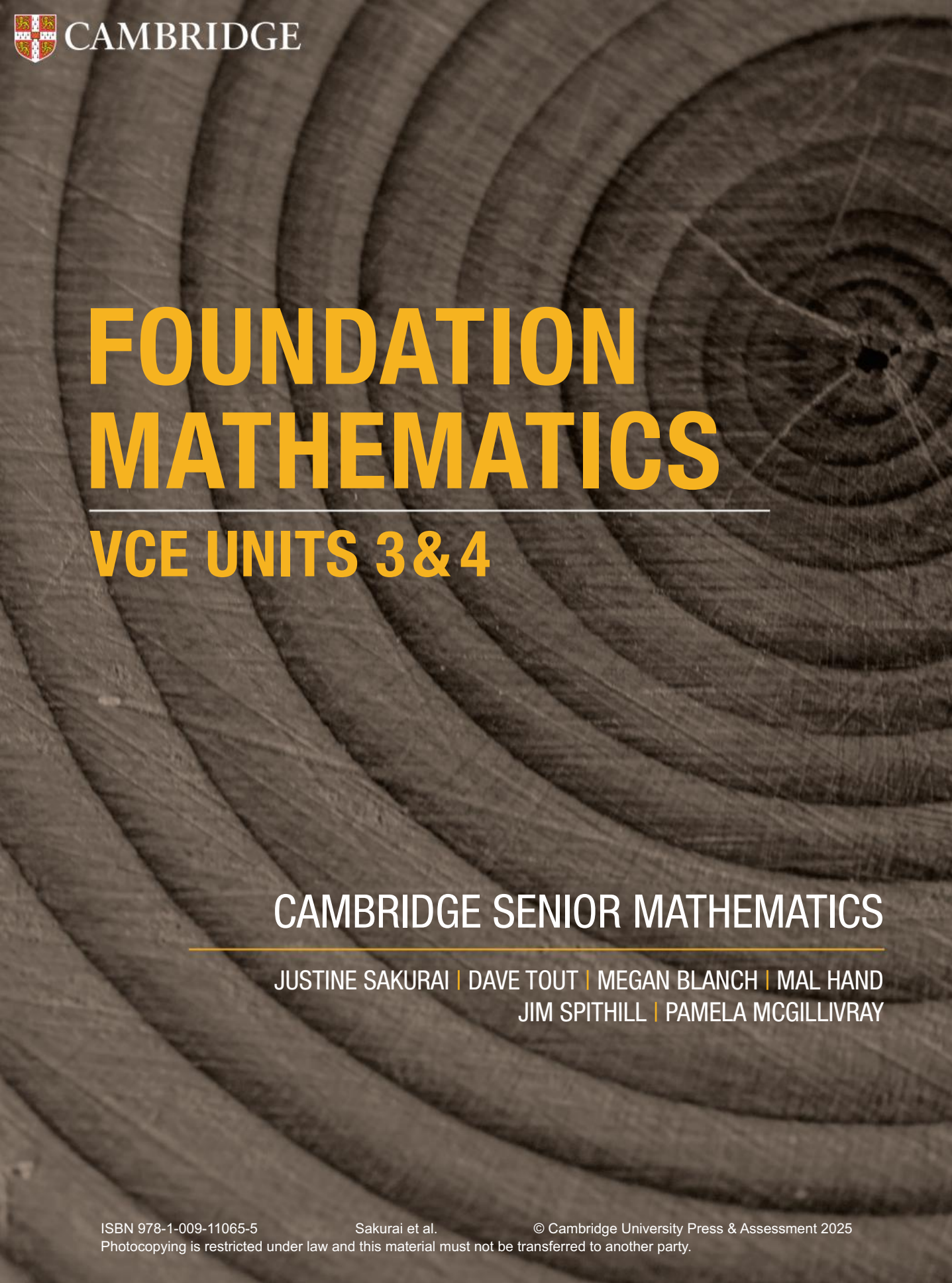


CAMBRIDGE

FOUNDATION MATHEMATICS

VCE UNITS 3&4

CAMBRIDGE SENIOR MATHEMATICS

JUSTINE SAKURAI | DAVE TOUT | MEGAN BLANCH | MAL HAND
JIM SPITHILL | PAMELA MCGILLIVRAY

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Shaftesbury Road, Cambridge CB2 8EA, United Kingdom
One Liberty Plaza, 20th Floor, New York, NY 10006, USA
477 Williamstown Road, Port Melbourne, VIC 3207, Australia
314–321, 3rd Floor, Plot 3, Splendor Forum, Jasola District Centre, New Delhi – 110025, India
103 Penang Road, #05–06/07, Visioncrest Commercial, Singapore 238467

Cambridge University Press & Assessment is a department of the University of Cambridge.

We share the University's mission to contribute to society through the pursuit of education, learning and research at the highest international levels of excellence.

www.cambridge.org
© Justine Sakurai, Dave Tout, Megan Blanch, Mal Hand, Jim Spithill and Pamela McGillivray 2025

This publication is in copyright. Subject to statutory exception and to the provisions of relevant collective licensing agreements, no reproduction of any part may take place without the written permission of Cambridge University Press & Assessment.

20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

Cover and text designed by Sardine Design
Typeset by Integra Software Services Pvt. Ltd.
Printed in China by C & C Offset Printing Co., Ltd.

A catalogue record for this book is available from the National Library of Australia at www.nla.gov.au

ISBN 978-1-009-11065-5

Additional resources for this publication at www.cambridge.edu.au/GO

Reproduction and Communication for educational purposes
The Australian *Copyright Act 1968* (the Act) allows a maximum of one chapter or 10% of the pages of this publication, whichever is the greater, to be reproduced and/or communicated by any educational institution for its educational purposes provided that the educational institution (or the body that administers it) has given a remuneration notice to Copyright Agency Limited (CAL) under the Act.

For details of the CAL licence for educational institutions contact:

Copyright Agency Limited
Level 12, 66 Goulburn Street
Sydney NSW 2000
Telephone: (02) 9394 7600
Facsimile: (02) 9394 7601
Email: memberservices@copyright.com.au

Reproduction and Communication for other purposes
Except as permitted under the Act (for example a fair dealing for the purposes of study, research, criticism or review) no part of this publication may be reproduced, stored in a retrieval system, communicated or transmitted in any form or by any means without prior written permission. All inquiries should be made to the publisher at the address above.

Cambridge University Press & Assessment has no responsibility for the persistence or accuracy of URLs for external or third-party internet websites referred to in this publication and does not guarantee that any content on such websites is, or will remain, accurate or appropriate. Information regarding prices, travel timetables and other factual information given in this work is correct at the time of first printing but Cambridge University Press & Assessment does not guarantee the accuracy of such information thereafter.

Please be aware that this publication may contain images of Aboriginal and Torres Strait Islander people who are now deceased. Several variations of Aboriginal and Torres Strait Islander terms and spellings may also appear; no disrespect is intended. Please note that the terms 'Indigenous Australians' and 'Aboriginal and Torres Strait Islander peoples' may be used interchangeably in this publication.

Cambridge University Press & Assessment acknowledges the Aboriginal and Torres Strait Islander peoples of this nation. We acknowledge the traditional custodians of the lands on which our company is located and where we conduct our business. We pay our respects to ancestors and Elders, past and present. Cambridge University Press & Assessment is committed to honouring Aboriginal and Torres Strait Islander peoples' unique cultural and spiritual relationships to the land, waters and seas and their rich contribution to society.

Table of contents

About the authors viii
Introduction x
Guide to this resource xii
Acknowledgements xvii

1 Introducing working with maths in the real world (online only) 2
Chapter overview
1A Why you need to know some mathematics
1B Tuning in
1C Taking a problem-solving approach
1D Your investigations: Finding a context
1E Some important issues in maths problem solving
1F Stage 1: Formulate
1G Stage 2: Explore
1H Stage 3: Communicate
1I Sample investigation topic: Australia's population and immigration
Chapter review

2 Working with numbers 4
Chapter overview and Spotlight 6
2A Starting activities 8
2B Tuning in 11
2C Understanding rational and irrational numbers 13
2D Order of operations, powers and roots 17
2E Estimation and reasonableness 23
2F Very large and very small numbers 36
Investigations 41
Chapter review 46

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3 Brushing up your calculating skills 54

Chapter overview and Spotlight 56
3A Starting activities 58
3B Tuning in 61
3C Refresher on ratios and proportions 64
3D Proportions and direct variation 74
3E Indirect variation 79
3F Refresher on calculating with percentages 84
3G Percentage change 91
3H Percentage error 100
Investigations 107
Chapter review 112

4 Using and applying algebraic thinking 120

Chapter overview and Spotlight 122
4A Starting activities 124
4B Tuning in 126
4C Writing algebraic expressions 130
4D Writing and solving equations 137
4E Transposing equations and formulas 143
4F Seeing equations and formulas visually 149
4G Using and applying simultaneous equations 171
Investigations 184
Chapter review 190

5 Collecting data 198

Chapter overview and Spotlight 200
5A Starting activities 202
5B Tuning in 205
5C The statistical cycle 208
5D Types of data 213
5E The purpose of data collection 216
5F Data collection specifications 220
5G Developing and producing surveys 225
5H Can we believe the data? 231
Investigations 238
Chapter review 243

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6 Representing data 252

Chapter overview and Spotlight 254
6A Starting activities 256
6B Tuning in 260
6C Collating data in tables 262
6D Refresher on common graphical representations 271
6E Creating graphs and charts using Excel and Word 287
6F Contemporary graphs 303
Investigations 316
Chapter review 321

7 Analysing and interpreting data 332

Chapter overview and Spotlight 334
7A Starting activities 336
7B Tuning in 337
7C Interpolation and extrapolation 339
7D Measures of central tendency 345
7E Measures of spread 362
7F Seeing the bigger picture 377
7G Telling the story 382
7H Twisting the data 391
Investigations 401
Chapter review 405

8 Connecting chance and data 416

Chapter overview and Spotlight 418
8A Starting activities 420
8B Tuning in 423
8C Refresher on working with probability and chance 426
8D Long-term data 448
Investigations 462
Chapter review 465

Revision of Chapters 1–8 474

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9 Managing your money **480**

Chapter overview and Spotlight 482
9A Starting activities 484
9B Tuning in 485
9C Interest and repayments 488
9D Comparing credit options 507
9E Student loan schemes 513
9F Wage growth and the cost of living 521
Investigations 527
Chapter review 531

10 National and global financial and consumer issues **540**

Chapter overview and Spotlight 542
10A Starting activities 544
10B Tuning in 546
10C Comparing products and services 548
10D Responsibilities to our society: Understanding taxes and more 560
10E National and global money factors 572
10F Risk versus reward 578
10G Environmental and health issues 588
Investigations 602
Chapter review 606

11 The maths of business **614**

Chapter overview and Spotlight 616
11A Starting activities 619
11B Tuning in 622
11C Financial planning and business revenue 625
11D Expenses and the BAS 641
11E Financial statements 654
Investigations 666
Chapter review 670

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

12 Using and applying shape and geometry skills **678**
Chapter overview and Spotlight 680
12A Starting activities 682
12B Tuning in 684
12C Shapes and objects in the world 687
12D Transforming shapes 700
12E Angle properties 706
12F Using maps and map applications 713
12G Reading and working with plans 721
12H Creating 3D from 2D 730
Investigations 734
Chapter review 737

13 Using and applying measurement skills **746**
Chapter overview and Spotlight 748
13A Starting activities 750
13B Tuning in 752
13C Measuring 754
13D Converting units 761
13E Calculating length and area 770
13F Calculating volume, capacity and density 786
13G Measurement error, accuracy, precision and tolerance 795
Investigations 802
Chapter review 806

Revision of Chapters 9–13 815
Revision Units 3 and 4 821
Answers 830

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

About the authors

Justine Sakurai

Justine has extensive experience teaching in Victorian secondary schools across multiple settings. She is currently researching and working in tertiary teacher education and teacher professional learning. She is deeply interested in the importance of numeracy education and the role of using authentic real-life contexts in the classroom. Justine has written curricula and teacher support materials at the Victorian state level and is also an educational consultant in numeracy improvement. Her resources and teacher professional learning have been targeted at VCAL, VM, VPC and VCE mathematics. She is currently the editor of the Victorian Maths Teacher Association (MAV) secondary journal, *Vinculum*.

Dave Tout

Dave is an experienced numeracy and maths educator who is particularly interested in making maths relevant, interesting and fun for all students – especially those students who are disengaged from mathematics. He has 50 years' educational experience, mainly in the VET sector, working in schools, TAFEs, community providers, universities and workplaces, and national research organisations such as the ACER (Australian Council for Educational Research). Dave has written numerous teaching resources and numeracy and maths curricula including for the VCE and VCAL (and its successor).

Megan Blanch

Megan is an experienced secondary mathematics and science teacher of over 12 years. She has worked in a range of education settings including Government, Independent and Catholic secondary schools as well as a support and development role with an educational software company. She has presented at numerous conferences including MAV, MASA and Primary Mathematics Teacher Conferences. She is passionate about making mathematics engaging, relevant and accessible for all students.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mal Hand

Mal started teaching in 1975, and quickly found that she had a knack for engaging reluctant students with maths. She has taught maths in secondary schools, RTOs and TAFEs. Having taught VCAL since its inception, Mal is a committed advocate of applied learning and has presented many professional development sessions for the Victorian Applied Learning Association. She believes students can metaphorically fold up what they have learned in her maths classes, put it in their pockets, and take it out into their real worlds.

Jim Spithill

Jim has taught in a variety of schools around Melbourne for over four decades. Starting as a test developer at the Australian Council for Educational Research (ACER) in 2010, he worked on a wide range of assessments, from the formality of NAPLAN and PISA, to the CSPA, which is used at TAFE as a placement assessment with a workplace focus, up until his retirement. Jim believes that well-planned resources set in meaningful contexts enable students to feel good about themselves as they are interacting with and learning mathematics.

Pamela McGillivray

Pamela came late to teaching maths, having previously worked in the computer industry and quality assurance fields. She has taught maths at all levels in secondary school and has been able to share her previous work experience to make the maths real for students. Pamela currently teaches in a Melbourne metropolitan secondary college.

Consultants and reviewers

The authors and publisher wish to thank **Carly Sawatzki** for her expertise and assistance on the financial mathematics chapters, and **Zoe Withers**, **Brian Hodgson** and **Jennifer Nolan** for their significant contributions across all chapters.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Introduction

Cambridge Senior Mathematics for VCE Foundation Mathematics Units 3 & 4 provides a wholistic approach to teaching and learning Units 3 and 4 of the VCE Foundation Mathematics course. The underpinning philosophy of this book, as with the companion textbook for Units 1 and 2, is that all students can successfully engage with and learn mathematics, and that a wide range of numeracy skills are essential for effective participation in modern life.

This book acknowledges that students learn best when the mathematics is connected to their lives. The scenarios, examples, questions and investigations are drawn from contexts that students may encounter in life, at home, in the community, or at work, and in Units 3 and 4 contexts range from the personal to the global.

Each chapter begins by introducing students to the topic through introductory activities, examples of 'epic successes' of the use of mathematics drawn from real life, and a revision of requisite prior knowledge. The teachers' expertise is acknowledged and through these starting activities, the teacher can ascertain a student's cognitive understanding of the topic. Marking rubrics for these activities are provided in the Online Teaching Suite.

A problem-solving approach is employed throughout the book to facilitate Outcome 2 of the study design. Using a problem-solving cycle with the key steps of identifying the mathematics, undertaking the mathematics, and reflecting and communicating the results of the problem, students should connect the mathematics content to the real-life contexts from which problems are drawn.

As in the Units 1 & 2 textbook, a set of 'Tasks and questions' replace traditional exercises and address the study design requirements. These tasks and questions include the following components: Thinking tasks to set the scene and ask students to consider the mathematical concepts from a broad perspective; Skills questions for traditional explicit practice; Mathematical literacy tasks to encourage students to engage with comprehension of the words supporting the mathematics; and Application tasks, which provide opportunities for students to engage with the mathematics in contexts found in life. Mixed practice questions are also included for activating memory pathways to strengthen cognitive understanding.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

The use of different technologies is found throughout the book, addressing the requirements of Outcome 3 in the VCE Study Design. The tools and technologies used in life and at work move beyond traditional calculators or computer algebra systems, and encompass software applications found on computers, handheld devices and in specialised equipment. Industry has long called for students to have flexibility and adaptability with using technology in workplaces and this book, and the associated online support materials, aim to address this.

Each chapter concludes with two sample student-focused investigations using the problem-solving cycle. The first is scaffolded for student support, and the second is more open-ended to reflect the reality of mathematical problems found in life. A revision section – including a summary of the key ideas, and review questions categorised under success-criteria statements – along with a mathematical toolkit and a glossary of key vocabulary are provided at the end of each chapter.

Three sets of VCAA exam-style questions are included to give students the opportunity to demonstrate their knowledge by answering questions like the ones they will face in their final exam. The first set comes after Chapter 8 and covers topics across the first eight chapters, the second comes after the final chapter and covers the second half of the book, and the last set covers the entirety of Units 3 and 4.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

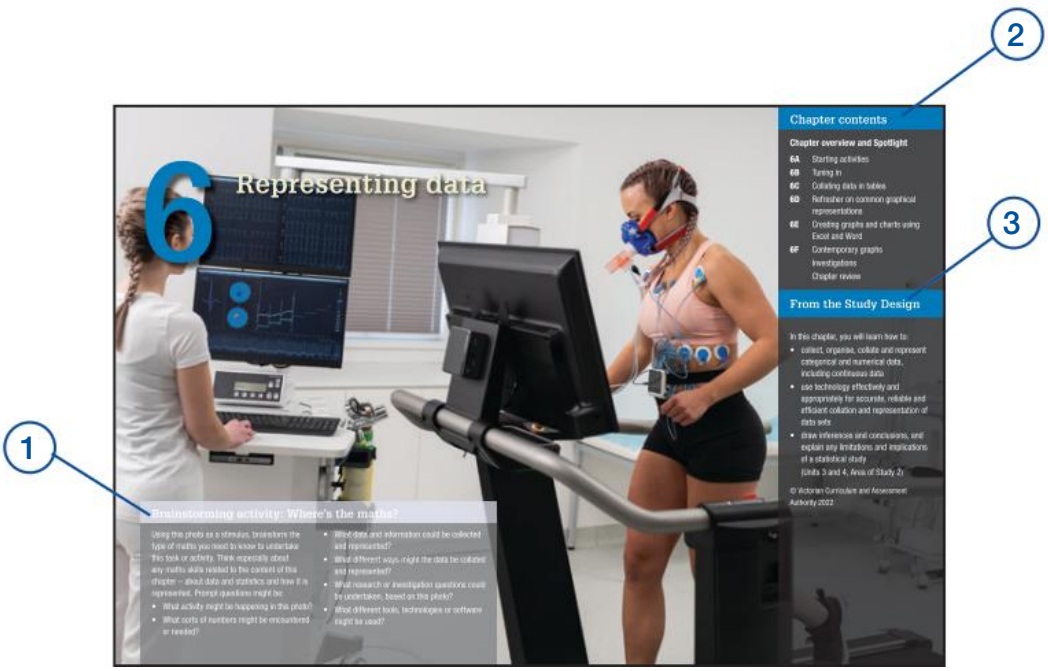
Guide to this resource

PRINT TEXTBOOK

1 **Brainstorming activity: 'Where's the maths?'** sets context for students about how the topic connects with the real world and the history of mathematics

2 **Chapter contents** provide an overview of what is covered in the chapter

3 **'From the Study Design'** shows what parts of the Foundation Mathematics Units 3 and 4 Study Design are covered by the chapter

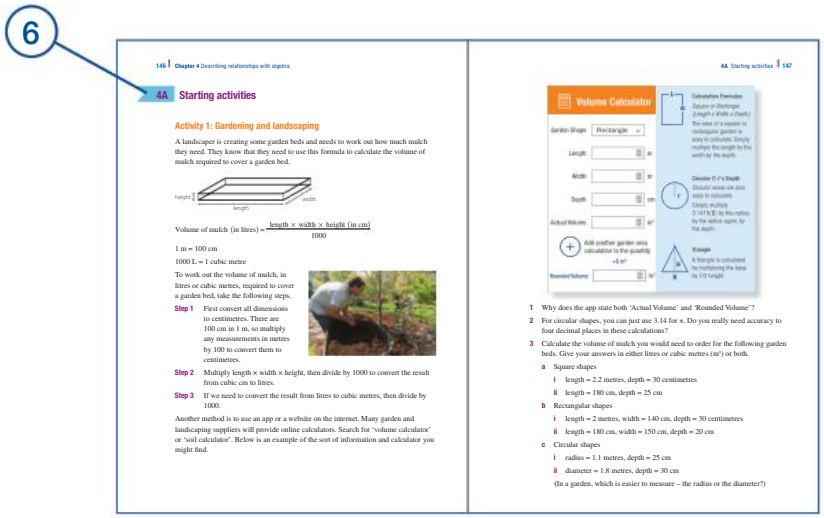


4 **Learning intentions** at the start of the chapter set out what a student will be expected to learn in the chapter

5 **Spotlight interviews** at the start of chapters feature professionals who explain how they use mathematics connected to the chapter in their day-to-day work, including their use of technology to make their jobs easier

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

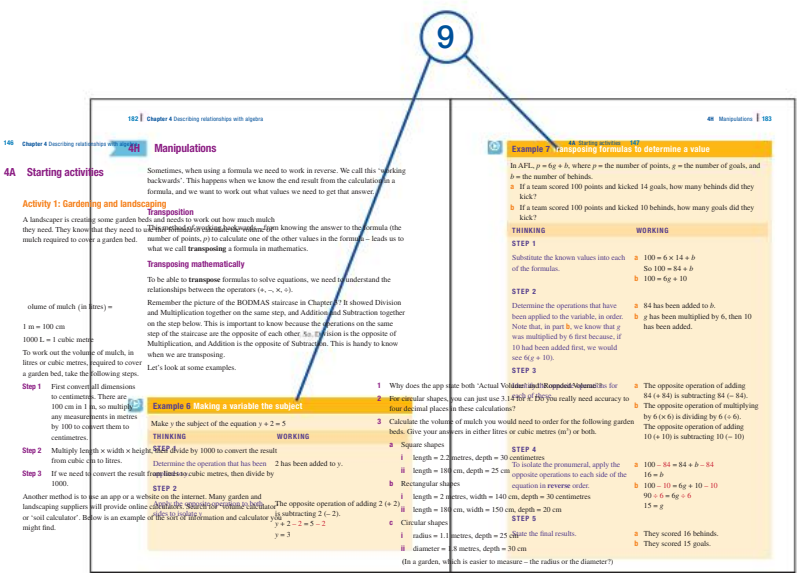
6 **Starting activities** act as pre-tests to assist the teacher to ascertain their students' understanding of prior knowledge before beginning the chapter; marking rubrics are provided in the Online Teaching Suite



7 A **'Tuning In'** section in each chapter includes an 'Epic Success' (in contrast with the 'Epic Fails' found in the Units 1 & 2 textbook), which shows the value of good mathematics, and revision of requisite prior knowledge for the chapter

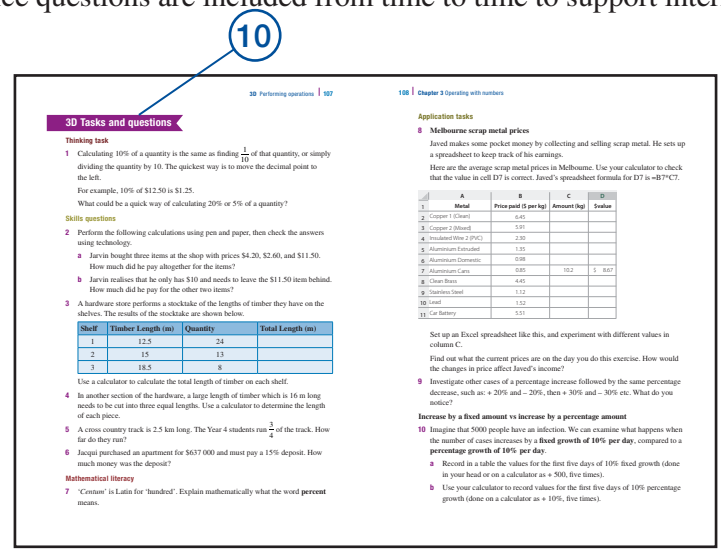
8 **Context-first approach** in each lesson allows for authentic, meaningful connections to be made with the mathematics right from the start of the lesson

9 **Worked examples** contain solutions and explanations of each line of working, along with a description that clearly describes the mathematics covered by the example

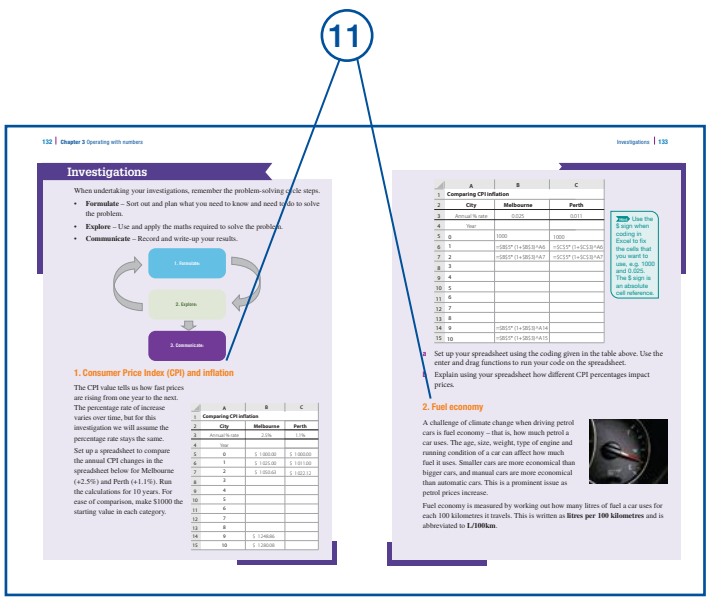


ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

10 **Tasks and questions** in each section replace traditional exercises, and include a Thinking Task, Skills questions, Mathematical literacy activities, and Applications questions. Mixed practice questions are included from time to time to support interleaving



11 **Two Investigations** are provided at the end of each chapter to assist students to meet the requirements of the study design; the first investigation is scaffolded and the second more open-ended, and both provide practice at implementing the problem-solving cycle



12 **Key concepts** summarises the critical information from the chapter, including important formulas and definitions

13 **Success criteria and review questions** allow students to check their understanding of the chapter by completing review questions connected to 'I can …' statements

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

14 **Mathematical toolkit** allows students to reflect on the range of different calculations, technologies and tools they used throughout each chapter.

15 **Key vocabulary** includes a list of the mathematics terms used in the chapter and their definitions

16 **Three sets of VCAA exam-style questions** are provided in the Units 3 & 4 textbook: one midway through covering the first eight chapters, one after the final chapter covering the last five chapters, and then a final set covering all of Units 3 and 4

INTERACTIVE TEXTBOOK

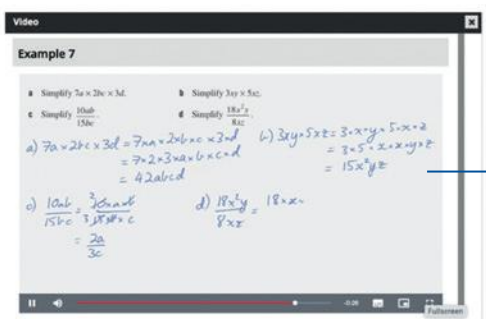
17 **Workspaces** allow questions to be completed inside the Interactive Textbook by using either a stylus, a keyboard and symbol palette, or uploading an image of the work

18 **Self-assessment:** students can self-assess their own work and send alerts to the teacher.

19 An **auto-marked practice quiz** in every lesson gives students immediate feedback with how they're going

20 **Worked example videos**: every worked example is linked to a high-quality video demonstration, supporting both in-class learning and the flipped classroom

21 **Desmos graphing calculator, scientific calculator** and **geometry tool** are always available to open within every lesson



20

DOWNLOADABLE OFFLINE TEXTBOOK

22 In addition to the Interactive Textbook, a **PDF version of the textbook** has been retained for times when users cannot go online. PDF search and commenting tools are enabled

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

ONLINE TEACHING SUITE

23 **Learning Management System** with class and student analytics, including reports and communication tools

24 **Teacher view of students' work and self-assessment** allows the teacher to see their class's working out, how students in the class assessed their own work, and any 'red flags' that the class has submitted to the teacher

25 **Revamped task manager** allows teachers to incorporate many of the activities and tools listed above into teacher-controlled learning pathways that can be built for individual students, groups of students and whole classes

26 **Worksheets and chapter tests** for every chapter are provided in editable Word documents

27 **Marking rubrics** are provided for diagnostic Starting Activities, sample Investigations, and more

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Acknowledgements

The author and publisher wish to thank the following sources for permission to reproduce material:

Cover: © Getty Images / wwing

Images: © Getty Images / SolStock, Chapter 1 Opener / Johnnygreig, p.889 / Fotograzia, p.891 / Solstock, p.892(1) / Tim Platt, p.892(2) / Andrew Merry, p.892(3) / Barry Austin Photography, p.893(1) / Chris Henderson, p.893(2) / Winslow Productions, p.898 / Aflo, p.900 / Ljubaphoto, p.902 / Leopatrizi, p.903(1) / Brett Monroe Garner, p.903(1) / Westend61, p.904(1), p.912 / Alenapaulus, p.904(2) / Heritage Images, p.916 / Naomi Rahim, p.918 / Caroline Purser, p.921 / Sutthichai Supapornpasupad, p.924 / Tom Werner, p.926 / Firstsignal, p.928(2) / Sean Anthony Eddy, Chapter 2 Opener / Nils Versemann, p.6(1) / Monkeybusinessimages, p.6(2) / AlexPhotoStock, p.6(3) / Fotografia Inc., p.8(1) / Michele Constantini, p.8(2) / Mf3d, p.11 / Bloomberg, p.13(1) / Chris Jackson, p.13(2) / Zen Rial, p.13(3) / Katrin Ray Shumakov, p.13(4) / Ron Watts, p.14(1) / Tetra Images, p.14(2) / Maria Stavreva, p.15 / Extracoin, p.16(1) / Tifonimages, p.16(2) / Elena Noviello, p.17 / Steve Weaver, Canterbury, Uk, p.21 / Mike Harrington, p.22 / Fg Trade, p.23 / Jokmedia, p.26 / Fcafotodigital, p.30 / Image Source, p.32, p.33 / Imamember, p.35 / Enjoynz, p.36 / Nenov, p.40 / Antonin Thuillier, p.41 / AzmanL, Chapter 3 Opener / ArtistGNDphotography, p.56 / Avalon, p.59, p.100 / Interim Archives, p.61(1) / Donaldson Collection, p.61(2) / Roy Morsch, p.63 / Food style and photography, p.64 / Olga Rolenko, p.67(1) / DebbiSmirnoff, p.67(2) / Vithun Khamsong, p.69 / AlasdairJames, p.71 / Peter Dazeley, p.73(1) / Formatoriginal, p.73(2) / Lighthousebay, p.74 / Thurtell, p.78(1) / David Arky, p.78(2) / Jamievanbuskirk, p.78(3) / Thomas Trutschel, p.79 / Penpak Ngamsathain, p.81 / Elke Meitzel, p.82 / Umkehrer, p.83 / Simon McGill, p.84 / Burke, p.89, p.110 / Phil Boorman, p.90 / Merovingian, p.91 / Image Source, p.94 / LeoPatrizi, p.98 / Lena_Zajchikova, p.99 / Jeff Greenberg, p.106 / Egiss, p.107 / SolStock, Chapter 4 Opener / LaylaBird, p.122 / Jędrzej Budzik, p.125 / Image Source, p.126(1) / Universal History Archive, p.126(2) / Neil W Zoglauer, p.127(A) / Aaron Foster, p.127(B) / Andresr, p.127(C), p.133, p.183(1), p.191(3) / Hershin, p.127(D) / SimpleImages, p.128(E) / John W Banagan, p.128(F) / Tracielouise, p.128(G) / Ginevre, p.128(H) / Wavebreakmedia, p.129(1) / PhotoAlto/Ale Ventura, p.129(2) / Bloodstone, p.130 / Image Source, p.132 / Tan Dao Duy, p.136 / Tara Moore, p.137(1) / Stuart Walmsley, p.137(2) / James Braund, p.143 / Jayk7, p.144 / Karl Tapales, p.148 / Rosa María Fernández Rz, p.153 / Tanukiphoto, p.154 / Mint Images, p.155 / Westend61, p.169 / Luis Ascui, p.170 / Alena Frolova, p.171 / Boulder Daily Camera, p.172 / Youst, p.175 / We Are, p.181 / VCG, p.183(2) / Ilfede, p.184 / Alistair Berg, p.191(1) / Vm, p.191(2) / TommL, Chapter 5 Opener / Gorodenkoff, p.200 / John W Banagan, p.202 / Scott E Barbour, p.203 / Rick Friedman, p.205 / Sean Gladwell, p.206 / Alubalish, p.207(1) / Silverlining56, p.207(2) / Tolgart, p.207(3) / Hispanolistic, p.211 / Delmaine Donson, p.214 / Cuhrig, p.216 / AndreyPopov, p.217 / Heather Paul, p.220 / Yellow Dog Productions, p.222 / Zachary Miller, p.225 / petrroudny, p.226 / SolStock, p.229 / Deagreez, p.230 / Alashi, p.231 / LumiNola, p.234 / John Giustina, p.237 / Andriy Onufriyenko, p.239 / Tashi-Delek, Chapter 6 Opener / Todd Wright, p.256 / Universal History Archive, p.260(1) / Peter Dazeley, p.260(2) / Ashley Cooper, p.261 / Madiz, p.262 / Halfpoint Images, p.265(1) / GlobalP, p.265(2) / Bloodstone, p.266 / Alina555, p.267 / Simon McGill, p.271 / Shannon Fagan, p.272 / Tara Moore, p.276 / Natalie Fobes, p.278 / Issarawat Tattong, p.280 / SimpleImages, p.281 / Golfcphoto, p.282 / Westend61, p.286 / Abdullah Durmaz, p.287 / Scott Barbour, p.288 / Maskot, p.298 / Tiripero, p.299 / Sutthichai Supapornpasupad, p.301 / Boggy22, p.302 / Oliver Strewe, p.308 / JackF, p.311 / ArtistGNDphotography, p.315 / Urilux, p.327 / Westend61, Chapter 7 Opener / Lianne B Loach, p.336 / Giuliano Benzin, p.337 / Jay Yuno, p.338 / Adisa, p.339 / SimonSkafar, p.344 / Pongnathee Kluaythong, p.343 / Bloomberg, p.345, p.346, p.373 / Daniel Pockett, p.348 / Joesboy, p.361 / Dimensions, p.362 / Robert Cianflone, p.370 / Prostock-Studio, p.371 / James Yu, p.372 / Takashi Aoyama, p.376, p.408 / Dardespot, p.377 / Paul Bradbury, p.379 / Bekefi, Adel, p.381 / Jose Luis Pelaez Inc, p.387 / Louise Beaumont, p.389 / Deagreez, p.390 / Creativ Studio Heinemann, p.393(1) / Caracarafoto, p.393(2) / Mensent Photography, p.397 / Clive Mason, p.400 / Steve Waters, Chapter 8 Opener / Linearcurves, p.420 / Sammie Martin, p.422 / Sukanya Sitthikongsak, p.423 / Wayne Eastep, p.424 / Stockbyte, p.428 / Macca236, p.429(1) / Pamspix, p.429(2) / Fcafotodigital, p.430 / OsakaWayne Studios, p.435 / Maskot, p.436 / Javier Zayas Photography, p.444 / SOPA Image, p.454(1) / Luis Ascui, p.454(2) / Andrey Sayfutdinov, p.457(1) / MStudioImages, Chapter 9 Opener / Oscar Wong, p.482 / Malte Mueller, p.484 / Nenov, p.487(a) / Rouzes, p.487(b) / boonchai wedmakawand, p.487(c) / Yevgen Romanenko, p.487(d) / AleksandarGeorgiev, p.487 / Traceydee Photography, p.488 / Sitox, p.489 / Nora Carol Photography, p.490 / Suwichaw, p.496 / Pattarisara Suvichanarakul, p.505 / Lioputra, p.507 / EyeOfPaul, p.508 / Bloomberg, p.509 / Marilyn Nieves, p.513 / PeopleImages, p.516 / Sturti, p.518, p.524, p.525 / Kong Ding Chek, p.519 / Peter Dazeley, p.520(1) / Holloway, p.520(2) / Yoshiyoshi Hirokawa, p.521 / SunnyVMD, p.526 / Eduard Figueres, p.527 / Courtneyk, p.529 / Brenton Edwards, Chapter 10 Opener / AFP, p.544 / Handout, p.545 / Torsten Blackwood, p.548 / Westend61, p.550 / Sefa Ozel, p.554 / Andresr, p.556 / John Clutterbuck, p.559 / Sturti, p.563 / Rafael Ben-Ari, p.566 / Mikael Vaisanen, p.568(1) / MirageC, p.568(2) / Izusek, p.569 / Vertigo3d, p.578(1) / MicrovOne, p.581 / Torsten Asmus, p. 582 / Oxygen, p.583 / Tracielouise, p.586 / Brett Monroe Garner, p.588 / Xavier Lorenzo, p.587 / Michael Hall, p.590(1) / Bloomberg, p.593(1) / Alvaro Gonzalez, p.593(2) / Unalozmen, p.597(2) / Alistair Berg, p.596 / Omersukrugoksu, p.601 / Imagevixen, p.602 / Davidf, p.604 / Krisanapong Detraphiphat, Chapter 11 Opener / Peter Dazeley, p.621 / Sjoerd van der Wal, p.622 / Kittipong Likitwannawong, p.623 / FG Trade, p.624 / Annabogush, p.625 / Helen King, p.629 /

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Westend61, p.630 / Bet_Noire, p.632 / Richard Villalonundefined undefined, p.634 / Maskot, p.637 / ljubaphoto, p.641 / Witthaya Prasongsin, p.644 / skynesher, p.648 / kupicoo, p.651 / ArtistGNDphotography, p.653 / M_a_y_a, p.652 / JMichl, p.655 / Jon Feingersh Photography Inc, p.658 / Peathegee Inc, p.662(1) / Pekic, p.662(2) / Dougal Waters, p.664 / Lisegagne, p.665 / Tara Higgins Hill, p.666 / SDI Productions, p.668 / Westend61, Chapter 12 Opener / DieterMeyrl, p.680 / Madiha Ali, p.682(1) / BanksPhotos, p.682(2) / Roslan Rahman, p.683 / Gavinmay, p.684 / Nitat Termmee, p.686(1) / Naomi Rahim, p.687(1) / Helder Faria, p.687(2) / Olga Shumytskaya, p.688(1) / Matteo Colombo, p.688(2) / Yuanyuan Yan, p.688(3) / Seksan Mongkhonkhamsao, p.688(4) / John C Magee, p.689(1) / Boy_Anupong, p.689(2) / Verushka, p.689(3) / Borirak, p.689(4) / Tracey Nimmo, p.689(5) / Anna Linda Knoll, p.689(6) / Abstract Aerial Art, p.690(1) / SENEZ, p.690(2) / Peter Dazeley, p.690(3) / Far700, p.690(4) / Ruhey, p.690(5) / Artpartner-Images, p.690(6) / Digital Vision, p.691(1) / Gulfu Photography, p.691(2) / DavidZydd, p.691(3) / Simon McGill, p.691(4) / Drpnncpp, p.691(5) / Michael Urban, p.691(6) / Carduus, p.695 / Kok Kai Ng, p.699 / Gary Yeowell, p.700(1) / John White Photos, p.700(2) / Isabel Pavia, p.701(1) / Hispanolistic, p.701(2) / Wedninth, p.705(a) / Jung-Pang Wu, p.705(b) / Igorbondarenko, p.706(1) / Gusztav Hegyi, p.706(2) / CaronB, p.707(1) / MarioGuti, p.707(2) / Ekspansio, p.708 / Thomas De Wever, p.710(a) / MsNancy, p.710(b) / Michael Duva, p.711(c) / Wendi Duan, p.711(d) / Mykola Romanovskyy, p.711(e) / Alex Walker, p.711(f) / Wirestock, p.711(g) / Vithun Khamsong, p.711(h) / Liyao Xie, p.711(i) / Shaunl, p.711(j) / Nastasic, p.712(a) / Xia Yuan, p.712(b) / Smartshots International, p.712(c) / Sukanya Sitthikongsak, p.715 / Medesulda, p.724(1) / Pamspix, p.724(2) / H. Armstrong Roberts, p.724(3) / GavinD, p.727(a) / Westend61, p.727(b) / Portishead1, p.730(1) / Maciej Frolow, p.730(2) / Horned_Rat, p.730(3) / Tarras79, p.736 / Avalon, Chapter 13 Opener, p.749 / Bloomberg, p.750, p.795 / Newscast, p.751 / Comezora, p.752 / Peter Dazeley, p.755(1), p.758(b), p.790(2), p.793(b) / MakcouD, p.755(2) / Elizabeth Fernandez, p.755(3) / Science Photo Library, p.756(1) / Bill-Livingstone, p.756(2) / Yagi Studio, p.756(3) / VisualField, p.756(4) / Michael Burrell, p.756(5) / Yevgen Romanenko, p.756(6) / Chuchart Duangdaw, p.757(1) / Bembodesign, p.757(2) / Annick Vanderschelden Photography, p.757(3), p.757(4), p.758(d) / JoKMedia, p.758(a) / Deepblue4you, p.758(c) / Nugroho Ridho, p.758(e) / Alexey Kabanov, p.759 / MassanPH, p.760(a) / Ilbusca, p.760(b) / Eduardo R, p.760(c) / AngelPietro, p.760(d) / Tetra Images, p.761 / NurPhoto / Contributor, p.762 / MirageC, p.767 / Danchooalex, p.769(1) / Burazin, p.769(2) / Bill Oxford, p.770 / Douglas Sacha, p.784(e) / Flavio Coelho, p.784(f) / Annick Vanderschelden Photography, p.785 / Rtyree1, p.786(1) / DonNichols, p.786(2) / SOPA Images, p.788 / Empire331, p.788 / RHJ, p.790(1) / Image Source, p.792(a) / To_Csa, p.792(c) / Yuichiro Chino, p.793(a) / Aitor Diago, p.793(c) / Djmilic, p.793 / Narvikk, p.794(1) / Mura, p.794(2) / Stockcam, p.798 / Photodisc, p.800 / AndrewJohnson, p.801 / Andrii Borodai, p.802 / Barry Winiker, p.804 / Jonathan Kitchen, p.808(a) / Ultra.F, p.808(b); 'Burj Khalifa Height' by Rama licensed under CC BY-SA 3.0, via Wikimedia Commons, p.58; 'Dorothy Johnson Vaughan' by Euell A. Dixon, via Wikimedia Commons, p.62; 'The Compendious Book on Calculation by Completion and Balancing' by Al-Khwarizmi, via Wikimedia Commons, p.127(1); Reproduced with the permission of Longitudinal Surveys of Australian Youth website, NCVER, Adelaide, p.210; Reproduced with the permission of WHO child growth standards:height-for-age © World Health Organization 2006, p.256(2); 'Miss Nightingale, in the hospital, at Scutari' by The Illustrated London News, via Wikimedia Commons, p.319; Reproduced with the permission of SEEK, p.362(1), p.362(2), p.362(3); Imagery © 2024 TetraMetrica, Map data © 2024 Google, p.715(2); Reproduced with the permission of the Bureau of Meteorology, p.448; 'Our world in data' / Creative Commons Attribution 4.0 International, p.456(1), p.456(2); Reproduced with permission of ASIC for each reproduced extract: Moneysmart website, moneysmart.gov.au, 17 June 2024', p.497, p.501, p.502(1), p.502(2), p.502(3), p.497; 'Sustainable Development Goals' by © United Nations, via Wikimedia Commons, p. 546; © State of Victoria (Department of Energy, Environment and Climate Action) / Creative Commons Attribution 4.0 international licence, p.549(2); Licensed from the Commonwealth of Australia under a Creative Commons 3.0 licence. This material is available from the Private Health Insurance Ombudsman website at https://privatehealth.gov.au/, p.551; © Australian Taxation Office for the Commonwealth of Australia, p.560; © Reserve Bank of Australia / Creative Commons Attribution 4.0 International License, p.572, p.575, p.576(1), p.577; Used from Credit Suisse Global Wealth Databook 2021, p.573; Used from Visual Capitalis, p.574; Used from Copyright © United Nations, p.589; 'Water Use on Australian Farms 2020–21 financial year', © Commonwealth of Australia / Creative Commons Attribution 4.0 International licence, p.590(2), p.591(1); © Department of Agriculture, Fisheries and Forestry 2023 / Creative Commons Attribution (CC-BY) 4.0 International licence, p.591(2); Reproduced with the permission of Solar Choice, p.595; © Commonwealth of Australia / Creative Commons Attribution 4.0 International licence, p.597(1); Downham, R & Gupta, M 2021, Trends in water entitlement holdings and trade: Analysis of ABARES survey data, ABARES research report, Canberra, July. CC BY 4.0. https://doi.org/10.25814/z815-1w77, p.598; Australian Sports Commission — www.ausport.gov.au / Attribution-NonCommercial-NoDerivs 3.0 Australia licence, p.599(1), p.599(2); Republished with permission from Geopolitical Futures, LLC, p.600; Finder.com.au. Extract from www.finder.com.au/health-insurance/best-health-insurance on 14/08/2024. Product information reflected may no longer be current and is subject to change at any time, p.607; Imagery © 2024 Airbus, CNES / Airbus, Maxar Technologies, Map data © 2024 Google, p.706(3); Reproduced with the permission of Public Transport Victoria PTV, p.716(1), p.716(2), p.717; Map data © 2024 Google, p.719; Reproduced with the permission of Smith Collective, p.721; 'Plan and North, East and South Elevations of Core, and Section' by Milnarik, Elizabeth, via Wikimedia Commons, p.723; Reproduced with the permission of Electrical Engineering Portal, p.726(1); ConceptDraw® DIAGRAM / Creative Commons Attribution Non-Commercial No Derivatives License, p.726(2); Reproduced with the permission of Strathbogie Shire Council and Department of Energy, Environment and Climate Action (DEECA), p.741; Reproduced with the permission of Transport Accident Commission (TAC), p.897; '2012 Toyota Corolla (ZRE152R) Ascent Sport 5-door hatchback' by OSX, via Wikimedia Commons, p.928(1).

Text: Data used from © Open Athens, p.204; Australian Bureau of Statistics (2023) 'Table 1.2 Australia's overseas-born population – top 10 countries of birth(a)', Australia's Population by Country of Birth / Creative Commons Attribution 4.0 International licence, p.934–935; Reproduced by permission of Transport Accident Commission (TAC) 'Age breakdown of Victorian road fatalities 2013 to 2023', p.219; Australian Bureau of Statistics (ABS) 'Employees by demographic characteristics and full-time or part-time' / Creative Commons Attribution 4.0 International licence, p.223; Data used from © 2024 Pew Research Center, p.224; Reproduced by permission of Bureau of Meteorology '2021 floods: cumulative rainfall vs. long-term averages', p.258; 'Cost Of Weather-Related Disasters In Australia, By Decade' Climate Council of Australia Limited / Creative Commons Attribution 3.0 Australia License. p.258–259; Reproduced by permission of Transport Accident Commission (TAC), 'Victorian road fatalities, by user (2017–2023)' and 'Total road fatalities, Victoria (2013–2023)', p.261; 'Gambling in Victoria: total losses', © Copyright State Government of Victoria / Creative Commons Attribution 4.0 license, p.261, p.261; 'Player loss and taxes ($ million) paid by category activity, 2021–22'. © State of Victoria (Victorian Gambling and Casino Control Commission) / Creative Commons Attribution 4.0 license, p.267; Australian Bureau of Statistics, 'Average weekly ordinary time earnings, full-time adults by industry, original' / Creative Commons Attribution 4.0 license, p.268–269; Australian Bureau of Statistics 'Household spending through the year by category, current price, calendar adjusted' / Creative Commons Attribution 4.0 license, p.269; 'Grams of protein per person per day', Food and Agriculture Organization of the United Nations / Creative Commons, p.270; Data used from Transport Accident

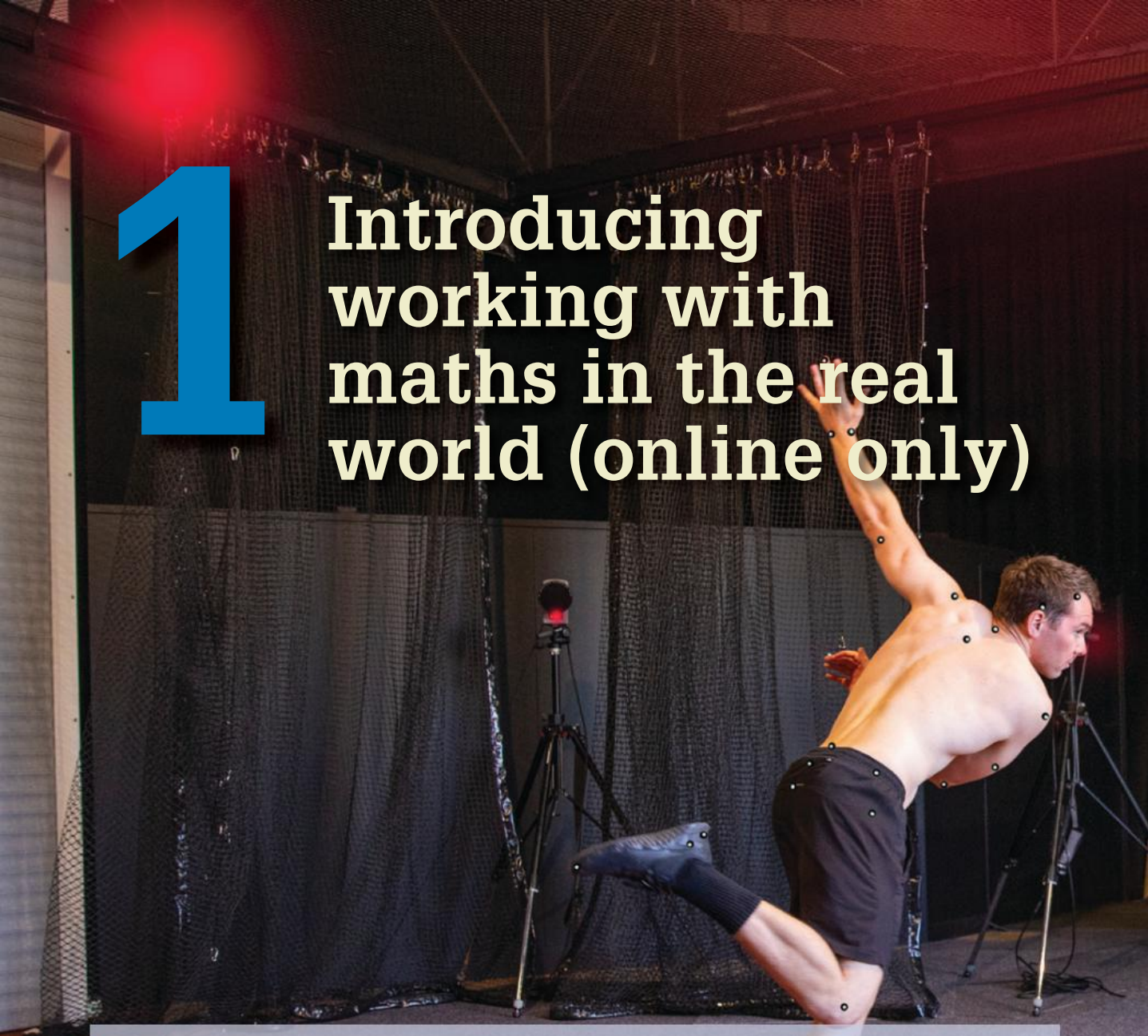
 © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Commission, p.273; Reproduced by permission of the Bureau of Meteorology, 'Swan Hill Post Office', p.274; Reproduced by permission of Excel Easy excel-easy.com, 'Annual population of bears from 2017 to 2022', p.278; Chart created with the QI Macros SPC Software for Excel developed by Jay Arthur, www.qimacros.com, p.279; Australian Bureau of Statistics (2017–18), 'Proportion of people who consume selected sugar sweetened drinks on a daily basis, 2017–18', / Creative Commons Attribution 4.0 International licence, p.281; 'Global Ev Sales And Market Share, 2010–2021', International Energy Agency / Creative Commons Attribution 4.0 license, p.282; Reproduced by permission of United States Census Bureau, p.282; Data used from 'Our world in data' / Creative Commons Attribution 4.0 International, p.284; Reproduced by permission of GWI data, 'Chart showing Jan 2019 Time spent with media', https://wearesocial.com/au/blog/2019/02/digital-report-australia/ p.286(1); Reproduced by permission of GWI data, 'Chart showing Jan 2023 Daily time spent with media', https://wearesocial.com/au/blog/2023/02/digital-2023-australia-1-in-3-australians-use-social-networks-for-brand-research/ p.286(2); Data used from Climate Council, p.301; 'Top three motivations for adults to engage in sporting activities', Australian Sports Commission – www.ausport.gov.au / Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Australia licence, p.302; Used from Contextures, p.304; 'Spider Chart' by Ordoon, via Wikimedia Commons, p.305; Reproduced by permission of 'Melbourne train patronage by line, excluding City (2018–2019)' Phillip Mallis, p.306; Reprinted from TidBITS; reuse governed by Creative Commons license. TidBITS has offered years of thoughtful commentary on Apple and Internet topics. For free email subscriptions and access to the entire TidBITS archive, visit tidbits.com., p.307; Reproduced by permission of the Bureau of Meteorology 'Mean monthly maximum temperatures in Melbourne, 2012–2021', p.308; Used from Global Software (Insight Software), p.309, p.313; Reproduced by permission of Bloomberg, 'Renewable energy trends', p.310; Used from Medium, p.312; Reproduced by permission of Microsoft, 'Breakdown of bookstore revenue', p.314; 'Aboriginal population over time', PHIDU / Creative Commons Attribution-NonCommercial-ShareAlike 3.0 Australia licence, p.317; Peltier Technical Services, Inc / Creative Commons Attribution-Noncommercial-Share Alike 3.0 Unported License., p.323; Reproduced by permission of Excel Easy excel-easy.com, 'What your car says about your salary', p.323; Reproduced by permission of Excel Easy excel-easy.com 'Wildlife population', p.325; Used from Global Software (Insight Software), p.326; Chart created using the QI Macros SPC Software for Excel developed by Jay Arthur, www.qimacros.com, p.327; Data used from 'Our world in data' / Creative Commons Attribution 4.0 International, p.341, p.342, p.344, p.407, p.456, p.576, p.609; 'Global capture fishery production', World Bank's World Development Indicators (WDI) / Creative Commons Attribution 4.0 International, p.357; 'Sulphur dioxide emissions', OECD Stats / Creative Commons Attribution 4.0 International, p.357; 'Road deaths per year in Australia' IHME, Global Burden of Disease (2019) / Creative Commons Attribution 4.0 International, p.360; Reproduced by permission of CSIRO 'Reconstructed global mean sea levels', p.361; 'Number of reports by the public to the EPA', © Copyright State Government of Victoria / Creative Commons Attribution 4.0 International licence, p.370; 'Bonds from rental properties in Victoria', © State of Victoria (Consumer Affairs Victoria) / Creative Commons Attribution 4.0 International licence, p.371; 'Waste and recovery in Victoria each year', © Recycling Victoria 2024 / Creative Commons Attribution 4.0 licence, p.374; 'Volume of water inflowing – Eastern Treatment Plant', Melbourne Water Corporation / Creative Commons Attribution 4.0 licence, p.375; © European Union, 1995–2024, p.380; Australian Bureau of Statistics, 'Height of students', Creative Commons Attribution 4.0 International licence, p.384; Used from Meta, p.385; Adapted with permission © NSW Clinical Excellence Commission 2024', p.386; 'Body Mass Index (BMI) for a sample of adults', 'Reproduced with the permission of John Wiley & Sons', p.386; Used from Data Science Discovery, p.386; Australian Bureau of Statistics, '*Negatively skewed distribution: Height of students*' / Creative Commons Attribution 4.0 International licence, p.388; Australian Bureau of Statistics, '*Data for number of students attaining Year 12'* Creative Commons Attribution 4.0 International licence, p.390; Used from Est.warhead, p.398; Used from ESPN Cricinfo (2019), p.400; 'Road deaths in Australia', Wikipedia / Creative Commons Attribution-ShareAlike License 4.0, p.423; Department of Transport and Main Roads (2015). Figures are based on the crashes validated in the Queensland Road Crash Information System from 1 January 2007–31 December 2011. Report reference number: rqC19729 and 'Reprinted from 'The handbook of road safety measures', Elvik, R. & Vaa, T. (Eds). (2004), with permission from Elsevier' Also Lancet special credit-The handbook of road safety measures, Elvik, R. & Vaa, T. (Eds). (2004), with permission from Elsevier, p.424; Reproduced by permission of the Bureau of Meteorology, 'Six-day weather forecast', p.426; Reproduced by permission of Sportsencyclo 'The top five Olympic sports in which Australia has won medals', p.434; Reproduced by permission of The Preventing Tobacco Addiction Foundation, 'Year 12 cigarette vs. E-cigarette use', p.446; Reproduced by permission of BBC News at bbc.co.uk/news, 'Ages of people dying of influenza in 1918 and 1919', p.447; 'Australian retirement assets' Parliament of Australia / Creative Commons Australia Attribution 3.0 Licence, p.449; Reproduced by permission of GFM Asset Management, 'Growth of $100 k, Dec 2007–Dec 2017', p.450(1); Reproduced by permission of Rainmaker, 'Superannuation vs. ASX market values in Australia, 2016–22', p.450(2); 'Reported polio cases and deaths in the US from 1910 to 2019', US Public Health Service, US Center for Disease Control and WHO / Creative Commons Attribution 4.0 International, p.452(1); 'Share of one-year-olds vaccinated against polio', World Health Organization, UNICEF / Creative Commons Attribution 4.0 International, p.452(2); Reproduced by permission of XDI (Cross Dependency Initiative), 'Potential coastal flooding of Melbourne suburbs', p.453; 'Population growth of some countries and regions in 1820 and 2021', HYDE (2023); Gapminder (2022); UN WPP (2024) / Creative Common Attribution 4.0 International, p.455; Source: Institute for Health Metrics and Evaluation. Used with permission. All rights reserved, p.459, p.460, p.461; 'Percentage of Australians who consume the RDI of fruit and vegetables', Australian Bureau of Statistics / Creative Commons Attribution 4.0 International licence, p.469; Reproduced by permission of VISA, p.509; Reproduced with the permission of © Australian Taxation Office for the Commonwealth of Australia, p.515, p.517; Reproduced by permission of Thankyou, 'Thankyou Water regarding impact of planet', p.545; 'ATO tax table for 2023-24', © Australian Taxation Office for the Commonwealth of Australia, p.562; 'Superannuation rate', © Australian Taxation Office for the Commonwealth of Australia, p.571; ABC RN / Michael Janda © 2019 Australian Broadcasting Corporation, p.578; Department of Climate Change, Energy, the Environment and Water.2022 / Creative Commons Attribution (CC-BY) 4.0 International licence, p.590; Data used from Australian Bureau of Statistics, p.591; Reproduced by permission of Australian Institute of Petroleum Ltd, 'Average weekly petrol price in Australia over a 6-month period from November 2023 to May 2024', p.593; Reproduced by permission of Solar Choice, 'Average cost of solar in Australia', p.595; Reproduced with the permission from the 2024 Rules of Tennis International Tennis Federation (ITF), p.798.

Every effort has been made to trace and acknowledge copyright. The publisher apologises for any accidental infringement and welcomes information that would redress this situation.

Selected extracts from the VCE Foundation Mathematics Study Design (2023–2027) are copyright Victorian Curriculum and Assessment Authority (VCAA), reproduced by permission. VCE® is a registered trademark of the VCAA. The VCAA does not endorse this product and makes no warranties regarding the correctness or accuracy of its content. To the extent permitted by law, the VCAA excludes all liability for any loss or damage suffered or incurred as a result of accessing, using or relying on the content. Current VCE Study Designs and related content can be accessed directly at www.vcaa.vic.edu.au. Teachers are advised to check the VCAA Bulletin for updates.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.



1 Introducing working with maths in the real world (online only)

Brainstorming activity: Where's the maths?

Using this photo as a stimulus, brainstorm how the mathematics required for this task is related to the content of this chapter. Prompt questions might be:

- What might be being investigated or researched?
- Can you think of some questions that they might want answered?
- What types of mathematics might be involved? For example:
  - Data
  - Chance and probability
  - Measurements such as time, distance and speed
  - Shape and design
- What calculations might be involved?
- What different tools, technologies or software might be used?
- What do you think the outcomes of such research would be? How might it be documented and written up or presented?

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter contents

This chapter takes you through the steps required to undertake the three Investigations you are expected to complete as part of your studies. The investigations are based around the problem-solving cycle and are a significant part of the formal assessment for VCE Foundation Mathematics. A number of sample investigations are introduced as a guide. This chapter is available in the digital version of this resource.

Chapter overview

1A Why you need to know some mathematics

1B Tuning in

1C Taking a problem-solving approach

1D Your investigations: Finding a context

1E Some important issues in maths problem solving

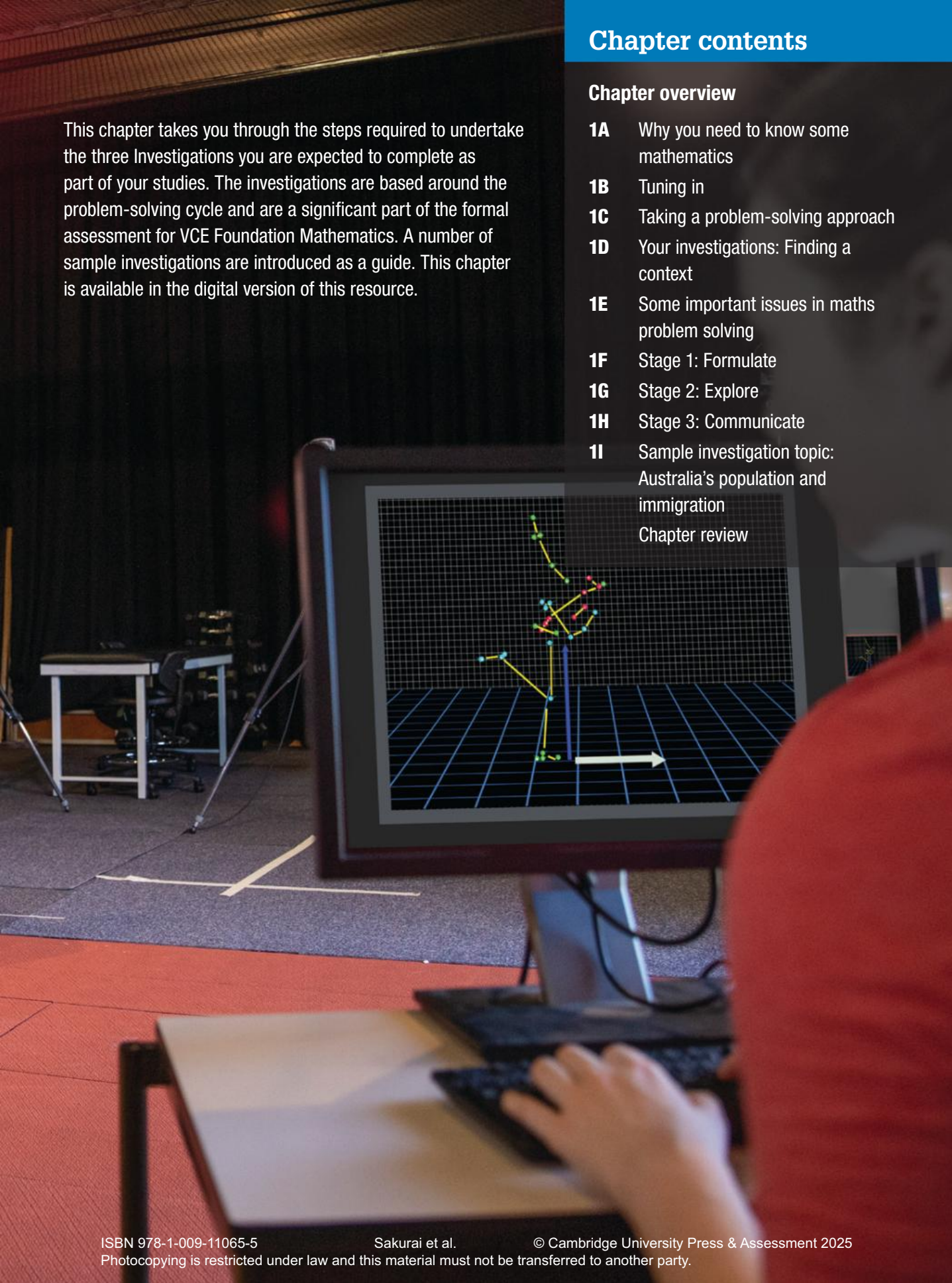
1F Stage 1: Formulate

1G Stage 2: Explore

1H Stage 3: Communicate

1I Sample investigation topic: Australia's population and immigration

Chapter review



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

2 Working with numbers

Brainstorming activity: Where's the maths?

Using this photo as a stimulus, brainstorm the type of maths we need to know to undertake this task or activity. Think especially about any maths skills related to the content of this chapter – different types of numbers, such as integers, decimals, fractions, proportions and percentages. Prompt questions might be:

- What might this person be doing in this photo?
- What materials would they need for this job?
- What measurements and calculations would they need to undertake?
- What about preparation and treatments?
- What about costs and charges?
- What about times and schedules?
- What formulas might be needed for any of the above?
- What different tools, technologies or software might be used?
- What research or investigation questions could be undertaken based on this photo?

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter contents

Chapter overview and Spotlight

2A Starting activities

2B Tuning in

2C Understanding rational and irrational numbers

2D Order of operations, powers and roots

2E Estimation and reasonableness

2F Very large and very small numbers

Investigations

Chapter review

From the Study Design

In this chapter, you will learn how to:

- use and apply the conventions of mathematical notations, terminology and representations
- make estimates and carry out relevant calculations using mental and by-hand methods
- use different technologies effectively for accurate, reliable and efficient calculations
- solve practical problems which require the use and application of a range of numerical and algebraic computations involving rational and real values of variables
- use estimation and other approaches to check the outcomes, including for accuracy and reasonableness of results
- evaluate the mathematics used and the outcomes obtained relative to personal, contextual and real-world implications (Units 3 and 4, Area of Study 1)

© Victorian Curriculum and Assessment Authority 2022

ISBN 978-1-009-11065-5 Sakurai et al.

© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transfe red to another party.

Chapter overview

Introduction

We encounter numbers every day.

You probably set your alarm to make sure that you have enough time for your morning routine. You might check the milk to estimate if there's enough for everyone to have cereal for breakfast. If you're unsure of what to wear, you might look up the Bureau of Meteorology weather forecast. And if you've noticed that there have been changes or issues with your public transport lately, you might check the PTV app before you head out.

Learning intentions

By the end of this chapter, you will be able to:

- read and use mathematical notation
- make estimates of calculations and check for reasonableness
- identify rational and irrational numbers
- use the order of operations to solve problems
- use scientific notation.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Spotlight: Kevin Rule

An interview with a taxonomist

Tell us about some of the work that you have done and currently do as a taxonomist.
I conduct research as a botany taxonomist of native eucalypts. This involves determining whether a type of plant being studied is sufficiently distinctive to be recognised as a new species or subspecies. In 1990, after a lot of field work and growing seedlings, I discovered and published a new species of eucalypt called *Eucalyptus wimmerensis*. Since then, I have published papers naming and describing another 44 naturally occurring eucalypts. Discovering new plants involves considerable detective work and my process starts with finding something I think is unusual or that doesn't fit with anything I know. I gather specimens, particularly seeds, of the unknown plant and go off to compare them with known specimens using seedling trials. I also analyse the plant carefully and gather data on its minute parts such as its leaves, bark, fruit and buds. Once I have determined that I have discovered something new, I prepare a manuscript to present my research.

How has maths played a part in your work?
In describing a new species, it is important to provide accurate information about its morphology (its physical features) in terms of measurement, such as how high the plant grows and the size of its leaves, buds and fruits. I also need to roughly estimate the area that the specimen occupies in the place that I found it and work out how many plants there might be in that area. This estimation is needed to provide conservation recommendations. If there are only a few plants of a new species that are sparsely spread in a large area, I would recommend that the species is 'critically endangered'. But if there are, say, 10 000 plants over 800 square kilometres, then by international standards that new species is not at risk of becoming extinct. I also need to be able to describe where the plant is located using distances (e.g. from roads or the nearest town), latitude and longitude.

What is the most useful maths-related tool or piece of technology that you use?
To pinpoint the location of particular plants, I use a GPS and Google Maps for distances. Google Maps also gives me the precise latitude and longitude of the location. I also use a program by Parks Victoria that helps with measuring distances and working out area of occupation for plants. To determine the measurements of the plant's physical features, I use a ruler and a micrometer.

What was your attitude towards learning maths at school? Has this attitude changed over time?
I opted out of studying maths after Year 11 as I found it uninteresting and irrelevant at the time. I only really got interested in maths when I went to university where I studied statistics as part of psychology. I regret not having done maths in all of secondary school and my attitude towards it has changed, particularly through my interest in taxonomy and botany where I need to understand research papers that use statistics and complicated ways of analysing data.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

2A Starting activities

In a wide range of recreational activities, mathematical knowledge and skills are involved. We know that sports games include lots of maths such as the numbers related to scoring and the points awarded for winning, the data collected about players' performance and the size and shape of the playing fields. But other games also include lots of maths skills. For example, card games often involve chance and probability alongside needing to know about numbers and counting etc. In games like poker, blackjack or bridge, understanding the probability of certain card combinations or outcomes can help players make better decisions. Games that use dice, such as Yahtzee, Dungeons & Dragons and backgammon, or in relation to gambling, craps, are classic games that involve probability.

Nowadays, mathematics is an essential element in gaming, using probability theory and game theory, statistics, and more. It is a critical aspect of gaming that players must understand to improve their chances of succeeding.

Activity 1: Dice games

In small groups, play the following dice games to strengthen and sharpen your maths skills!

Game A. Closest to 100

Each player rolls four dice.

Using the operations of $+, -, \times, \div, x^2, \sqrt{\ }$ and your four numbers, find the combination that gets you closest to 100. You must use all the numbers.

e.g. Roll 6, 4, 3, 5

$6 \times 5 \times 3 + 4 = 94$

Alternative 1. Roll six dice and closest to 500

Alternative 2. Roll five dice, closest to 200 and using any mathematical operations

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Game B. Five dice (also known as Greed)

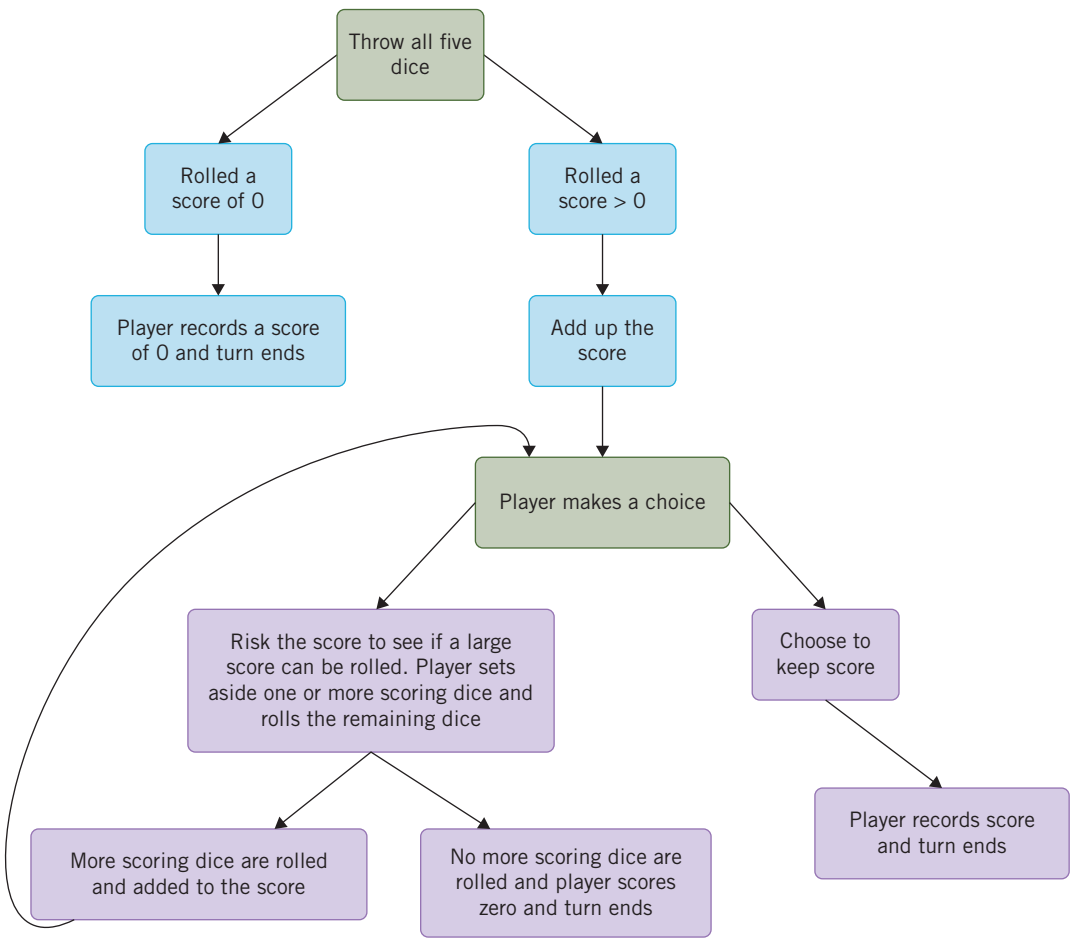
Five dice is a very old dice game played for many generations. It is played with two players. The aim is to be the highest score after a set number of rounds. When you first play this game, start with 20 rounds each, but adjust the number of rounds once you are familiar with the game.

Rules

The game commences with the first player rolling all five dice. The player adds the score of the five dice according to the table shown. If a player does not roll any of these combinations the score is zero.

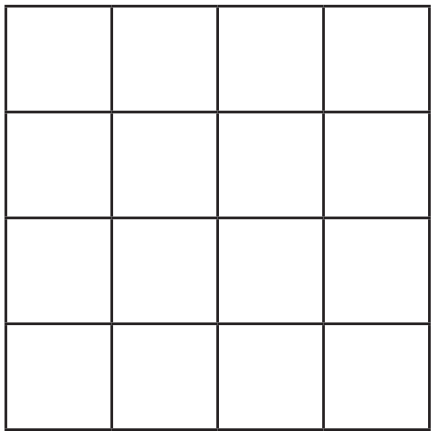
One 1	is worth 100 points
Three 2s	are worth 200 points
Three 3s	are worth 300 points
Three 4s	are worth 400 points
Three 5s	are worth 500 points
Three 6s	are worth 600 points
Three 1s	are worth 1000 points

The game progresses as per the following flowchart:



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Activity 2: Bingo game



Working in pairs or small groups, design a bingo game on a 4 × 4 grid.

The grid will have the answers to 16 mathematical calculation questions that you have written. Each answer should be between 0 and 50 and no numbers can be repeated.

Your calculation questions should include calculations using the following:

- addition of a positive and a **negative number**
- calculating a **fraction** of a number
- writing a fraction as a decimal
- writing a decimal number as a fraction
- calculating a **percentage** of a number
- a calculation that involves the **order of operations**
- **squaring** or **cubing** a number
- finding the square or cube root of a number
- knowing about an irrational number.

Once all cards are made, play the bingo games with your classmates. Assign one person to call out the numbers (or the teacher). Use a computer program or app to randomly generate each number between 0 and 50.

Practice question

1 Using the contexts of playing the sets of maths games above and on the previous pages, find and list examples of each of the following types of numbers you have used, or could have used:

a positive and negative numbers

b fractions

c decimals

d percentages

e powers such as squares or cubes

f square or cube roots (surds)

g rational and irrational numbers.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

2B Tuning in

Epic Success: Encryption

Encryption protects your bank details against hackers. In 1977 in the UK, Ron Rivest, Adi Shamir and Leonard Adleman commercialised the mathematical idea of encryption, RSA (named after their last initials).

RSA works by using prime numbers. If you multiply two large prime numbers together using a computer you can get the answer very quickly!

Try it yourself: Multiply 439 × 1877
What is your answer?

Remember, a prime number is divisible (can be divided by) only 1 and itself.

Now that you have your solution, imagine going back the other way.
If you had the number 824 003, could you find the two prime number factors that multiply to give you this number?

It turns out that computers struggle with this calculation. This type of encryption is known as a 'trapdoor'.

Discussion question

What other systems do you know of that are used to protect your online data?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Refresher: key number ideas from Units 1 & 2

There are different types of numbers that we use, such as:

- **whole numbers** like 43, $599
- **negative numbers** like –4, –234
- **fractions** like $\frac{1}{5}, \frac{1}{3}$
- **decimals** like 0.25, 76.5
- **percentages** like 20%, 95.5%
- **rates** like 40 km/h, $2.50 per kg

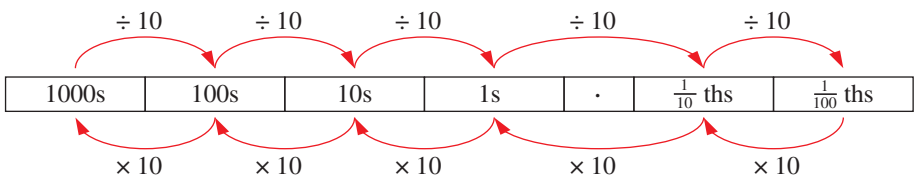
Large numbers can be written with either a space or a comma.

- 3 099 865 could also be written as 3,099,865
- $43 990.95 could also be written as $43,990.95

When we say large numbers, it is helpful to think of them in groups of three.

	Millions			Thousands			Hundreds		
	Hundreds	Tens	Ones	Hundreds	Tens	Ones	Hundreds	Tens	Ones
e.g.	9	3	2	8	4	6	7	1	4
	nine hundred and thirty-two million			eight hundred and forty-six thousand			seven hundred and fourteen		

Place value is important in mathematics.



There are some common percentages, fractions and decimals that we need to know.

- $\frac{1}{2} = 0.5 = 50\%$
- $\frac{1}{4} = 0.25 = 25\%$
- $\frac{1}{10} = 0.1 = 10\%$
- $\frac{1}{3} = 0.\dot{3} = 33\frac{1}{3}\%$
- $\frac{1}{5} = 0.2 = 20\%$
- $\frac{1}{100} = 0.01 = 1\%$

Practice questions

1 Write the following numbers in words as you would say them.

a 593 **b** 435 237 **c** 435 678 245 **d** 2 349 988 123

2 Find the equivalent fraction and percentage for the following decimals.

a 0.25 **b** 0.4 **c** $0.\dot{6}$ **d** 0.75

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

2C Understanding rational and irrational numbers

We meet a range of fractions in our daily lives. Fractions are examples of what we call **rational** numbers.

Rational numbers can be written as a fraction where both the numerator and denominator are **integers**. For example, $0.5 = \frac{1}{2}$.

Think about sharing a pizza equally with your mate: you would get half each.

If you were sharing a pizza with 6 people, you'd need to cut it into 7 equal pieces. Good luck with that!

The decimal form of rational numbers either terminate, or are recurring decimals; that is, there is a sequence of **digits** that repeats itself.

For example:

$\frac{1}{2} = 0.5$

$\frac{2}{3} = 0.6666666\ldots = 0.\dot{6}$ (we write recurring decimals with a dot over the digits that repeat)

$\frac{1}{13} = 0.0769230769230769\ldots = 0.\dot{0}76923\dot{0}$ (we write recurring decimals with a dot over the first digit and the last digit of a sequence of digits that repeats)

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Irrational numbers cannot be written as a fraction where the numerator and denominator are integers. In decimal form, irrational numbers do not terminate, and are non-recurring, that is, there is no finite sequence of digits that repeats itself.

Irrational numbers are commonly written as roots or surds such as $\sqrt{3}, \sqrt{6}, \sqrt{8}$.

An irrational number that you will already be familiar with is pi (π). The value of π is the ratio of the circumference of a circle to its diameter and is approximately equal to 3.14159… or often rounded off to 3.14 or to the fraction $\frac{22}{7}$.

π is crucial in calculations such as finding the circumference or area of a circle, or the volume of a cylinder. It is used in these formulas:

$C = 2\pi r$

$A = \pi r^2$

$V = \pi r^2 h$

2C Tasks and questions

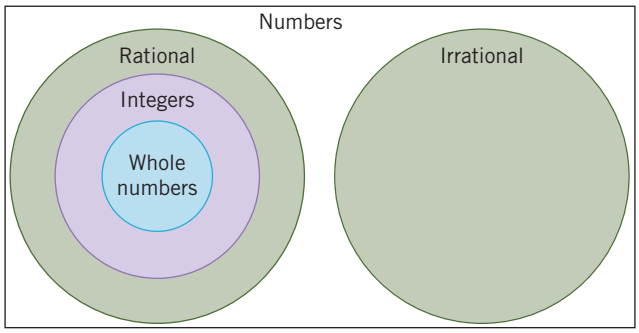
Thinking tasks

1 The Golden Ratio is another irrational number that is given the symbol φ, which is from the Greek alphabet and pronounced 'phi'.

Use the internet to discover some examples of where φ is either to be found, or is used. For example, what is its connection to shells and in art?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

2 Make a Venn diagram of rational and irrational numbers using the template. Write as many different examples as you can think of into each section of the Venn diagram.



Skills questions

3 Write each of the following numbers as fractions.

a 5 **b** 2.5 **c** 3.75 **d** 1.95

4 For each of the following, state whether they are rational or irrational numbers.

a 0.5 **b** 0.27 **c** $\sqrt{2}$ **d** $\sqrt{16}$

5 Write each of the following as a decimal.

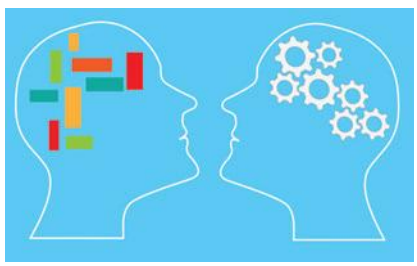
a $\frac{1}{5}$ **b** $\frac{1}{25}$ **c** $\frac{1}{3}$ **d** $\frac{1}{9}$

6 Where possible, write a fraction for the number. If not possible, label the number as irrational.

a 4.5 **b** $\sqrt{11}$ **c** 6.75 **d** $2.\dot{3}$

Mathematical literacy

7 Answer the following questions about rational and irrational numbers.



a Why do you think rational and irrational numbers were named that way?

b Think about what the words can mean, and why they might be used to distinguish between rational and irrational numbers.

c Verify whether you're correct by using the internet.

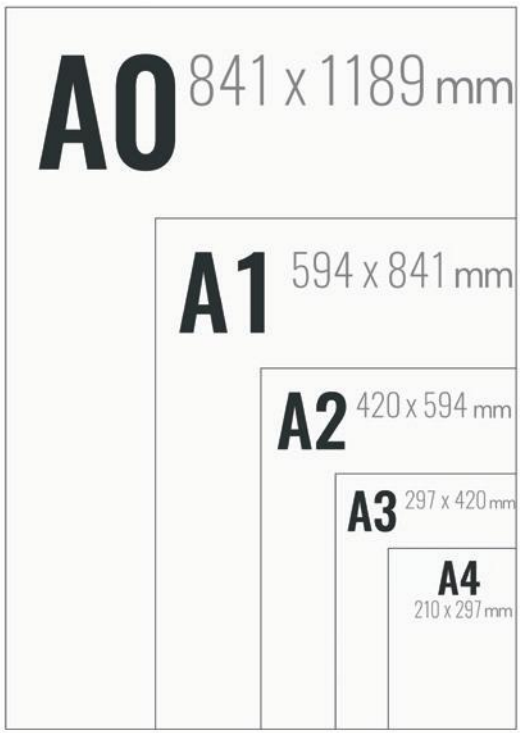
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Application task

8 Standard paper sizes are based on an irrational number.

Using the dimensions in the diagram, complete the table below by inserting the answer to each division of the relative dimensions. Write each answer correct to 3 decimal places.

For example, the length/height of the A0 size is 1189 mm and the width is 841 mm.



Divide the length of A0 by the length of A1:	Divide the width of A0 by the width of A1:
Divide the length of A1 by the length of A2:	Divide the width of A1 by the width of A2:
Divide the length of A2 by the length of A3:	Divide the width of A2 by the width of A03:
Divide the length of A3 by the length of A4:	Divide the width of A3 by the width of A4:

a What number or numbers seem to be coming up as your answers? Check with other students.

b What is the irrational number that is the key to the relationship between standard paper sizes? (*Hint:* Try calculating the square root of different whole numbers.)

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

2D Order of operations, powers and roots

Knowing how to do the order of operations when doing calculations is crucial when you are doing maths – especially if they involve your money. Consider the following scenario:

Nel is giving a potential customer a quote for a job that she expects will take her and her mate three 8-hour days to complete. They charge $25 per hour, and materials will be $400.

But at the last minute her mate backs out of the job, which means that the job will take twice as long – so Nel doubles the quote. Is she right?

Initial quote: $3 \times 8 \times \$25 + \$400 = \$1{,}000$

Without her mate to help: $\$1{,}000 \times 2 = \$2{,}000$

She didn't get the job because she didn't use the correct order of operations!

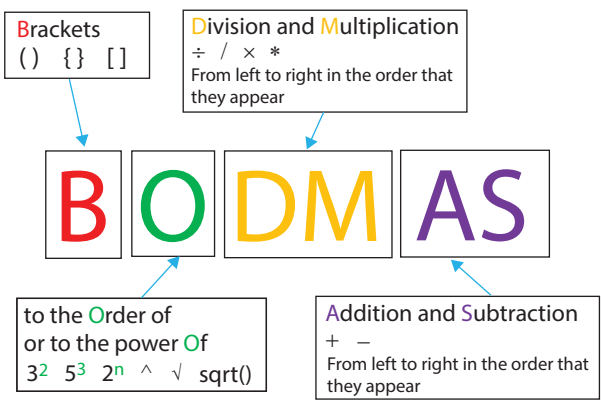
The correct second calculation should be: $(2 \times 3 \times 8 \times \$25) + \$400 = \$1{,}600$. So they charged too much and lost the job.

BODMAS

There are four main arithmetical operations: +, −, ×, ÷.

When you have a string of operations such as: $3 + 2 \times 5 + 4 - 9 \div 3$, there are rules to help us know which operation should be carried out first. This topic was covered thoroughly in the Units 1 & 2 textbook in section 3E. Refer back to this section if you need to refresh your memory, but it is summarised below.

There are rules in mathematics that we follow to make sure everyone gets the same correct answer. We call them the order of operations, or you might remember learning them as **BODMAS**, which is an acronym to help you remember the order.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

As we just saw, it is critical that everyone knows about the order of operations and how to use their calculator. The order in which operations (+, −, ×, ÷) are performed within a calculation can make a difference to the answer, but only one of the answers will be correct.

Do calculators know BODMAS?

In fact, no – not all calculators have BODMAS written into their operating program. You need to check they have done the order of operations correctly.

Does your calculator use BODMAS? A quick check is to enter: 3 + 4 × 5 and see what answer it gives you. If it gives you 23 then it does know BODMAS, but if it gives you 35 it doesn't know BODMAS.

Example 1 Ordering operations

Calculate $12+8\times3\div4-(7+1)+3^2$.
Use BODMAS to choose the order in which you will do the operations.

THINKING	WORKING
STEP 1	
First, evaluate the **brackets**. $12+8\times3\div4-(7+1)+3^2$	$12+8\times3\div4-(7+1)+3^2$ $=12+8\times3\div4-8+3^2$
STEP 2	
Next, evaluate **orders** (powers). $12+8\times3\div4-8+3^2$	$=12+8\times3\div4-8+9$
STEP 3	
Next, evaluate **division** and **multiplication**, working from left to right. $12+8\times3\div4-8+9$ then $12+24\div4-8+9$	$=12+24\div4-8+9$ $=12+6-8+9$
STEP 4	
Finally, evaluate any **addition** or **subtraction**, working from left to right. $12+6-8+9$ then $18-8+9$	$=18-8+9$ $=10+9$ $=19$

For the above example, solving the mathematical sentence without using the order of operations will lead you to a very different answer.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Common mistakes in answering this might be:

$$12+8\times3\div4-(7+1)+3^2$$
$$=20\times3\div4-(7+1)+3^2$$
$$=60\div4-(7+1)+3^2$$
$$=15-(7+1)+3^2$$

$$=15-(7+1)+3^2$$
$$=8+1+3^2$$
$$=9+3^2$$
$$=9+9$$
$$=18$$

$$=15-(7+1)+3^2$$
$$=15-8+3^2$$
$$=7+3^2$$
$$=7+9$$
$$=16$$

As you can see, it is very important to complete the maths in the correct order!

Powers and roots

Powers, (sometimes we call them *indices* too), are ways of writing numbers that have been multiplied by themselves. **Roots** are the opposite of powers.

When you multiply the same two numbers together this is finding a square or **power** of 2.

For example, $2\times2=2^2=4$ $3\times3=3^2=9$

When you reverse this operation, this is finding a square root: the value that can be multiplied by itself to give the original number.

For example, $\sqrt{4}=2$ $\sqrt{9}=3$

Square powers and square roots are when you have two of the same numbers. If raising a number to a power of 2 tells us to use this number twice in a multiplication, what does raising a number to a power of 3 mean? Or 4?

We can do this operation with three or more of the same number.

$2\times2\times2=2^3=8$ $3\times3\times3\times3=3^4=81$

You can do this with as many of the same number as you like!

$2\times2\times2\times2\times2\times2\times2\times2\times2=2^9=512$

As you can see, writing with the power notation is a great shorthand.

On a calculator, we use the x^2 or x^3 or x^y button for power calculations. Try 2^9 on your device.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Like we have square roots when the power is 2, we can also have cube roots, and roots to the fourth power etc.

For example, we know that $3 \times 3 \times 3 = 3^3 = 27$

Therefore, the cube root of 27 is 3. We write this as $\sqrt[3]{27}$

Some calculators have a root function that looks like $\sqrt[x]{\ }$ but not all calculators have this.

2D Tasks and questions

Thinking task

1 Make a table of all the squares, square roots, cubes and cube roots from 2 to 10.

Power	Squares	Square roots	Cubes	Cube root
2	$2 \times 2 = 2^2 = 4$	$\sqrt{4} = 2$	$2 \times 2 \times 2 = 2^3 = 8$	$\sqrt[3]{8} = 2$

What do you think happens when the power is 1? Think about this and then discuss it with some classmates.

Skills questions

2 Solve the following calculations using BODMAS.

a $(8+4) \div 3 + 16 - 7$

b $\frac{15}{3} + 6 - 3 \times 2$

c $4 + 8 - 3 + 2 - 11 \times 3$

d $(14 \div 2) + (34 \div 2) + 11$

3 As quickly as you can, and without technology, give the answers for the following.

a 3^2 **b** 1^2 **c** 4^3 **d** 6^3

e 2^4 **f** 6^2 **g** 5^4 **h** 8^2

4 As quickly as you can, and without technology, give the answers for the following.

a $\sqrt{4}$ **b** $\sqrt{25}$ **c** $\sqrt[3]{8}$

d $\sqrt{16}$ **e** $\sqrt{49}$ **f** $\sqrt[3]{125}$

Mixed practice

5 Solve each of these calculations.

a $3^2 + 4 \times 5 + 3$

b $\sqrt{64}$

c $\sqrt{25} + \sqrt{81}$

d 4^4

e $5^2 + 3^2$

f $3 + 18 \div 6 + 20 \div 4 - (31 - 6)$

g $\sqrt{81}$

h $\sqrt[3]{64}$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mathematical literacy

6 Read the following BODMAS story and then use the story to write a mathematical equation.

Sophie, Sam, Emma and Kitty decided to take the paddleboard out on a hot Melbourne day. They couldn't all fit on the one board, so they made friends with three others nearby who had brought their blow-up board. Later, they were joined by two friends who had finished their shift at the pet shop. With three others who were nearby they played a game of beach volleyball and so needed to split into two teams. The winning team got hungry and decided that they would get dinner, but as they were on their red P-plates only two could go in each car.

Write an equation that represents the number of cars needed for the winning team to get dinner.

7 Write your own BODMAS story about numbers and calculations like the one in question **6**. Your story will have words and sentences, not symbols or digits.

The calculation behind your story should include at least:

- addition
- subtraction
- multiplication or division
- brackets.

You may also consider including negative numbers, decimals and/or fractions.

Once you have written your story, swap with your classmates and write the mathematical equations from your stories.

Application tasks

8 The materials for necklaces that you make cost $80 per 100. It would cost $40 to hire a stall at a farmers' market, where you think you could sell all 100 of your necklaces at $15 each.

a Use BODMAS to work out the profit you would make.

b You decide to share your stall with a friend who makes earrings. How much profit will you now make, assuming you share the costs of hiring the stall?

c The stall is going so well that you both agree that hiring a canopy to shade customers in the summer is well worth the extra $20. How much profit will you make now?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9 Erica and Josiah each want to take out a new gym membership. They looked at several nearby fitness businesses and settled on the one that was the most convenient for them both. Membership costs $34 per week per person, but they have to sign up for a minimum of one year. Erica adds the aerobics class option, which is an extra $572 for the year. Josiah adds the pool option, which costs an extra $15 per week.

a Write a mathematical equation for each of their weekly memberships.

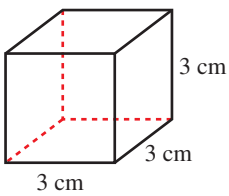
b How much are each of them paying per week?

c How much will each of them pay for the year?

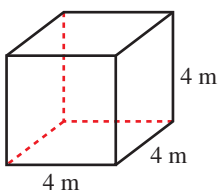
d Josiah got his mate to sign up to the gym, which got him a 15% discount on all his fees for a year. How much is his annual membership now?

10 Using powers and roots solve the following problems where you need to use the formula for the volume of a cube: $V = (\text{side length})^3$

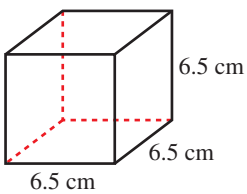
a Find the volume of a cube with side length 3 cm.



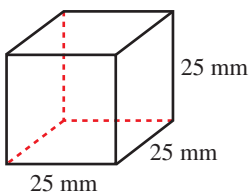
b Find the volume of a cube with side length 4 m.



c Find the volume of a cube with side length 6.5 cm.



d Find the volume of a cube with side length 25 mm.



e Find the side length of a cube that has a volume of 125 cm^3.

f Find the side length of a cube that has a volume of 216 m^3.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

2E Estimation and reasonableness

We estimate and check for reasonableness every day – whether it's doing a rough tally while we're grocery shopping or splitting a bill for a night out.

Contractors or consultants often work in a world of estimates. Rarely do they know all the facts up front and there could be many variables at play. Therefore, estimates based on an understanding of the situation and what is reasonable and fits the context is important.

The initial parts of this topic were covered back in the Units 1 & 2 textbook in section 3C Is it reasonable? Refer back to this section if you need to refresh your memory, but it is summarised below, before we move on to some new aspects related to estimating and reasonableness.

Reasonableness

When working with numbers and preforming calculations it is important to check the answers to determine if the result is reasonable and if the answer makes sense. When using a tool such as a calculator or computer to perform the calculations it is easy to enter the numbers incorrectly or make errors.

There are two ways you can check your answers.

- You can do a rough calculation to **estimate** the result. We can do this by **rounding** the numbers in the calculation to simpler numbers so that they are easy to work with. There are different ways we can round numbers, which will be discussed further below.
- You can consider what would be a **reasonable** answer, an answer that makes sense or seems about right, and check this against the result you have obtained.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Rounding

The process of rounding makes a number simpler to work with, while keeping the value close to the actual value. The resulting number is an **approximation** of the actual number.

It is especially important when we want to do quick calculations as mentioned above, or when the situation has very long or complex numbers and we need to make them simpler to work with. An example is when we read the answer of a calculation from a calculator.

We can round to different levels of accuracy.

Rounding rules

To round off, decide whether you are past halfway towards the next number up, or are you closer to the number you were already at?

We summarise rounding into the following **rules**.

RULE 1: ROUNDING DOWN

If the next digit to the right of the rounding off digit is a 0, 1, 2, 3 or 4, it means you are before halfway, so you leave the rounding off digit as it is, or **round down**.

RULE 2: ROUNDING UP

If the next digit to the right of the rounding off digit is a 5, 6, 7, 8 or 9, it means you are past halfway, so you increase the rounding off digit by 1, or **round up**.

Accuracy

To round off numbers, first decide what you are rounding off to – this is called the **accuracy**.

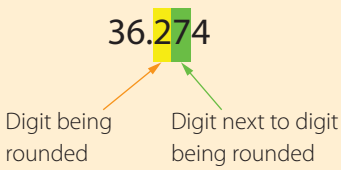
You may need to round off to one of the following:

- The nearest whole number (with money, this means the nearest dollar)
- The nearest 100 or 1000 (this could be for rough calculations, especially with bigger numbers)
- The nearest 5 cents (as we do with money now that we don't have 1-cent or 2-cent coins)
- To a specified place value or number of decimal places, such as the nearest second decimal place (with money, this is to the nearest cent).

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

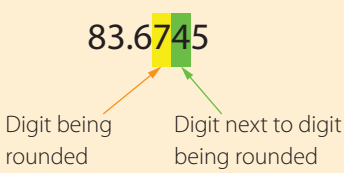
Example 2 Rounding to one decimal place

Round 36.472 to 1 decimal place.

THINKING	WORKING
STEP 1	
Write the number and identify the digit being rounded. Since we are rounding to 1 decimal place, this is 2. Identify the digit to the right of the digit being rounded. This is 7.	36.274 Digit being rounded: 2 Digit to the right of digit being rounded: 7
	
STEP 2	
If the next digit to the right of the digit being rounded is < 5, we round down. If the digit is ≥ 5, we round up. Given $7 \geq 5$, we round up.	Since $7 \geq 5$, round up.
STEP 3	
Increase the digit being rounded (2) by 1 to become 3. Write the number with 1 decimal place as required.	$36.274 \approx 36.3$

Example 3 Rounding to two decimal places

Round 83.6745 to 2 decimal places.

THINKING	WORKING
STEP 1	
Write the number and identify the digit being rounded. Since we are rounding to 2 decimal places, this is 7. Identify the next digit to the right of the digit being rounded. This is 4.	83.6745 Digit being rounded: 7 Digit to the right of digit being rounded: 4
	

... continued

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 2	
If the next digit to the right of the digit being rounded is < 5, we round down. If the digit is ≥ 5, we round up. Given 4 < 5, we round down and leave the digit 7 as is.	Since 4 < 5, round down.
STEP 3	
Write the number to 2 decimal places as required.	83.6745 ≈ 83.67

Significant figures

Significant figures are often used for science and measurements. **Significant figures** are the digits that are meaningful in a number. They are used to indicate how precise a measurement is. They are a way to help describe how accurate measurements are. Some ways of measuring are more precise than others.

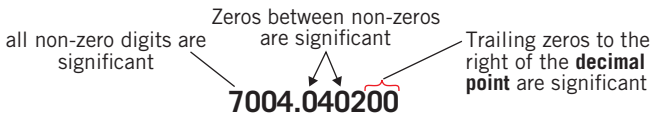
For example, if we measure the length of a table with a measuring tape that has millimetre (mm) increments, then it does not make sense to quote the length as 123.500 centimetres or 123.500 cm. Our measurement tool is not accurate enough to measure to 3 decimal places or thousandths of a centimetre.

In another example, you might have two scales for weighing things, one that was accurate to the nearest gram and another that was accurate to the nearest one hundredth of a gram. If they both had a measurement of 3 grams, this number would mean different things. The first measurement you would record as just 3 grams, because you know that the measurement is only accurate to 1 gram. The second measurement you could record as 3.00 grams. This says that the measurement was accurate to the hundredths place. These extra significant figures help to record how accurate the measurement was.

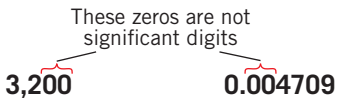
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

One of the critical issues in considering significant figures is related to the role of the digit zero in numbers. Here is how they are handled.

Significant zeros are:



Non-significant zeros are:



The following rules are used to determine if a digit is significant.

1. All non-zero digits are significant. For example, **192.23** has 5 significant figures.
2. Zeros between non-zero digits are significant. For example, **20.8** has 3 significant figures.
3. Leading zeros (the leftmost digits) are NOT significant. For example, 0.00**8** has 1 significant figure.
4. Trailing zeros to the right of a decimal point are significant. For example, 0.00**2 300** has 4 significant figures.
5. Trailing zeros to the left of the decimal point may or may not be significant, depending on how they are measured or determined.

To round numbers to a specific number of significant figures, count from the left the number of significant figures required, then use the same rounding rules as outlined above.

Example 4 Rounding significant figures

Round 0.002 305 78 to 4 significant figures.

THINKING	WORKING
STEP 1	
Write the number and identify the first significant digit. (The zeros before the digit 2 are not significant.) 0.00**2** 305 78	0.002 305 78 First significant digit: 2
STEP 2	
We are rounding to 4 significant figures so count the four digits from left to right: 2, 3, 0 and 5. Since the fourth significant digit is 5, the digit to be rounded is 5. 0.00**2 305** 78	Fourth significant digit: 5 So, digit being rounded is 5.

... *continued*

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 3	
Identify the next digit to the right of the digit being rounded. This is 7. 0.002 305 78 Given 7 ≥ 5, we round up.	Digit to the right of digit being rounded: 7 Since 7 ≥ 5, round up.
STEP 4	
Increase the digit being rounded (5) by 1 to become 6. Write the number with 4 significant figures as required.	0.002 305 78 to 4 significant figures is 0.002 306

Example 5 Rounding the results of calculations using significant figures

The heights of seven members of a basketball team are 187 cm, 192 cm, 201 cm, 192 cm, 188 cm, 197 cm and 189 cm. What is the average height of this team?

THINKING	WORKING
STEP 1	
The average height of the team will be the total height divided by the number of people.	Average height $= \frac{187 + 192 + 201 + 192 + 188 + 197 + 189}{7}$ $= \frac{1346}{7}$ $= 192.285\ 714\ 285\ 7\ldots \text{cm}$
STEP 2	
The measurements were not made to decimal place accuracy, so round the result to the same number of significant figures as the original measurements. The original measurements are listed to 3 significant figures. Since the next digit to the right of 192 is 2, the number is rounded down to 192.	Original measurements are listed to 3 significant figures. Average height of team ≈ 192 cm

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Leading-digit approximation

Leading-digit approximation is useful when dealing with very big whole numbers and very small decimal numbers.

The leading digit for very big numbers is the first digit, with the rounding rules applied, followed by zeros replacing the digits in the original number.

For example, 2 340 007 becomes 2 000 000 as the digit after the leading digit (3) is less than 5.

With very small numbers, the leading digit is the first non-zero digit to the right of the decimal point, with the rounding rules applied.

For example, in the number 0.000 000 181 6 the leading digit is 1, and the following digit (8) is greater than 5 so with rounding rules applied, the leading digit approximation is 0.000 000 2.

Example 6 Leading-digit approximation

Round 0.000 002 879 76 to its leading digit.

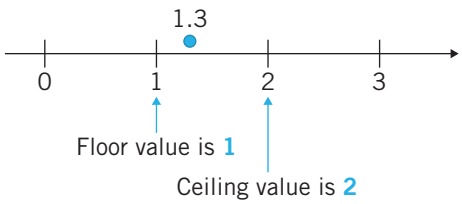
THINKING	WORKING
STEP 1	
Write the number and identify the leading digit. The first non-zero digit to the right of the decimal point is 2. 0.000 00**2** 879 76	0.000 002 879 76 Leading digit: 2
STEP 2	
Identify the digit to the right of the leading digit. 0.000 002 **8**79 76 Given 8 ≥ 5, we round up.	Digit to right of leading digit: 8 Since 8 ≥ 5, round up.
STEP 3	
Increase the digit being rounded (2) by 1 to become 3. Write the leading-digit approximation as required.	0.000 002 879 76 ≈ 0.000 003

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

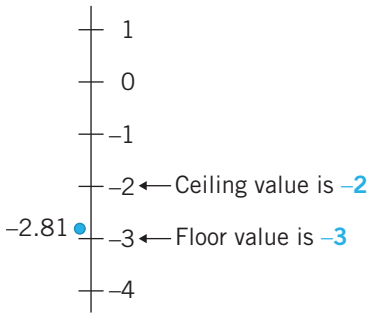
Floor and ceiling values (or functions)

The **floor** and **ceiling values** of a number are the next integer below (floor) and next integer above (ceiling) that number. The floor value and ceiling value for an integer is that same integer.

The example below illustrates the floor value and ceiling value of 1.3.



The example below illustrates the floor value and ceiling value of –2.81.



Here are some other examples for you:

Value	Floor	Ceiling
4.8	4	5
–3.4	–4	–3
1.23	1	2
5	5	5

Notation

Sometimes we use symbols to represent floor and ceiling values. These look like square brackets with the bottom or top missing.

$\lfloor 2.1 \rfloor$ This represents the floor value of 2.1, which is 2.

$\lceil 2.1 \rceil$ This represents the ceiling value of 2.1, which is 3.

Interval estimates

Sometimes it is difficult to make one estimate of a value, but it might be possible to estimate the range that a value will fall into. For example, when you go for a 5 km bike ride you might estimate that the time it will take you, depending on the weather, will be between 25 and 35 minutes.

You might be making pumpkin soup and the recipe states:

Add 1 kg pumpkin or squash, cut into chunks, to the pan, then carry on cooking for 8–10 mins, stirring occasionally until it starts to soften and turn golden.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

This cooking time is an **interval estimate** of 8–10 minutes. Or the recipe might have said 'about 9 minutes', which would be the same as saying an interval estimate of 8–10 minutes.

The application of interval estimates often occurs in relation to measurements. When you keep fresh food in your fridge, there is a 'cold food zone' where it is suggested that you aim for a temperature of about 3°C. This is often also expressed as a temperature interval estimate of 0°C–5°C. On the other hand, the ideal temperature setting for freezers is −18°C to −20°C, another interval estimate.

When goods are manufactured or produced, they probably need to meet some specifications regarding their size – it might be weight, or it might be in one of their key dimensions, like their length or width. For example, the net weight of a packet of food might be specified as needing to be 105 ± 5 grams, which is the same as saying an interval estimate of 100–110 grams. The variation of the ± 5 grams is often called the allowable tolerance.

Note: The symbol ± means 'plus or minus' the value specified.

Making estimates and checking reasonableness

You will often be required to make estimates of values in your home or work life. You might estimate the time it takes to complete a job, or the amount it will cost to host a party. This is different to determining the actual value or result. When you estimate, you need to look at the context and see if your estimate is reasonable. For example, if you and three friends have dinner and the total bill is $128.95, a reasonable estimate for your share would be $30.

A quick and rough calculation can be done to get an idea of what the answer should be. It is not an accurate answer – just a check on your calculations. Usually, we round off the numbers to easier, simpler numbers which we can add, subtract, multiply or divide in our head. Let's look at an example.

Example 7 Making estimates

You are catering for a party and plan that you will need to buy six pizzas. Each pizza costs $18.50. What will be the approximate cost of the pizzas?

THINKING	WORKING
STEP 1	
Round the cost of one pizza to the nearest 10.	$18.50 ≈ $20
STEP 2	
Use the rounded value to estimate the cost of six pizzas.	$6 \times 20 = 120$ The approximate cost of six pizzas is $120.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Is it reasonable? Using your common sense

After estimating, you need to think about whether the answer feels correct or not – that is, use common sense to check whether your answer is about right. Check if the size of the number is about right for the context.

Develop a *feeling* for the size of different numbers and visualise their relative size – for different values of objects or things. This creates confidence that your calculations are probably correct.

But how do you do this? You can ask yourself questions like the following.

- Does this answer make sense?
- Does this seem to cost too much (or too little)?
- Is it too big or too small – is it going to fit (if it's a measurement)?
- Is the time about right – or is it too long or too short?

2E Tasks and questions

Thinking task

1 Explain whether each scenario below is more likely to be an estimated value or an actual value.

a The number of students who regularly buy lunch at the school canteen

b The number of passengers you can have in your car when you are a red P-plater

c The number of rooftop solar panels that have been installed in your area

d The number of babies born in a particular hospital in September

Skills questions

2 Round these values to the level of accuracy indicated in the brackets.

a 23.765 (2 decimal places)

b 1 345 378 (nearest thousand)

c 0.0548 (3 decimal places)

d $67.96 (nearest dollar)

e 123 693.3385 (nearest whole number)

f $176.937 283 7 (nearest cent)

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3 Round these numbers to the number of significant figures indicated in the brackets.

a 23.057 (3) **b** 0.300 674 (2)

c 45 003.46 (2) **d** 0.004 568 02 (3)

4 Round these numbers using leading-digit approximation.

a 0.000 000 326 **b** 856.1

c 0.000 025 7 **d** 71 923.45

5 State the floor value and ceiling value for each of these numbers.

a 15.367 **b** 4.289 **c** 1403.64 **d** –0.58

6 What are the interval estimates for these situations?

a Normal body temperature is considered to be 37°C, but a normal person's mean body temperature can differ by 0.5°C.

b Government specifications for the amounts to be in packaged products specify that quantities from 200 mL to 300 mL have an allowable tolerance of ± 9 mL. What is the interval estimate for a packet that nominally has a volume of 250 mL?

c A recipe says to bake a cake for about 40 minutes.

d The time it takes for you to do a 5-kilometre walk.

e The amount of Children's Panadol™ to give to a baby who is 5 months old (see dosage below).

Children's Panadol™ Colourfree liquid 1 Month – 1 Year

Age	Average weight	Dose	Time between each dose	Maximum Dose
1–3 months	4–6 kg	0.6–0.9 mL	Repeat 4–6 hourly if required	Maximum 4 times within 24 hours
3–6 months	6–8 kg	0.9–1.2 mL	Repeat 4–6 hourly if required	Maximum 4 times within 24 hours
6–12 months	8–10 kg	1.2–1.5 mL	Repeat 4–6 hourly if required	Maximum 4 times within 24 hours
1–2 years	10–12 kg	1.5–1.8 mL	Repeat 4–6 hourly if required	Maximum 4 times within 24 hours

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mathematical literacy

7 Match each term on the left (a–h) with its definition on the right (A–H).

Term		Definition	
a	Significant figures	**A**	A range of values that an estimate lies in
b	Interval estimate	**B**	Making an educated guess of a value or result of a calculation
c	Rounding	**C**	A result that makes sense
d	Ceiling value	**D**	The first non-zero digit to the right of the decimal place
e	Leading digit	**E**	Meaningful digits in a number
f	Estimation	**F**	Making a number simpler while keeping it close to its actual value
g	Floor value	**G**	The nearest integer value above the number
h	Reasonable	**H**	The nearest integer value below the number

Mixed practice

8 On a particular day, the exchange rate of the Indian rupee to the Australian dollar is 0.018433. Round this number using leading-digit approximation.

9 Frankie works for $3\frac{1}{4}$ hours and her rate of pay is $23.35 per hour. How much does Frankie get paid for the shift? Round your answer to the nearest dollar.

10 A student weighs a powder sample using a set of lab scales. The reading on the scales says 23.4 g. What is the interval estimate of the weight of the powder sample? (*Hint:* The variation is half of the smallest interval on the scales.)

11 What are the floor and ceiling values for a child whose height is 1.62 m?

Application tasks

12 On a shopping trip, you bought a pair of runners for $160.50, a hoodie for $52.99, a pair of jeans for $75.85 and a cap for $34.45. You estimated that you spent $300. Explain whether your estimated total is reasonable or unreasonable.

13 Average walking speed is about 4 km per hour. You're going to walk the 5 km to your mate's place and need to be there at noon. Explain whether leaving your house at 10:15 a.m. is a reasonable or an unreasonable starting time.

14 Your parents think that you spend too much time on social media. You counter that you only spend 3 hours a day, and that the international average for teens is about 2.5 hours a day. Explain whether their concern is reasonable or unreasonable.

15 As a seventeen-year-old hospitality worker, Dee is entitled to be paid at 60% of the adult rate, which is $38.79 per hour. After working a 15-hour week, her pay was $195. Does this seem reasonable?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

16 A garden company has been asked to provide a quote for replacing the fencing around a children's playground.

The dimensions of the playground are approximately 11.3 m wide and 18.9 m long.

a Estimate the perimeter of the fence. (The perimeter is the total length of fence around the playground.)

b Select a type of fence from the table below and estimate the cost of materials.

Average fencing costs per metre by type (1.8 m high)

Type of fence	Average cost per metre
Timber	$50 to $120
Treated pine paling	$75 to $120
Colorbond®	$65 to $100
Hardwood	$80 to $125
Timber or treated pine slat	$280 to $380
PVC	$25 to $180

c The job is expected to take two people about 8 hours to complete and the cost of labour is $38.95 per hour. Estimate the cost of labour for the job.

d Estimate the total cost of replacing the fence.

17 This task requires you to plan a two-week summer holiday to New Zealand. Before you start saving for the trip you want to have a rough idea of what it will cost.

a What are the main costs that you will incur on the trip? List them in a spreadsheet.

b Conduct internet research to obtain leading-digit estimates of the costs for each of these items. Include these in your spreadsheet.

c Assuming that you will do at least five tourist activities while you are in New Zealand, research the cost for each. Include the leading-digit estimates for each of these in your spreadsheet.

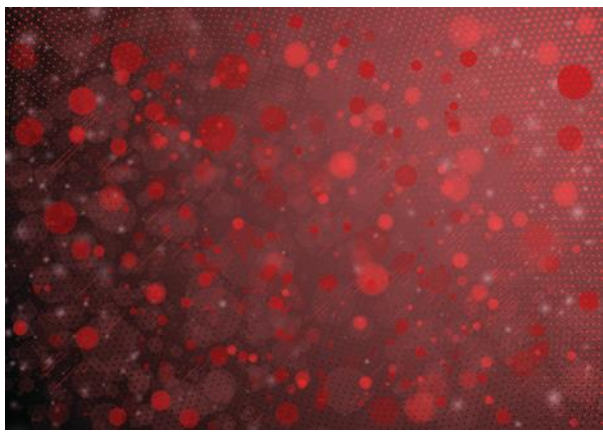
d Use an online currency exchange to convert the costs from New Zealand dollars to Australian dollars.

e Provide a leading-digit estimate for the total cost of your holiday.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

2F Very large and very small numbers

In a range of areas, there is the need to know about very large and very small numbers. For example, the distance to the Sun is 149 597 870 700 metres - a **very** large number!



If you work, for example in the medical or scientific field like as a laboratory technician where you'll work for pathologists, biochemists, clinical chemists, pharmacologists, veterinarians or microbiologists, you'll be measuring very small dimensions of things like cells and tissues. For example, the average diameter of a human red blood cell is 0.000 007 5 mm. Could you identify this on a ruler?

Research the current world population. Write this out as a number.

When there are so many zeros it would be easy to make a mistake when we are working with these very large or very small numbers. Therefore, we often write these numbers using scientific notation.

Scientific notation

We can write very large numbers as numbers multiplied by powers of 10. Remember 100 is also equal to 10×10 or 10^2. See the table below for other powers of 10.

10	$= 10$	= just one ten	$= 10^1$
100	$= 10 \times 10$	= 2 tens multiplied together	$= 10^2$
1000	$= 10 \times 10 \times 10$	= 3 tens multiplied together	$= 10^3$
10 000	$= 10 \times 10 \times 10 \times 10$	= 4 tens multiplied together	$= 10^4$
100 000	$= 10 \times 10 \times 10 \times 10 \times 10$	= 5 tens multiplied together	$= 10^5$

The distance from Earth to the Sun, written in **standard notation**, is approximately 150 000 000 000 km. The number written in **scientific notation** is 1.5×10^{11}.

How do we get this?

$$150\,000\,000\,000 = 1.5 \times 100\,000\,000\,000$$

$$150\,000\,000\,000 = 1.5 \times 10^{11}$$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

We can use the same idea when writing very small numbers.

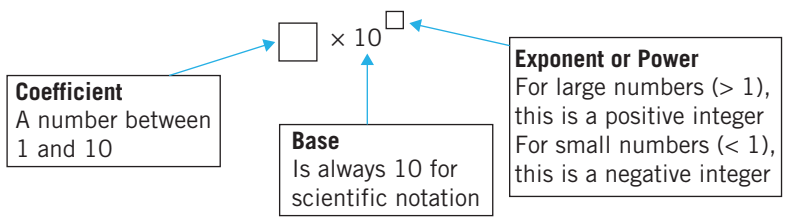
0.1	$= \frac{1}{10}$	$= \frac{1}{10^1}$	$= 10^{-1}$
0.01	$= \frac{1}{100}$	$= \frac{1}{10^2}$	$= 10^{-2}$
0.001	$= \frac{1}{1000}$	$= \frac{1}{10^3}$	$= 10^{-3}$
0.0001	$= \frac{1}{10\,000}$	$= \frac{1}{10^4}$	$= 10^{-4}$
0.000 01	$= \frac{1}{100\,000}$	$= \frac{1}{10^5}$	$= 10^{-5}$

Written in standard notation, the diameter of a blood cell is approximately 0.000 007 5 m. The number written in scientific notation is 7.5×10^{-6}. How do we get this?

$$0.000\,007\,5 = 7.5 \times 0.000\,001$$

$$0.000\,007\,5 = 7.5 \times 10^{-6}$$

The form for writing scientific notation is:



Example 8 Writing a large number in scientific notation

Write 34 000 in scientific notation.

THINKING	WORKING
STEP 1	
Write the number as a number between 1 and 10, multiplied by a power of 10.	$34\,000$ $= 3.4 \times 10\,000$
STEP 2	
Since $10\,000 = 10^4$, write the number in scientific notation.	$= 3.4 \times 10^4$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 9 Writing a small number in scientific notation

Write 0.000 000 53 in scientific notation.

THINKING	WORKING
STEP 1	
Write the number as a number between 1 and 10, multiplied by a power of 10.	$0.000\,000\,53 = 5.3 \times 0.000\,000\,1$
STEP 2	
Since $0.000\,000\,1 = 10^{-7}$, write the number in scientific notation.	$= 5.3 \times 10^{-7}$

Calculations with scientific notation

When performing calculations with scientific notation, it may be useful to use a calculator. Some calculators have a $\boxed{\times 10^x}$ button. You need to be careful when entering scientific notation and always use brackets around scientific notation so that the calculator performs the operations correctly.

For example, if you want to calculate 3.4×10^4 divided by 5.6×10^3, without the brackets, the calculator will calculate $(3.4 \times 10^4 \div 5.6) \times 10^3$ which will give the wrong answer. You need to enter $\left(3.4 \times 10^4\right) \div \left(5.6 \times 10^3\right)$ to get the correct answer.

Note: **1** You can use the memory function on the calculator to store the first part of the calculation.

2 On a smartphone calculator, you can use the **EE** button and not use brackets. EE represents ×10. For example, EE 2 means $\times 10^2$.

Example 10 Calculations with scientific notation

Calculate $\left(4.6 \times 10^8\right) \div \left(3.5 \times 10^3\right)$ and round your answer to an appropriate number of significant figures.

THINKING	WORKING
STEP 1	
Use a calculator to enter the numbers and operations. Be careful to use brackets around each number in scientific notation. Alternatively, use the EE button on a smartphone calculator: 4.6 EE 8 ÷ 3.5 EE 3	$\left(4.6 \times 10^8\right) \div \left(3.5 \times 10^3\right)$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 2	
Write the answer from the calculator or phone.	= 131 428.571 4…
STEP 3	
Identify the number of significant figures in each number of the original calculation.	The numbers in the original calculation have 2 significant figures so the answer should be written to the same number of significant figures.
STEP 4	
Round the answer to 2 significant figures. Since the third significant digit is 1 and $1 < 5$, we round down.	Since $1 < 5$, round down.
STEP 5	
Write the answer to 2 significant figures and then in scientific notation.	To 2 significant figures, 131 428.571 4 … = 130 000 $= 1.3 \times 10^5$

2F Tasks and questions

Thinking task

1 Why do you think it is important to be able to write numbers in scientific notation? Discuss with some of your classmates.

Skills questions

2 Write these numbers in scientific notation.

a 245 876 000 **b** 0.000 005 6

c 0.23 **d** 1 000 000

3 Write these numbers in standard form.

a 2.3×10^3 **b** 1.36×10^{-5}

c 5.0×10^{-3} **d** 7.45×10^8

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mixed practice

4 Perform these calculations and express the answers in scientific notation with 3 significant figures.

a $\dfrac{0.000\,456 \times 0.35}{234}$

b $2.34 \times 10^{-2} + 1.5 \times 10^{-2}$

c $\left(5.354 \times 10^{4}\right) \div \left(6.23 \times 10^{3}\right)$

d $\left(1.2 \times 10^{-3}\right) \times \left(3.56 \times 10^{-6}\right)$

e $234\,567 \times 12\,444$

Application tasks

5 A chess board has 64 squares. If you were given \$1 on the first square, \$2 on the second square, and continue doubling the amount for each square until you get to the last square on the chess board, how much money will you be given for the last square? Write your answer in scientific notation.

6 The populations of the 10 most populous countries in Oceania in January 2024 are shown below.

a How many more people live in Australia than New Zealand?

b One country has a population approximately ten times another country. Which two countries are they?

c It is projected that Australia will grow by 10 million people over the following 30 years. What is the predicted population of Australia in 2054?

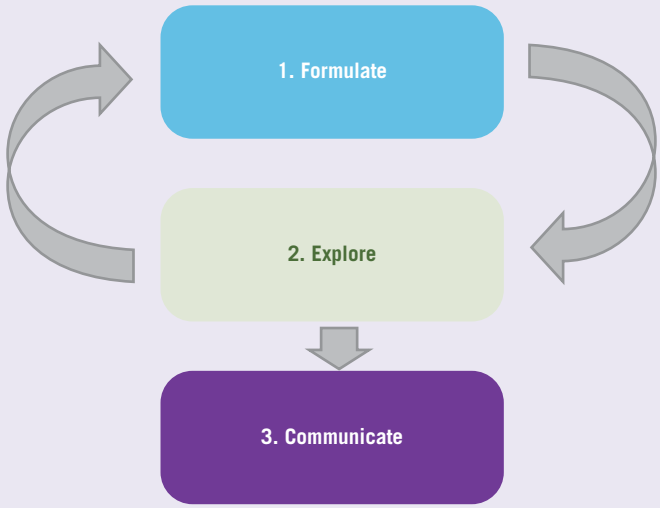
Country	Population
Australia	2.64×10^{7}
Papua New Guinea	1.03×10^{7}
New Zealand	5.23×10^{6}
Fiji	9.36×10^{5}
Solomon Islands	7.40×10^{5}
Micronesia	5.44×10^{5}
Vanuatu	3.35×10^{5}
French Polynesia	3.09×10^{5}
New Caledonia	2.93×10^{5}
Samoa	2.26×10^{5}

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Investigations

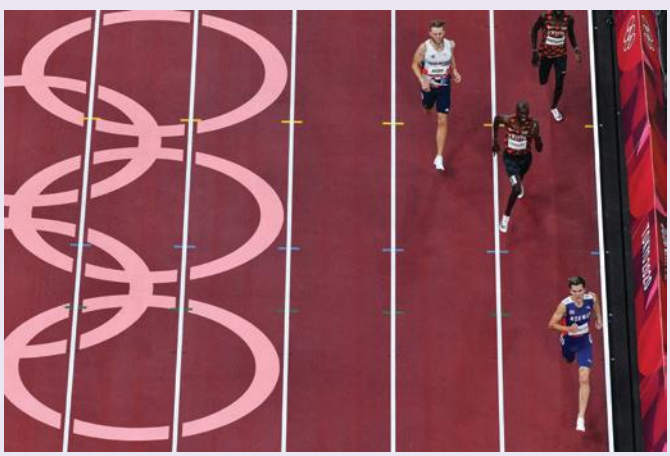
When undertaking your investigations, remember the problem-solving cycle steps:

- **Formulate** – Sort out and plan what you need to know and need to do to solve the problem.
- **Explore** – Use and apply the maths required to solve the problem.
- **Communicate** – Record and write up your results.



1 Olympic sports times and distances

Have you ever thought about how results are determined in events at the Olympics or World titles, especially in events such as running races on the track (100 metres, 200 metres, 400 metres and more) or the equivalent in swimming in the pool where *time* is being measured? Or what about in events where *distance* decides the winners and runners up, and whether people have beaten any records – such events include the jumps (pole vault and the high, long and triple jumps) or throwing events such as the discus, shot put or javelin?



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Formulate

What type of numbers are used to determine the results of World or Olympic events? To what accuracy are the numbers that are used to measure distance and time and how are they used to determine placement and records?

Work in groups of two or three.

a Select two different events to investigate – one with results based on time and the other based on distance. You will need to be able to undertake the events selected, and measure and record your performances. So the pole vault may not be a good event to choose.

b How will you measure the time and distance? What units will you use?

c Where, when and how will you undertake your chosen events?

d What tools will you need to measure them with? Is it possible to use two different tools for each event?

e How will you record the outcomes?

f How will you research how these events are measured and how they are recorded in the Olympic Games or at World Championships? What questions might you need to ask and find answers to?

Explore

Now you need to do the work to undertake the mathematical tasks of measuring and recording your own two events and their results, and then comparing these with how those same two events are measured and recorded at a national or international level.

Undertake your own events.

g Estimate in advance how long your jump or throw will be, and how long the run will take.

h What accuracy do you think you could measure to using each tool?

i Undertake the activity and measure the distances and times using the different tools.

j Record and analyse your results. What level of accuracy are they measured to? Have you rounded the results? How and why?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Research the equivalent Olympic or World Championship events.

You could try the websites for the Olympics, World Athletics and World Aquatics.

k How are the events measured?

l What are the current World and Olympic records in each event?

m What equipment and tools are used to measure the events and decide the winners? What is the level of accuracy of these tools?

n To what accuracy are the results recorded? Is this different to the accuracy of the tools used? If so, why?

o Compare the tools that you used to measure your results with the tools used at the World and Olympic level. Is there a difference in the tools that are used now compared to 50 years ago?

Communicate

p Write up and present the findings of your investigation of the two events you participated in. You could choose to write a report, create a poster or create a multimedia presentation that explains what you found out.

You might choose to include the following in your presentation.

- What maths did you use and what types of numbers did you encounter? To what accuracy levels were the numbers measured?
- Compare the results of the two activities. Were there any differences and similarities? Were there any challenges you faced undertaking your own measurements and what insights were identified? Were there any surprises or new things you learned?
- Reflect on the technologies that are used to determine results in sports such as athletics or swimming.

2 Our state in numbers

What numbers describe our state of Victoria? There is such a range of interesting facts and figures about the state of Victoria.

Your task is to find and compare different numerical facts and figures, no matter whether they are about geographic or environmental attributes or about factors related to the population, or our flora and fauna. And you can compare your data between Victoria and other states and territories, or with other countries.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Formulate

a Conduct a brainstorm to identify possible geographic or environmental information you think might be interesting to learn more about. What mathematics do you think will underlie these facts about Victoria? Where might you find this information?

b From your brainstorm, identify information and characteristics of Victoria that you will research so that you will be able to represent and describe a wide range of facts and figures about Victoria. Remember, it could be about:

- geographic or environmental attributes of the state or country such as land area, height of mountains, lengths of rivers, amount of desert etc.
- population issues such as population of states, capital cities and regional towns; immigration or cultural backgrounds; age breakdown etc.
- our flora and fauna such as the types and numbers of animals or birds, or their relative speeds; types and numbers of trees or flowers etc.

You need to find and document examples of the following types and aspects of numbers:

- rational numbers
- irrational numbers. *Hint:* Be creative – think of a calculation that might require you to use an irrational number.
- scientific notation/powers of ten – for both very big and very small numbers. *Hint:* For a very small number perhaps do a comparison; for example, what fraction or proportion is one figure of a much bigger figure?
- estimations. *Hint:* Guess some of the answers to your facts and figures *before* you research to find the answers.
- rounding, approximations and significant figures.

Remember, you can compare your data between states or with other countries of the world.

Develop a plan that outlines:

- the different facts or pieces of information you are going to undertake research on (a minimum of **five** different facts or areas of information should be researched and compared)
- the range of types of numbers you need to identify or create based on your facts and figures

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- where and how you will research the information
- how you will record the outcomes – can you use a technological tool, such as a spreadsheet like Excel, to record and analyse the data?

Explore

c Conduct your research of numbers that describe the state of Victoria. Record your data and information in an appropriate form.

d How do you know the data and information you are collecting is reliable?

e What is the accuracy of the data and information that has been collected?

f Do you need to undertake some calculations based on your data to compare different aspects of the data?

g Are there particular tools or technologies used to measure, record or analyse the data that has been collected?

Communicate

h Write up and present the findings of your investigation. You could choose to write a report, create a poster or create a multimedia presentation that explains and shows what you found out. Remember to highlight the maths you had to use and what sorts of numbers you encountered, and to what accuracy levels the numbers were available.

Remember to include the following in your report:

- The reasons why you chose your different facts or figures
- The rational and irrational numbers you found
- Examples of scientific notation or powers of ten
- Your estimations
- The accuracy of the data and information
- Examples of rounding, approximations and significant figures
- Your reflections on what you found
- Comments on any challenges you faced in undertaking your research and what insights that gave you. Were there any surprises or new things you learned?
- Reflections on the tools and technologies that you identified in your research. How are they used to measure or record the data?

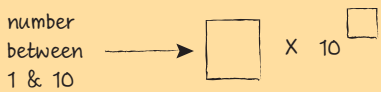
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key concepts

- The **real number** system consists of **rational** and **irrational** numbers.
  - Rational numbers can be expressed as a fraction, e.g. $0.5 = \frac{1}{2}$
  - Irrational numbers cannot be written as a fraction, e.g. $\sqrt{29}, \pi$
- The **order of operations** to solve equations is given by the acronym **BODMAS**.
  - **B**rackets ( )
  - **O**rders such as $\sqrt{x}$, $\sqrt[3]{x}$, x^2, x^3 etc.
  - **D**ivision ÷ and/or **M**ultiplication × (working from left to right in the calculation)
  - **A**ddition + and/or **S**ubtraction − (working from left to right in the calculation)
- Powers and roots are terms that represent repeated multiplication of a number. For example:
  - $2 \times 2 \times 2 \times 2 \times 2 = 2^5$
  - $\sqrt[3]{8} = 2$ because $2 \times 2 \times 2 = 2^3 = 8$
- Rounding numbers is the process of approximating a number with a simpler value.
  - To round a number, first decide what place value you are rounding to. Then, look at the next digit to the right of that place value.
  - If it is < 5 (that is, 0, 1, 2, 3, 4), round down, which means the digit to be rounded does not change.
  - If it is ≥ 5, (that is, 5, 6, 7, 8, 9), round up, which means the digit to be rounded is increased by 1.
    (e.g. rounding to 1 decimal place: 6.421 becomes 6.4, and 6.481 becomes 6.5)
- Significant figures are the number of digits that are meaningful in a number.
  - All non-zero digits are significant.
  - Zeros between non-zero digits are significant.
  - Leading zeros (the left-most digits) are not significant.
  - Trailing zeros to the right of a decimal are significant.
  - Trailing zeros to the left of the decimal may or may not be significant, depending on how they are measured or determined.
    (e.g. $69.95 has 4 significant figures; 0.007 has 1 significant figure.)

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- Leading-digit approximation is used to round very large or small numbers.
  - To obtain a leading-digit approximation, identify the first non-zero digit and use rounding rules to round to this place value.
    (e.g. The leading digit of 0.000 045 6 is 4 and this number would be rounded to 0.000 05; the leading digit of 62 300 is 6 and this number would be rounded to 60 000)
- Floor value is the nearest integer value below the number.
  Ceiling value is the nearest integer value above the number.
  (e.g. 2.56 has a floor value of 2 and a ceiling value of 3.)
- An interval estimate indicates a typical range of a value. (e.g. the net weight of a packet of food might be specified as needing to be 105 ± 5 grams, which is the same as saying an interval estimate of 100–110 grams.)
- Scientific notation is often used to represent very large or very small numbers.
  - Numbers are written as a number between 1 and 10, multiplied by 10 to a power.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Success criteria and review questions

☐ I can recognise rational and irrational numbers.

1 For each of the following, state whether they are rational or irrational numbers.

a 0.25 **b** $\sqrt{24}$

c π **d** 1.809

☐ I can calculate using the order of operations, including with powers and roots.

2 Calculate the following.

a $5+3\times6-19$ **b** $\sqrt{10\,000}$

c $\sqrt[3]{64}$ **d** 3^7

e $10\times100\times1000\times10\,000$ **f** $6\times6\times6\times3\times3\times2\times2\times2$

g 3^2+4^2 **h** $192-63\div9+3^2\times8$

☐ I can round numbers.

3 Round these values to the level of accuracy indicated in the brackets.

a 45.6789 (2 decimal places)

b 67 934 (nearest thousand)

c 0.000 764 (5 decimal places)

d \$2599.99 (nearest dollar)

☐ I can determine the number of significant figures.

4 Round these numbers to the number of significant figures indicated in the brackets.

a 18.08 (1)

b 0.000 342 (2)

c 98 000 (1)

d 785 678.98 (2)

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

☐ I can determine leading-digit approximations.

5 Round these numbers using leading-digit approximations.

a 0.000 074 5 **b** 18.423 65

c 0.008 27 **d** 21 734 061

☐ I can determine floor and ceiling values.

6 State the floor value and the ceiling value for each of these numbers.

a 98.99 **b** $798.45

c 3030.5 mm **d** 246.9867

e –16.4° C **f** –$2,569.35

☐ I can determine interval estimates.

7 What are the interval estimates for these situations?

a A packet of nuts that states it has a weight of 125 grams and has an allowable tolerance of ± 5 grams

b A recipe says to bake a cake for about 50 minutes

c A pottery kiln states that it should be used at about 1200°C, with a variation of up to 50°C allowed

d The time it takes you to get to school.

☐ I can write numbers using scientific and standard notations.

8 Write these numbers in scientific notation.

a 35 000 000 **b** 0.000 076

c 65 000 **d** 0.000 043 5

9 Write these numbers in standard notation.

a 2×10^{13} **b** 6.5×10^{-3}

c 9.8×10^{-6} **d** 4.55×10^{9}

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mathematical toolkit

1 Reflect on the range of different calculations, technologies and tools you used throughout this chapter, and how often you used them for undertaking your work and making calculations. Indicate how often you used and worked out results and outcomes for each of these methods and tools.

Method and tools/ applications used	**How often did you use this?**
• Calculating and working in your head, and using algorithms	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using pen-and-paper	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using a calculator	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using a spreadsheet	Not at all: ☐ A little: ☐ Quite a bit: ☐
• Using measuring tools – name the tool, technology or application: _____ _____	Not at all: ☐ A little: ☐ Quite a bit: ☐ Not at all: ☐ A little: ☐ Quite a bit: ☐
• Using other technology or apps – name the technology or application: _____ _____	Not at all: ☐ A little: ☐ Quite a bit: ☐ Not at all: ☐ A little: ☐ Quite a bit: ☐

2 Did this chapter and the activities help you to better understand how you use different tools and technologies in using and applying mathematics in our lives and at work? In what areas and ways? Write down some examples.

3 In one sentence, explain something relating to tools and technologies that you learned in the unit. Write an example of what you learned.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key vocabulary

Here is a list of this chapter's key maths terms and their meanings.

Term	Meaning
Accuracy	How close a measured value is to the true value.
Approximation	The result when a value is rounded off, e.g. a lap time of 87.956 seconds is approximately 88 seconds.
Base	The number in an index expression that is repeatedly multiplied, e.g. the **3** in $3^5 = 3 \times 3 \times 3 \times 3 \times 3$.
BODMAS	An acronym to help you remember the order of operations in a calculation: **B**rackets, then **O**rders (powers and roots), then **D**ivision or **M**ultiplication (from left to right), then **A**ddition or **S**ubtraction (from left to right).
Ceiling value	The next integer that is higher than a decimal value.
Coefficient (in scientific notation)	The numerical prefix in scientific notation, e.g. the 7.46 in the number 7.46×10^5.
Cube	To cube a value means to *multiply it by itself and then by itself* again, e.g. $2^3 = 2 \times 2 \times 2 = 8$. Cube means the same as *to the power of 3*.
Decimal point	The decimal point separates the *whole number* part on the left from the *fraction* part on the right in a decimal number. It is shown as a **.** or **,** in different countries.
Digit	Digits are the figures 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9. We use these ten digits to make up all our numbers.
Encryption	The process of converting information or data into a code, especially to prevent unauthorised access. Encryption scrambles plain text so it can only be read by the user who has the secret code, or decryption key.
Estimation	A value arrived at by an 'educated guess' rather than by the use of an accurate calculation.
Exponent or Index or Power	The superscript number in an index expression that indicates how many times the base is repeatedly multiplied, e.g. the **5** in $3^5 = 3 \times 3 \times 3 \times 3 \times 3$.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Term	Meaning
Floor value	The nearest integer that is lower than a decimal value.
Fraction	Fractions are parts of a whole number and are the numbers that lie between whole numbers, e.g. $\frac{1}{3}, \frac{3}{4}$.
Integers	Integers are whole numbers and include positive and negative whole numbers and zero.
Interval estimate	Two values that indicate the typical range of a value, e.g. 'it takes between 10 and 15 minutes to drive to the station'.
Irrational numbers	Numbers that cannot be written as fractions with an integer numerator and integer denominator and are infinite non-recurring decimals, e.g. π, $\sqrt{2}$.
Leading digit	The leading digit for very big numbers is the first digit in the number. The leading digit in a very small decimal number is the first non-zero digit after the decimal point.
Negative number	Negative numbers are less than zero (0).
Order of operations	See *BODMAS*.
Percentage	Percentage or per cent means 'per hundred' or 'out of a hundred'. We use the symbol % for percentages.
Place value	Where the digit is, or its place in a number, tells us what value the number has. For example, in 5712, the value of 7 is seven hundred, but in 5.712 the value of 7 is seven-tenths.
Rational number	A number that can be written as a fraction with an integer numerator and integer denominator.
Reasonable	Fair or sensible or what might be expected.
Roots	Written as a surd using the symbol $\sqrt{\ }$. They can be either rational or irrational.
Rounding	Approximating a number to a convenient value, e.g. to the nearest dollar $23.86 is rounded up to $24, or to the nearest five cents it is rounded down to $23.85.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Term	Meaning
Scientific notation	A format for writing very large or very small numbers with a coefficient (between 1 and 10) multiplied by a power of 10, e.g. 746 000 = 7.46×10^5.
Significant figures	The digits in a number that indicate its degree of accuracy, starting from the first non-zero digit.
Square	To square a value means to *multiply it by itself*. *Square* means the same as *to the power of 2*.
Standard notation	The familiar and everyday format for writing numbers, e.g. 746 000 or 746,000.
Whole numbers	Positive integers, including zero (0).

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3 Brushing up your calculating skills

Brainstorming activity: Where's the maths?

Using this photo as a stimulus, brainstorm the type of maths we need to know to undertake this task or activity. Think especially about any maths skills related to the content of this chapter – different types of calculations such as with percentages, ratios, proportion and variation, and calculating percentage change and error.

Prompt questions might be:

- What sorts of numbers might be encountered or needed?
- What mathematical calculations might be needed?
- What different measurements, amounts, costs and charges might be involved?
- What different tools, technologies or software might be used?

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter contents

Chapter overview and Spotlight

3A Starting activities
3B Tuning in
3C Refresher on ratios and proportions
3D Proportions and direct variation
3E Indirect variation
3F Refresher on calculating with percentages
3G Percentage change
3H Percentage error
Investigations
Chapter review

From the Study Design

In this chapter, you will learn how to:

- use and apply the conventions of mathematical notations, terminology and representations
- use different technologies effectively for accurate, reliable and efficient calculations
- evaluate the mathematics used and the outcomes obtained relative to personal, contextual and real-world implications (Units 3 and 4, Area of Study 1)

© Victorian Curriculum and Assessment Authority 2022

ISBN 978-1-009-11065-5 Sakurai et al.

© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter overview

Introduction

In our lives, we undertake a wide range of comparisons and calculations, and many of them relate to understanding and applying knowledge about **percentages**, **ratios** and **proportions**, or what is often referred to as variation. We use this knowledge when we go shopping and compare prices, when we are cooking or travelling from place to place.

Percentages are everywhere – from when we are working out discounts, to whether there are enough lollies left in a packet.

There are also many situations where we use ratios. A few common ones are when we are mixing household chemicals or using maps. At work, ratios are very common.

Understanding and using proportion and variation is essential when we are cooking, driving or making or drawing clothes, furniture or models.

This chapter focuses on calculations using ratio, variation and percentages – done both manually and using different technologies and software – and checking whether your answer is accurate and reasonable given the context of the calculation.

Learning intentions

By the end of this chapter, you will be able to:

- understand and use the conventions of different mathematical **notations**, **terminology** and **representations** when undertaking calculations
- calculate with and use and apply different operations when undertaking calculations using ratios, proportions, variation and percentages to solve practical problems
- be able to use different digital tools and devices, such as calculators and apps, to undertake your calculations.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Spotlight: Jaime Dorfman

An interview with a knitwear designer and small business owner

Tell us about your job and some of the work that you do.

I am a small business owner, knitting pattern designer, social media content creator and now a published author of my first book 'Fast and Fabulous Knits'. Being self-employed means that my day-to-day changes a lot, depending on what I'm working on. My general tasks involve a lot of business administrative work, creating new knitwear designs and written patterns, and creating social media content for promoting my business as well as other companies (like yarn brands) that I collaborate with. And of course, I spend a lot of my time knitting!

What maths do you use regularly in your work?

I use a lot of maths like multiplication, division and measurement in my work. When I am starting a new design, before I even start knitting, I need to work out how big the garment will be. To work out how many stitches I need to achieve my desired garment width, I make a small 10 cm × 10 cm swatch of the design. I then count how many stitches equal 10 cm, then divide 10 by the number of stitches to get the width of one stitch. I then divide the desired garment width by the width of one stitch. This gives me the number of stitches I need to cast on to achieve the desired width of the garment. I do the same for the number of rows I need to achieve the desired garment length. Once I have knitted my garment in my size, I then need to scale up and down to 'grade' my pattern for a range of different sizes. This involves the same mathematical principles as before, but I use a spreadsheet with in-built formulas based on my initial calculations to make the other measurement calculations easier and more accurate. This saves me having to knit up the design in each size.

What is the most maths-related useful tool or piece of technology in your work?

I use Excel for all my pattern writing calculations. I also keep a master spreadsheet to keep close track of all my pattern sales as I sell my patterns across six different platforms. As soon as I make a sale, I enter in the profit I have made and my spreadsheet automatically adds everything up.

What was your attitude towards learning maths in school? Has this attitude changed over time?

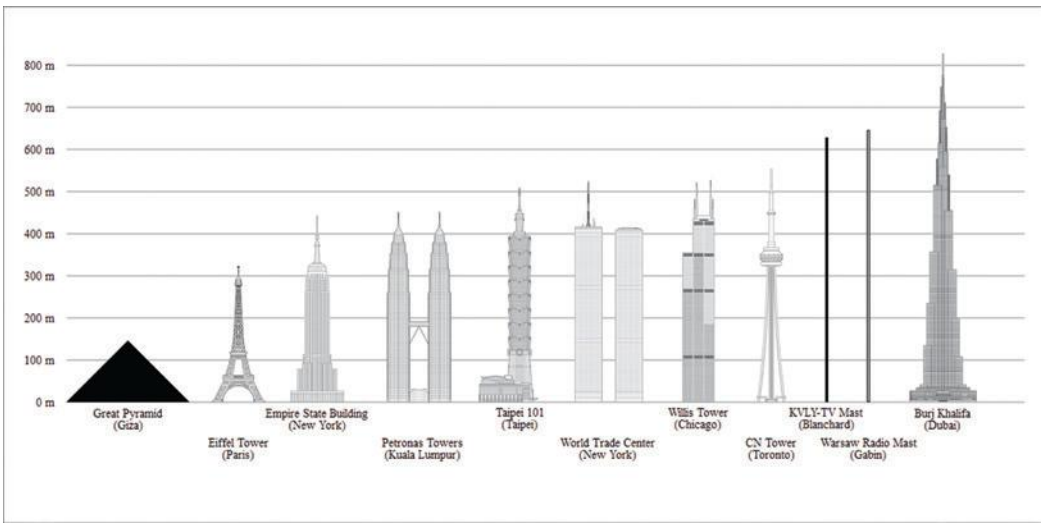
I wasn't bad at maths in school but I was not obsessed with it. I have always been a creative person, so I thought I would never use maths outside of high school. It never occurred to me that a creative career would involve so much maths! My attitude towards maths has definitely changed in the last few years and I have learned to embrace the maths in my business and pattern writing if I want to produce better quality products. I'm definitely proud of how far I have come with using maths in my work.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3A Starting activities

Activity 1: Using ratios as comparisons

This graphic shows the approximate heights of some of the tallest freestanding structures in the world – past and present (up to 2024). To be freestanding, a structure must not be supported by wires, the land or other types of support.



We can make statements comparing the heights of the different buildings.
For example:

- The Eiffel Tower is twice as tall as the Great Pyramid.
- The Great Pyramid is $\frac{1}{3}$ as tall as the Petronas Towers.
- The Burj Khalifa is 1.5 times taller than the CN Tower.

We can also write such comparisons as ratios:

- Eiffel Tower : Great Pyramid = 2 : 1
- Great Pyramid : Petronas Towers = $\frac{1}{3}$: 1
- Burj Khalifa : CN Tower 2 = 1.5 : 1

But ratios are best when they are simple and made into whole number ratios:

- Eiffel Tower : Great Pyramid = 2 : 1 is OK as it is
- Great Pyramid : Petronas Towers = $\frac{1}{3}$: 1 is better written as 1 : 3 (multiply both by 3)
- Burj Khalifa : CN Tower = 1.5 : 1 is better written as 3 : 2 (multiply both by 2)

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Practice questions

1 Here are the heights of five tall buildings:

- The Great Pyramid, Giza, Egypt: 150 metres
- Eiffel Tower, Paris, France: 300 metres
- Central Radio Tower, Beijing, China: 400 metres
- Petronas Towers, Kuala Lumpur, Malaysia: 450 metres
- Canton Tower, Guangzhou, China: 600 metres

a How many times bigger is the Canton Tower than the Eiffel Tower? What is this as a ratio?

b How many times smaller is the Central Radio Tower than the Canton Tower? What is this as a ratio?

c What is the height of the Great Pyramid compared with the height of the Eiffel Tower? Give your answer as a percentage.

d What is the ratio of the height of the Great Pyramid compared with the height of the Canton Tower? Give your answer as a simplified whole number ratio.

e What is the ratio of the height of the Petronas Towers compared with the height of the Eiffel Tower? Give your answer as a simplified whole number ratio.

Activity 2: Making concrete

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Concrete is made by mixing cement, sand and aggregates (stones). Enough water is added to make the mix workable. All the materials are then well mixed.

The relative amount of each material affects the properties of concrete. The table below shows the mix ratios used for some common, different purposes.

Application	Cement	Sand	Aggregate
Paths/Driveways/ Light shed floors	1	2	4
Heavy duty floors/ Pre-cast items	1	2	3
Post installation/ Normal static loads	1	3	6
High strength floors/Columns	1	1	2
Foundations/ Footings	1	3	3
Mortar	1	4	
Render	1	3	

Practice question

Work out the amounts of each material needed for each of the following projects. The first one is done as an example for you.

Project	Total amount of dry ingredients	Cement	Sand	Aggregate
Heavy duty floor	30 shovels	5 shovels	10 shovels	15 shovels
Path				10 shovels
Mortar			5 shovels	
Column	24 shovels			
Footings	3.5 m^3			
High strength floor	3 m^3			

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3B Tuning in

Understanding and being able to use a range of different calculations is important. In some endeavours this is a vital task and, as in the story below, the ability to undertake calculations efficiently and accurately was a critical task in the early days on researching and investigating travel in space.

Epic Success: Human computers

This is a story of women who did the calculations as part of all the research and mathematics that underpinned the science and physics of space exploration. Even before the space age launched back in 1957, women have worked on the United States' space effort, often as critical team members behind the scenes. The original National Advisory Committee for Aeronautics (NACA), which transformed into the National Aeronautics and Space Administration (NASA) in 1958, employed women in roles that were called 'human computers'. The term 'computer' referred to a job title for someone who performed highly complex mathematical calculations, not machines. These were people who processed data for aviation experiments and, eventually, spaceflights and they carried out these calculations completely by hand.

Mary Jackson (1921–2005)

Katherine Johnson (1918–2020)

Located at the Langley Research Center in Hampton, Virginia, all of NACA's and then NASA's human computers were women, and many of them were African American. Three of these famous mathematicians were Mary Jackson, Katherine Johnson and Dorothy Vaughan. Their work helped one of the

... continued

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

first American astronauts, John Glenn, orbit Earth in 1962 and ensured the safety of the mission. They were all brilliant scientists, and their job was to crack complex maths-based problems to make sure that astronauts could travel safely in space.

Examples of the calculations they undertook by hand included trajectory calculations for the first US orbital mission, where they needed to work to 8 significant digits.

For further information, use the internet to search about the work and careers of the three women and 'human computers'. You may like to try the 'Space.com' and NASA websites.

Dorothy Vaughan (1910–2008)

Discussion questions

1. Are you surprised about this story? If you are, in what ways?
2. What do you think might have been some of the consequences in their work at NACA and NASA of making an error in their calculations?
3. Discuss how this story relates to what we call **algorithms**. An algorithm is a set of step-by-step instructions that shows the order in which a process should be followed for an event to occur or for a problem (in our case a mathematical problem) to be solved. We use them, like when adding and subtracting numbers, or following the BODMAS rules for the order of operations and more. But algorithms are also used to program all of the devices we use in our lives – like computers, video games, our smartphones to your home's washing machine, as well as things like cars, aeroplanes and more. They all rely on the algorithms written into them by humans. Do you think algorithms were part of the processes that Mary Jackson, Katherine Johnson and Dorothy Vaughan employed in their work?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Practice questions

1 I have a diagram of a rectangle with sides 12 cm and 8 cm.

a What will be the length of the sides if I halve these dimensions?

b What can the lengths of the sides be if I halve the area?

2 A recipe to make 8 pancakes needs $2\frac{1}{4}$ cups of self-raising flour, 2 eggs, and 250 mL of milk. How much of each ingredient would you need to make 24 pancakes?

3 Housemates Sonia, Tran and Javi go to a restaurant for dinner. The total bill was $175.00, but one of them did not eat as much or drink as much as the other two. So, the friends decide to share the bill in the ratio of 2 parts to 2 parts to 1 part. How much did each person pay?

4 Malik receives a $240 discount on a lawn mower because it is the demonstration model. It was originally $699. What is the percentage discount that Malik receives, correct to 1 decimal place?

5 Work out what proportions each of the following financial transactions or payments are. Give your answers in two forms as:

- a percentage – round your answers to 1 decimal place
- a fraction – round your answers to the closest unit fraction (e.g. $\frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \frac{1}{5}$).

a A cash payment of $1,000 towards a new bike worth $4,750

b A share of $30 towards the total cost of a shared 18th birthday present worth $119.55

c A late payment penalty of $38.82 on a bill of $310.55

6 Work out what ratios each of the following are and express your answers as simplified whole numbers.

a A payment of $200 compared to one of $750

b A fortnight compared to five days

c A length of 2250 mm compared to a length of 4 m

7 Kala's taxable income for the past financial year was $136,000. They must pay 2 per cent of this income as a Medicare levy. Calculate how much Kala must pay.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3C Refresher on ratios and proportions

Ratios and proportions involve the comparison of two (or more) quantities and describe how the quantities relate to each other. For example, we use ratios and proportions when we resize photos to use on social media or in photo albums, or when we work out **unit prices** to compare different sized products, or when we compare different lengths or heights of objects, like we did with the tall buildings earlier on. They are also used in making up products like cordial, concrete or chemicals.

Refer to section 3F of the Units 1 & 2 textbook if you need a refresher on the topic of ratios and proportions.

Ratios

A common, everyday example of the use of ratios is in making up cordial.

For example, cordial is often mixed in the ratio of 1 part cordial syrup to 4 parts water.

Example 1 Using ratio to calculate how much of a quantity is needed

Calculate the amount of water to mix with 125 mL of cordial syrup in the ratio of cordial syrup : water = 1 : 4.

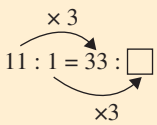
THINKING	WORKING
STEP 1	
Write the ratio of cordial syrup : water.	cordial syrup : water = 1 : 4
STEP 2	
The amount of cordial syrup is 125 mL. Since we need to multiply the ratio value for cordial syrup by 125 to have 125 mL, we need to also multiply the ratio value for water by 125. Then, write the ratios.	$1 \times 125 = 125$ $4 \times 125 = 500$ So, 1 : 4 = 125 : 500
$\overset{\times 125}{\curvearrowright}$ $1 : 4 = 125 : \square$ $\underset{\times 125}{\curvearrowright}$	
STEP 3	
Apply the ratio to calculate the amount of water needed.	Amount of water needed is 500 mL.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

When we know a ratio, we can use it in reverse to find out the total numbers required.

Example 2 Using ratio in reverse

The expected ratio of preschool children to staff in a childcare setting in Victoria is 11 children per staff member.
How many staff members are required in a preschool that has 33 children enrolled?

THINKING	WORKING
STEP 1	
Write the ratio of children to staff.	children : staff = 11 : 1
STEP 2	
The number of children is 33. Since we need to multiply the ratio value for children by 3 to have 33 children, we need to also multiply the ratio value for staff by 3. Then, write the ratios.	$11 \times 3 = 33$ $1 \times 3 = 3$ So, 11 : 1 = 33 : 3
	
STEP 3	
Apply the ratio to calculate the number of staff needed.	3 staff members are required for 33 children.

Writing a ratio in its simplest form helps when we are doing calculations.

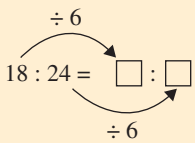
Example 3 Simplifying a ratio

Write the ratio 18 : 24 in its simplest form.

THINKING	WORKING
STEP 1	
Identify the factors of 18 and 24.	Factors of 18: 1, 2, 3, 6, 9, 18 Factors of 24: 1, 2, 3, 4, 6, 8, 12, 24
STEP 2	
Find the highest common factor (HCF) of 18 and 24.	HCF = 6

... continued

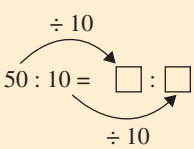
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 3	
Divide each number (18 and 24) by the HCF of 6. Then, write the ratios.	18 ÷ 6 = 3 24 ÷ 6 = 4 So, 18 : 24 = 3 : 4
	
STEP 4	
Write your answer.	The ratio 18 : 24 can be simplified to 3 : 4.

When measurement units are involved with a ratio, it is necessary to make the units the same before applying the ratio.

Example 4 Writing a ratio in the same units

Write 5 cm to 10 mm as a ratio.

THINKING	WORKING
STEP 1	
Convert 5 cm to mm. (1 cm = 10 mm)	5 cm = 5 × 10 = 50 mm
STEP 2	
Write the comparison as a ratio. Since the units are now the same, they can be left out.	50 mm : 10 mm = 50 : 10
STEP 3	
Find the highest common factor (HCF) of 50 and 10.	HCF = 10
STEP 4	
Divide each number (50 and 10) by the HCF of 10. Then, write the ratios.	50 ÷ 10 = 5 10 ÷ 10 = 1 So, 50 : 10 = 5 : 1
	
STEP 5	
Write your answer.	The simplest ratio of 5 cm to 10 mm is 5 : 1.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Proportion

Using and applying proportional thinking is used in solving many daily life problems such as in business while dealing with sales, working times and transactions; when making different products; or while cooking etc. It is about the relationship between two or more quantities, and it helps when you need to make comparisons.

Proportion, in general, is referred to as a part, share or number considered in comparative relation to a whole. Mathematically, proportion is defined that if two ratios are equivalent, then they are in proportion.

We've all seen the effects when someone has distorted a photograph by changing the length or the width of the photo, and not adjusting the other dimension so as to keep the photo in proportion.

We also use this knowledge when we are scaling a recipe up or down. All the ingredients need to stay in their original proportion.

Here is an example of a pizza base recipe. It makes three bases. What needs to happen if we need to make a lot more pizza bases than the recipe says? Here is how to work it out.

Pizza base (makes 3 bases)

$1\frac{1}{2}$ cups water
2 tsp (7 g) dried yeast
Pinch caster sugar
4 cups plain flour
1 tsp salt
$\frac{1}{4}$ cup olive oil

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 5 Using proportions

Calculate the amount of ingredients needed for 12 pizza bases using the recipe for three bases on the previous page.

THINKING	WORKING
STEP 1	
Work out how many times bigger the amount we want to make is, compared to the recipe.	12 bases = 3 bases × 4 Our quantities will be 4 times the quantities in the recipe.
STEP 2	
Scale up the quantities by a factor of 4. That is, multiply each quantity by 4.	$1\frac{1}{2}$ cups × 4 = 6 cups water 2 tsp (7 g) × 4 = 8 tsp (28 g) dried yeast Pinch × 4 = 4 pinches caster sugar 4 cups × 4 = 16 cups plain flour 1 tsp × 4 = 4 tsp salt $\frac{1}{4}$ cup × 4 = 1 cup olive oil

Ratios and proportions

Two ratios are said to be in proportion when the two ratios are equal. For example, when shapes are 'in proportion' their relative sizes are the same.

In these two photos, the dimensions (width and height) are in proportion as the ratios are the same. They look identical – just one is larger than the other.

Dimensions of photo:
width = 7.5 cm, height = 5 cm.
Ratio is width : height = 7.5 : 5
= 3 : 2 when simplified.

Dimensions of photo:
width = 6 cm, height = 4 cm.
Ratio is width : height = 6 : 4
= 3 : 2 when simplified.

So, the two photos are in proportion as their ratios are equal.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

In another example, a steel pipe's length and weight will be in proportion. For example, if 4 m of pipe weighs 4.5 kg, then:

- 8 m of that pipe weighs 9 kg (double both values)
- 40 m of that pipe weighs 45 kg (ten times both values).

If we compare the length to the weight:

4 : 4.5 = 8 : 9 when simplified (multiply both values by 2), which is the same as

40 : 45 = 8 : 9 (divide both values by 5).

3C Tasks and questions

Thinking task

1 Research to find five different jobs that use ratio or proportion and give an example for each. Discuss and compare your list with your classmates.

Mathematical literacy

2 Work with a small group of students to research the different use and meanings of the two key words related to this section: ratio and proportion.

Do we use them only in a mathematical sense or are they used both in maths and also in use outside of the world of maths? How do we use them within maths versus out-of-maths contexts? How is their use and meaning related?

Skills questions

3 Complete the following.

a For every 20 chairs, there are 5 tables.

i For every _____ chairs there is 1 table.

ii The ratio of chairs to tables is _____ : 1.

iii The ratio of tables to chairs is _____ : ____.

b For every 6 votes in favour, there are 4 votes against.

i For every 12 votes in favour, there are _____ votes against.

ii For every _____ votes in favour, there are 20 votes against.

iii For every 3 votes in favour, there are _____ votes against.

iv The ratio of votes in favour to votes against is _____ : 2.

v The ratio of votes against to votes in favour is _____ : _____.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4 Simplify the following ratios.

a 9 : 6

b 14 : 7 : 21

c 2.5 : 5

d 6 : 1.5

5 Write the following as ratios.

a 1 tin of white paint to 3 tins of red paint

b 11 children to 2 adults

c 50 mm to 30 mm

d 60 minutes to 37 minutes

6 Convert these ratios to their simplest form.

a 18 cm to 30 mm

b 100 metres to 2 kilometres

c $4 to 50 cents

d 250 g to 2 kg

7 For each of the following tables, write down the ratio of the top number (x) to the bottom number (y), and use this to calculate the missing numbers in the table.

a Ratio _____ : _____

x	1	2	4	7	
y	5	10	20		45

b Ratio _____ : _____

x	10	20	40	50	
y	4	8	16		44

8 Complete the following tables.

a Ratio 5 : 3

x	10	15	40	50	100
y					

b Ratio 2 : 3

x	2	4	6	10	40
y					

9 Which of the following pairs of ratios are in proportion?

a 4 : 9 and 7 : 12

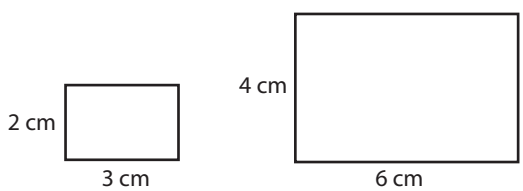
b 2 : 1 and 12 : 6

c 5 : 2 and 10 : 6

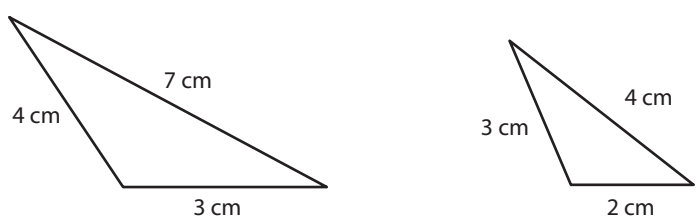
d 3 : 4 : 5 and 9 : 16 : 25

10 Which of the following shapes are in proportion?

a



b



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

11 Find the missing number in these proportional ratios.

a 60 : 15 and ? : 5

b ? : 3 and 24 : 12

c 9 : 33 and 18 : ?

d 17 : ? and 34 : 18

12 Using the recipe for muffins listed below, decide whether you will need to multiply or divide, and calculate the scale factor. Scale the given ingredients up or down as required.

Blueberry muffins (makes 12)

Ingredients:

$2\frac{1}{4}$ cups self-raising flour
90 g butter
$\frac{3}{4}$ cup brown sugar
125 g blueberries
1 cup milk
2 eggs

Complete the following.

a To make 96 muffins:

i I will have to multiply/divide by _____.

ii I will need _____ g of butter.

iii I will need _____ cup(s) of flour.

b To make 6 muffins:

i I will have to multiply/divide by _____.

ii I will need _____ egg(s).

iii I will need _____ cup(s) milk.

Mixed practice

13 For each of the following, find the ratio and then complete the table.

a Ratio _____ : _____

a	3	6	9	12	
b	9	18	27		45

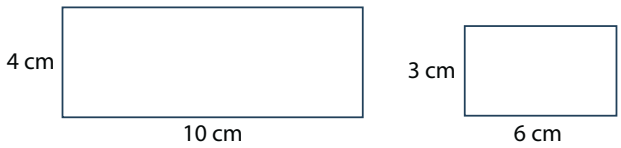
b Ratio _____ : _____

a	4	8	12		40
b	3	6	9	15	

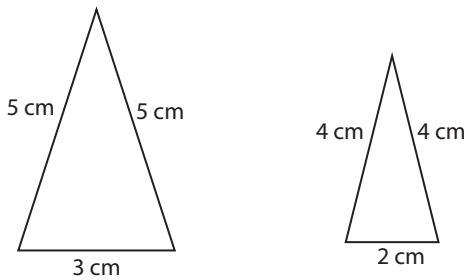
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

14 If the following pairs of shapes are in proportion, state the ratio. If a pair of shapes is not in proportion, apply a ratio so the second shape is in the same proportion as the first shape, copy the shapes and write the correct dimensions.

a



b



15 A recipe asks for 6 eggs and 4 cups of flour. But you only have 4 eggs.

a By what factor will you have to adjust the recipe?

b If the original recipe made 12 pieces, how many pieces will you be able to make with the adjusted recipe?

c How much flour will you need in the adjusted recipe?

16 Which of the following pairs of ratios are in proportion?

a 6 : 1 and 66 : 10

b 2 : 3 and 12 : 13

c 7.5 : 2 and 22.5 : 5

d 5 : 9 and 12.5 : 22.5

Application tasks

17 A car rally route is being planned as a fund-raising event for charity. A map is drawn up with 1 cm representing 2 km.

a The actual distance between two landmarks on the route is 4 km. How long would the distance be on the map?

b On one section of the route, there is a left-hand turn 1 cm after a landmark. How far is this in actual distance?

18 James, Lin, Bob and Sharon buy a Lotto ticket each week. James contributes $5.00, Lin puts in $10.00, Bob and Sharon each put in $2.50.

a Write the ratio that represents the four contributions. (Make sure you express the ratio in whole numbers.)

b One week they won $400.00. How much would each get if they shared the winnings in their contribution ratio?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

19 A Feed and Weed Lawn solution is mixed with water in the ratio 16 mL of solution to 4 L of water.

a Write the mix as a ratio.

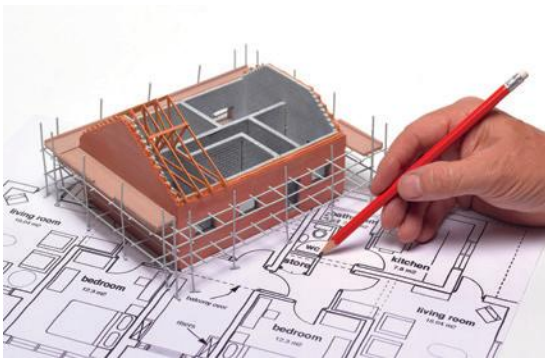
b How much solution would you mix with:

i 8 L water? **ii** 2 L water? **iii** 500 mL water?

c How much water would you need if you used:

i 20 mL solution? **ii** 4 mL solution? **iii** 1 mL solution?

20 A house plan is drawn at a scale of 1 : 100. For each of the following items shown on the plan, calculate the actual size.



a The garage door is 25 mm on the plan.

b The bench in the laundry is 8.5 mm wide.

c The wall in the family room is 48 mm long.

d The stairwell is 9.5 mm wide.

21 A plastics manufacturer mixes Chemical A and Chemical B in the ratio of 3 : 2 to produce a polymer.

a For a particular job, 15 kg of Chemical A is specified. How much of Chemical B is required?

b If there was 75 kg of input specified in total, how many kilograms of each of Chemical A and Chemical B would be required?

22 When colouring hair, hairdressers often mix two colours using the formula: 3 parts primary colour : 1 part secondary colour : 4 parts developer.

a If one part is 50 g, how much colour mix will be made in total?

b For long hair, it is suggested that you will need 600 g of colour mix. How much each of primary colour, secondary colour and developer will be required?

c Fabian was mixing the colour for a client, and he added 8 parts of developer instead of 4. What can he do to restore the mix to the correct ratio?

d Svetlana goes to mix colour for a client and finds there is not enough developer. There is only 160 g of developer, and she needs 200 g. What adjustment will she need to make to the quantities of primary and secondary colours?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3D Proportions and direct variation

How many hours we work and how much we are paid is an example of what is called **direct variation** or **direct proportion**. As a casual employee, if we don't work any hours, we don't get any pay, and for each hour of pay, our pay goes up by the same amount for each hour we work.

In the previous section, the cooking examples involve recipes where the quantity of each ingredient needed depends upon the number of portions. As the number of portions increases, the quantity required increases. The quantity per portion is the same. This is another example of direct variation – the quantity is said to be **directly proportional** to the number of portions.

Similarly, when we are buying multiple packets of an item, and we know the cost per item, we use direct variation to calculate the total cost.

Two variables are in direct proportion if as one increases, the other increases by the same factor and vice versa.

Example 6 Calculating a direct variation

In your part-time job, you work a 4-hour shift and earn $60. How much would you earn if you worked a 10-hour shift?

THINKING	WORKING
STEP 1	
List the amount earned for 4 hours.	Pay for 4-hour shift = $60
STEP 2	
Calculate the amount earned for 1 hour by dividing $60 by 4. This means that 4 × $15 is $60.	Pay for 1 hour = $60 ÷ 4 = $15 So, pay for a 4-hour shift = 4 × $15 = $60
STEP 3	
Hence, calculate the amount earned for 10 hours by multiplying 10 by $15 to keep the amounts in direct proportion.	10 × $15 = $150
STEP 4	
Write the answer.	The pay for a 10-hour shift will be $150.

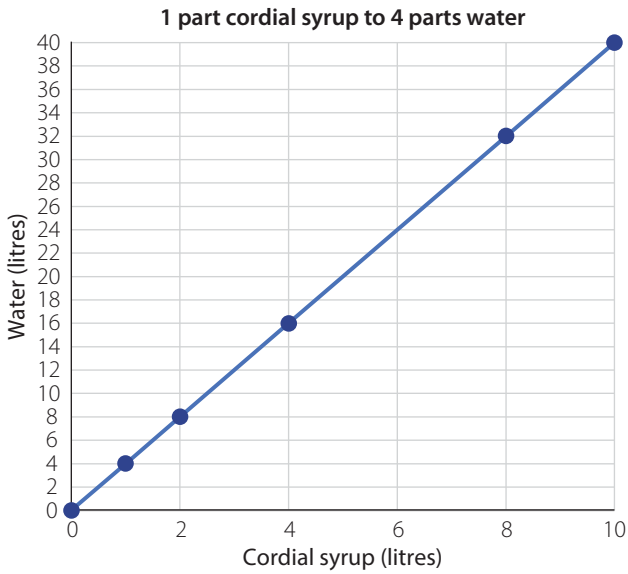
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 1 (Cordial) in the previous section is a good application of direct variation.

This relationship can be presented as a table.

Total amount required	5 litres	10 litres	20 litres	40 litres	50 litres
Amount of cordial syrup	1 litre	2 litres	4 litres	8 litres	10 litres
Amount of water	4 litres	8 litres	16 litres	32 litres	40 litres

This is how the relationship looks when presented as a graph.



The key features of a graph showing direct variation are:

- It is a straight line.
- The graph always goes through the origin – the point (0, 0).

Creating a direct variation table and graph

Cleaners need to mix a disinfectant solution for cleaning hard surfaces. The undiluted bleach has a 1% concentration and needs to be diluted in a ratio of 1 : 9 with water to achieve the required 0.1% bleach solution.

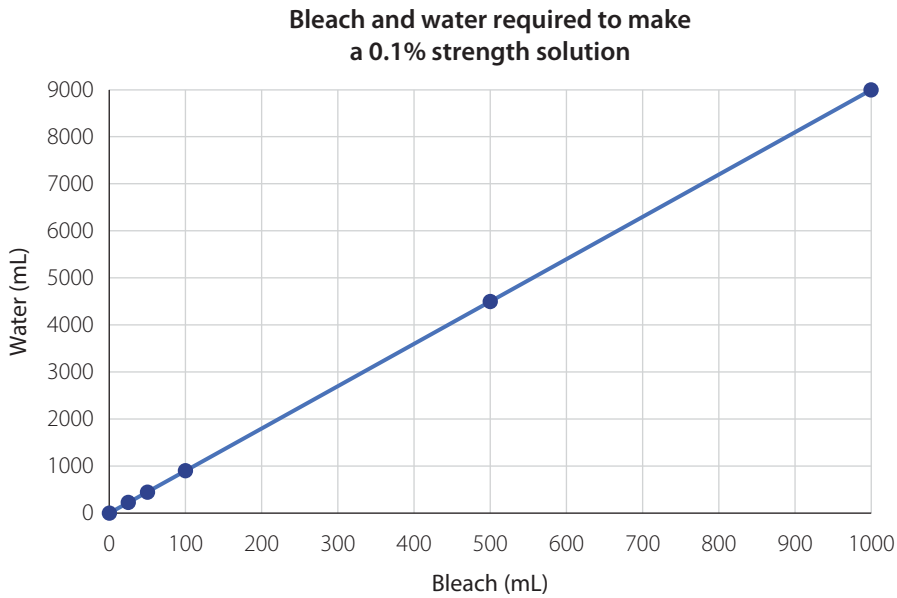
Here is a table of values for the different amounts of cleaning solution.

Amount of cleaning solution	250 mL	500 mL	1 L	5 L	10 L
Amount of bleach	25 mL	50 mL	100 mL	500 mL	1 L
Amount of water	25 mL × 9 = 225 mL	50 mL × 9 = 450 mL	100 mL × 9 = 900 mL	500 mL × 9 = 4500 mL = 4.5 L	1 L × 9 = 9 L

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Creating a direct variation graph

We can use the direct variation ratio to create both the table and graph by hand, or you can use spreadsheet software like Excel, which can be more efficient and provide good quality graphs.



3D Tasks and questions

Thinking task

1 List at least three other circumstances where direct variation is a part of your life or work. Share and compare these with your classmates.

Skills questions

2 Petrol is mixed with oil in the ratio of 40 : 1 to produce chainsaw fuel.

a Complete the table below to show the amounts of oil and petrol required to create the total amounts of fuel. Round your answers to 2 decimal places.

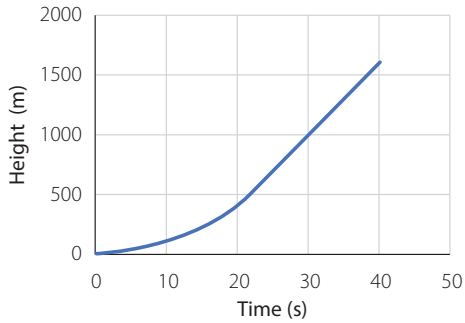
Total fuel (L)	5	10	20	40	60
Petrol (L)					
Oil (L)					

b Create a graph showing this direct variation.

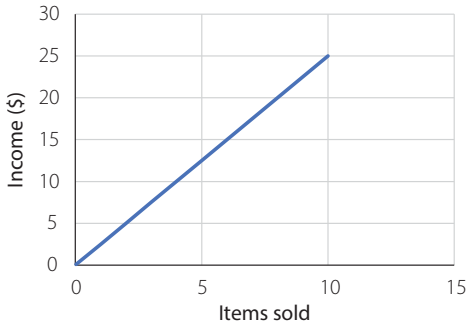
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3 Identify which of the graphs below represent relationships that are directly proportional.

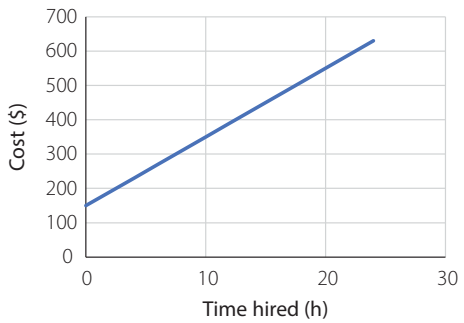
a



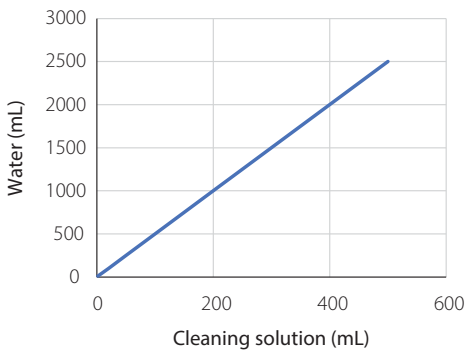
b



c



d



4 The cost of filling a car with petrol is shown in the table below.

Amount of petrol (L)	0	5	10	15	20	25	30
Cost ($)	0	9	18	27	36	45	54

a Draw a graph of cost versus amount of petrol.

b Is the cost of petrol directly proportional to the amount of petrol purchased? How do you know?

Mixed practice

5 Ishmail is paid $17.20 per hour. How much will he be paid if he works 34 hours?

6 Morey makes ceramic buttons which he sells as packets of 10 for $15 at markets.

a Create a table to show his income if he sells up to 40 packets.

b Create a graph of this scenario.

c Is this direct variation? Why?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

7 Sam makes candles using the ratio of 3 mL of essential oil to 500 g of wax.

a How much wax is needed if she uses 3 L of essential oil?

b How much essential oil is needed if she uses 4 kg of wax?

8 The volume of soft drink in a can is directly proportional to the height of liquid in the can. When there is 350 mL in the can, the height of the liquid is 10 cm.

a What is the height of the liquid when there is 200 mL of soft drink in the can? Round your answer to 2 decimal places.

b What volume of soft drink is there in a can when the height of liquid is 25 cm?

Application tasks

9 One American tablespoon measures 15 mL, while one Australian tablespoon measures 20 mL. When we are using an American recipe, we need to convert American tablespoons to mL.

a Create a table that shows the conversion of 0 to 6 American tablespoons into mL.

b Create a graph of this direct variation.

10 One of the services Brett offers to the clients of his lawn mowing round is to fertilise the lawns every spring. The fertiliser is applied at the rate of $\frac{1}{2}$ kg for every 7 m^2 of lawn.

a Calculate the amount of fertiliser required for a lawn that covers an area of:

i 84 m^2

ii 196 m^2

iii 784 m^2

iv 2940 m^2.

b One day, Brett has a total of 861 m^2 of lawn requiring fertilising. If fertiliser is supplied in 20-kg bags, how many bags will he need to load onto his truck to be able to carry out the day's work?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3E Indirect variation

Indirect variation (or **indirect proportion**) is when one component or variable increases, the other decreases, and vice versa. This is the opposite from what happens in direct variation or direct proportion. We also call this **inverse variation** (or **inverse proportion**).

For example, the amount of time it takes to travel a certain distance is inversely proportional to your speed – the faster you go, the less time it will take. In mathematical terms, we would say that 'time is inversely proportional to speed'.

Other examples include:

- The more people you have to complete a project, the less time it takes to complete.
- The amount of light you see diminishes as you get further away from the source.
- The number of pizza slices per person is inversely proportional to the number of people eating pizza.

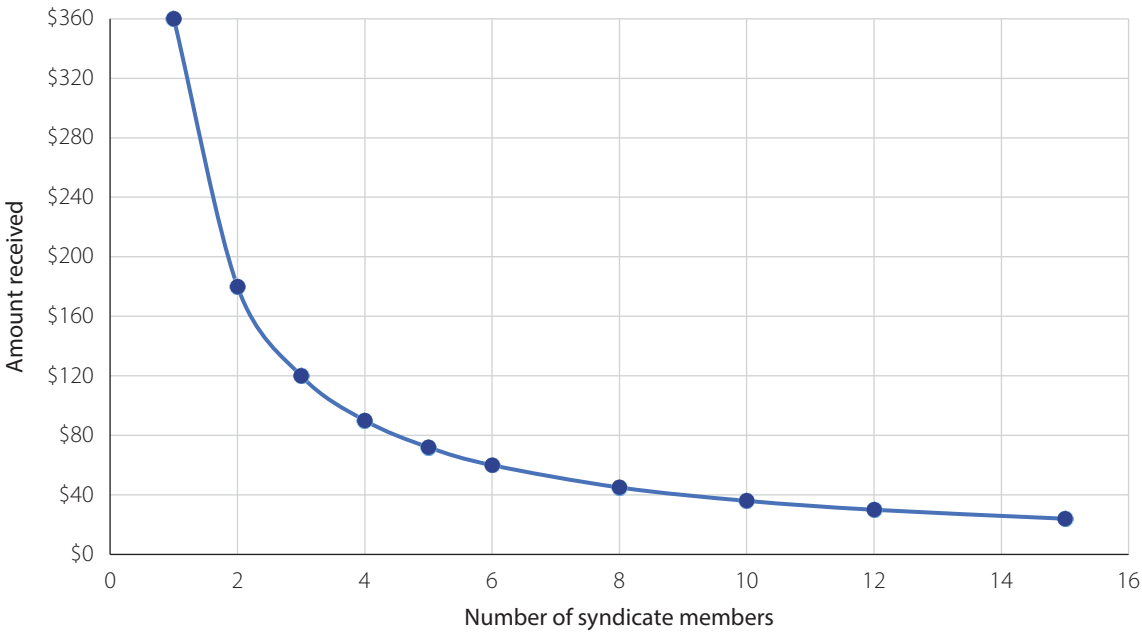
Calculating indirect variation

A syndicate group wins a Lotto prize of $360.00. The more members in the syndicate, the less money each person receives, as can be seen in this table.

Number of members	1	2	3	4	5	6	8	10	12	15
Prize each receives	$360	$180	$120	$90	$72	$60	$45	$36	$30	$24

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

The following graph can be obtained from the table of data.



All indirect variation graphs are curved like this one, and do not pass through the origin (0, 0). The mathematical name of this graph is a **hyperbola**.

Example 7 Calculating an indirect variation

When one person mows the school grounds and oval, it takes 6 hours. How long would it take if two people mow at an equal rate?

THINKING	WORKING
STEP 1	
How long does it take one person to mow the grounds and oval?	1 person takes 6 hours.
STEP 2	
If there are two people, the number of people has been multiplied by 2. The time needs to be divided by 2. (The inverse of $\times 2$ is $\div 2$.)	6 hours $\div$ 2 = 3 hours
STEP 3	
Write the answer.	Working at the same rate, it will take 3 hours for two people to mow the school grounds and oval.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 8 Calculating an indirect variation

When filling a large water tank, it takes two pumps 10 hours to fill it from the dam. How long will it take four, five or ten of the same pumps to fill the tank?

THINKING	WORKING
STEP 1	
How long does it take two pumps to fill the water tank?	Two pumps take 10 hours.
STEP 2	
If there are 4 pumps, the number of pumps has been multiplied by 2. The time taken needs to be divided by 2. (The inverse of × 2 is ÷ 2.)	10 hours ÷ 2 = 5 hours Four pumps will take 5 hours to fill the dam.
STEP 3	
If there are 5 pumps, the number of pumps has been multiplied by 2.5. The time taken needs to be divided by 2.5. (The inverse of × 2.5 is ÷ 2.5.)	10 hours ÷ 2.5 = 4 hours Five pumps will take 4 hours to fill the dam.
STEP 4	
If there are 10 pumps, the number of pumps has been multiplied by 5. The time taken needs to be divided by 5. (The inverse of × 5 is ÷ 5.)	10 hours ÷ 5 = 2 hours Ten pumps will take 2 hours to fill the dam.

3E Tasks and questions

Thinking task

1 If it takes one cleaner 2 hours to clean a kitchen, using indirect variation we can calculate that it will take six cleaners 20 minutes to clean the kitchen. Is this reasonable in real life? Why or why not?

Share your thinking with your classmates.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mathematical literacy

2 Like in a previous section, work with a small group of students to research the different use and meanings of the different key words and terms we have used in the last two sections.

- proportion
- variation
- direct
- indirect
- inverse
- direct proportion
- direct variation
- indirect proportion
- indirect variation
- inverse proportion
- inverse variation

How do we use the five words in the first column within the world of maths versus out-of-maths contexts? Are some of these words and the associated terms only really used within the world of maths? Is their use and meaning related, and in what ways?

Skills questions

3 Four painters take 3 days to paint a fence. How many days would it take two painters to paint the same fence?

4 A receptionist takes 5 hours to fold 100 letters and put each one in an envelope. How long would the task take if four people worked on it?

5 If 9 hoses can fill a pool in 4 hours, how long will it take 12 hoses flowing at the same rate to fill the pool?

6 Calculate the length of time a 540 km journey would take if you travelled steadily at:

a 120 km/h **b** 90 km/h **c** 60 km/h.

7 An advertising agency has 48 000 pamphlets to be delivered.

a Assuming that each person works at the same rate, complete the table below.

Number of people	1	2	3	4	6	8	10
Number of pamphlets per person							

b Construct a graph of the information in this table.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

8 An electricity company has been contracted to install 4800 electrical sockets in a new building. Assuming that each person works at the same speed, complete the following.

a Construct a table showing how many sockets would be installed if there were 1, 2, 3, 4, 5, 6, 8, 10, 12, 16 or 24 electricians available to complete this contract.

b Construct a graph of the information in this table.

Mixed practice

9 A device has 95% charge before use, but this charge reduces to 87% after one hour's use. It then drops to 62% after two hours' use, and 24% after three hours' use.

a Construct a graph showing the decrease in charge over time.

b Use this graph to estimate when the battery has 50% charge.

10 It usually takes 6 workers 24 hours to build a flood barrier – but the barrier needs to be built before the peak of the flood emergency in 8 hours.

a How many workers would be needed?

b Complete this table.

Number of workers	2	4	6	8	10	12
Hours taken to build barrier			24			

Application task

11 At the 2016 Rio Olympics, the synchronised swimming pool turned green because hydrogen peroxide was added to the water by mistake. The decision was made to pump 3.73 million litres of green water out of the pool and replace this water with 'clean' water pumped from one of the training pools.

a If 3 pumps were used that could each pump water at the rate of 100 litres/second, how many hours would it take to pump out the 3.73 million litres? Round your answer to a whole number of hours.

b In fact, the task was accomplished in 6 hours. Estimate how many identical pumps were used? Round your answer appropriately.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3F Refresher on calculating with percentages

Percentages are everywhere in our lives. When we are shopping, we look for percentage discounts, or wait for the '20% off everything in store' sales. If the Bureau of Meteorology forecast is a 5% chance of rain, we probably won't bother packing our umbrella. Australia's **Goods and Services Tax (GST)** rate is 10% added to the cost of everything except essential food and services.

This section is a refresher of the skills you might need when working with percentages.

A **percentage** is the rate, number or amount of something in each or every hundred. We often say this as *per* hundred.

Example: What do students drink?

A cafe on a TAFE college campus conducts market research about what students drink. After they collect the data, they calculate the percentages of student's drinking habits so that it's easier to compare and analyse.

There are three common and different types of percentage calculations.

1 Calculating a *percentage (%)* given the amount and the total.
e.g. If we have a class of 25 students, and 5 of them drink coffee, then the fraction who drink coffee is $\frac{5}{25}$. Expressed as a percentage (how many per hundred), this is $\frac{5}{25} \times 100 = 20\%$. This can be called finding the **unknown percentage**.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

2 Finding the *amount* if we know the percentage and the total.
e.g. If it is expected that 25% of students in a sample drink coffee, then in a group of 120 students we would calculate that 25% × 120 = 30 students drink coffee. This can be called finding the **unknown amount** or **unknown part**.

3 Finding the *total* if we know the percentage and its matching amount. This is where we need to work backwards.
e.g. If we know that there is a big group of students where 50 of them drank coffee and that 25% drank coffee, then the total number of students in the original whole sample would have been 4 times as many (4 × 50 = 200) because 25% is only $\frac{1}{4}$ of the students in the total (and 25% × 200 = 50). Mathematically, this is 50 (amount) ÷ 25% = 200. This can be called finding the **unknown total** or **unknown whole**.

Percentages are always expressed as out of 100. This is hidden within the % symbol.

Percentages are useful because it does not matter what unit we are using in the calculation – they become comparable because as percentages they are all expressed as 'out of 100'.

Percentages can be greater than 100. Think of the weight of a baby when it is born compared with its weight when it is one year old.

It is often useful to know the most common fractions as decimals and as percentages. These are often referred to as **equivalent** fractions, decimals and percentages.

Fraction	Decimal	Percentage
$\frac{1}{10}$	0.1	10%
$\frac{1}{4}$	0.25	25%
$\frac{1}{3}$	$0.\dot{3}$	$33.\dot{3}\%$
$\frac{1}{2}$	0.5	50%
$\frac{3}{4}$	0.75	75%
$1\frac{1}{2}$	1.5	150%
$\frac{2}{1}$	2.0	200%

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Here are some examples of the three types of percentage calculations that you need to be able to do.

Note: In each of these worked examples showing percentage calculations, you can work them out in ways that you are most familiar with, most likely with a calculator. In the next section, there is a refresher on how to use the % button on your calculator for a full range of percentage calculations. Refer to section 3G of this book if you need support on how to calculate percentages on your calculator – or talk to your teacher.

Finding the unknown percentage

To find a *percentage* given the amount and the total, we use:

$$\text{Percentage} = \frac{\text{amount}}{\text{total}} \times 100$$

Example 9 Calculating a percentage when a total amount is known

Find the percentage of cars using a side road in a day, given that 230 cars were counted out of a total of 287 vehicles.

THINKING	WORKING
STEP 1	
List the known information. How many cars were counted? How many vehicles in total?	 Number of cars: 230 Total number of vehicles: 287
STEP 2	
Substitute the information into the formula: $\text{Percentage} = \frac{\text{amount}}{\text{total}} \times 100$	$\text{Percentage} = \frac{230}{287} \times 100$
STEP 3	
Use a calculator to find the result and round appropriately.	$= 80.139\ldots\%$ $\approx 80\%$
STEP 4	
Write your answer.	Of the 287 vehicles using a side road, 80% were cars.

Finding the unknown amount

To find the *amount* if we know the percentage and the total, we use:

$$\text{Amount} = \frac{\text{percentage}}{100} \times \text{total}$$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 10 Calculating an amount when the percentage is known

How much would you pay for a computer monitor when the original price was $420 and the store was advertising 15% off everything?

THINKING	WORKING
STEP 1	
List the known information. What is the original price? What is the percentage discount?	Original price: $420 Percentage discount = 15%
STEP 2	
Substitute the information into the formula: $\text{Amount} = \frac{\text{percentage}}{100} \times \text{total}$	$\text{Amount of discount} = \frac{15}{100} \times 420$ $= \$63$
STEP 3	
Subtract the discount to calculate the sale price.	$\text{Sale price} = \$420 - \$63$ $= \$357$
STEP 4	
Write your answer.	When a 15% discount is applied to a monitor selling at $420, you would pay $357.

Finding the unknown total

To find the *total* if we know the percentage and its matching amount, we use:

$$\text{Total} = \frac{\text{amount}}{\text{percentage}} \times 100$$

Example 11 Calculating the total when the amount and percentage are known

The price Dino pays for a laptop is $935.00. This amount includes GST of 10% of the original price. What was the original price before GST was included?

THINKING	WORKING
STEP 1	
List the known information. What was the price paid? What is the percentage to be applied?	Amount paid: $935 Percentage: 100 + 10 = 110%

... continued

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 2	
Substitute the information into the formula: $\text{Total} = \frac{\text{amount}}{\text{percentage}} \times 100$ In this case, the 'total' is the original price.	$\text{Original price} = \frac{935}{110} \times 100$ $= \$850$
STEP 3	
Write your answer.	The price of the laptop before the 10% GST was applied was $850.

3F Tasks and questions

Thinking tasks

1 In a small group, discuss the following scenarios.

a Over summer, the level of a dam decreased by 15%. During autumn there was a lot of rain and the dam level increased by 15%. Will the level of the dam be the same at the end of autumn as it was at the start of summer?

b Is 32% of 15 the same as 15% of 32? Why or why not?

2 Think of some applications where we use percentages in real life. Why are percentages used instead of other types of numbers (such as integers and decimals)? For example, a store advertises 10% off. Why not $10 off? A bank charges interest at 4.2%, why not $50 a day?

Skills questions

3 Write the following as percentages, correct to 1 decimal place.

a 16 out of 145

b 78 out of 192

c 23.5 out of 76

d 18.3 out of 22.64

4 Find the amount, given the percentage and the original total, to an appropriate number of decimal places.

a 12% of 65

b 60% of 43.5

c 55% of 88.99

d 35% of 612.50

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

5 Find the original total, given the percentage and the amount, correct to 1 decimal place.

a 66% of the original total is 724

b 24% of the original total is 52

c 58% of the original total is 85.5

d 15% of the original total is 21.5

Mixed practice

6 Find the original total given a percentage of 20% and an amount of 64.

7 Find 64 out of 92 as a percentage.

8 Find the value given a percentage of 45% and an original total of 80.

9 Find the original total given a percentage of 80% and an amount of 4000.

10 Find the number given a percentage of 5% and an original total of 945.

11 Find the percentage of 365 out of 852.

12 Find the part given a percentage of 18% and a whole total of 562.

Application tasks

13 What is in our milk? Use the information taken from the side of a 2-litre carton of milk to answer the following questions.

Nutrition Facts

Serving size: 1 serving = Approximately 250 mL

	Qty per serving	Qty per 100 g / 100 mL	% daily intake*
Energy	672.25 kJ	268.9 g	7
Energy Cal	160.83 Cal	64.33 g	
Protein	8.75 g	3.5 g	
Total Fat	8.75 g	3.5 g	
Saturated Fat	5.25 g	2.1 g	
Carbohydrate	11.75 g	4.7 g	
Sodium	87.5 mg	35 mg	
Calcium	302.5 mg	121 mg	

*Percentage Daily Intake per serving. Percentage Daily Intakes are based on an average adult diet of 8700 kJ. Your daily intakes may be higher or lower depending on your energy needs.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

a How many servings of milk are in a 2-L carton?

b What percentage of one carton of milk is one serving size?

c What percentage of one serving is protein?

d What percentage of one carton is protein?

e What percentage of one serving is calcium?

f What percentage of one carton is calcium?

g Research the recommended daily intake of calcium and determine how many servings of milk would meet this.

14 Commercial bakers use what is known as the baker's percentage to calculate the amount of each ingredient to use to make a batch of loaves of bread. The baker's percentage makes the flour equal to 100%, and then all the other ingredients are a percentage of the flour. An example of a simple baker's percentage is:

Ingredient	Percentage
Flour	100%
Water	63%
Salt	1.8%
Dry yeast	1.4%
Butter	4%

Use this information to calculate the weight of each ingredient required for different numbers of loaves of bread. Complete the table below.

	Number of loaves to manufacture				
	1	5	10	100	200
Flour (g)	450				
Water (g)					
Salt (g)					
Dry yeast (g)					
Butter (g)					

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3G Percentage change

We are all familiar with the idea of buying items when they are on sale. The percentage discount applied to the items on sale means that we are spending less to buy these items.

Whether the shop is a physical shop or an online shop, the owners are running a business to make a profit. When they buy an item, it is at the **wholesale price**. They need to increase this to cover their expenses. The price we see advertised has had a percentage mark-up applied and is called the **retail price**.

This is also important for tradespeople. If they do not factor in their expenses for a job, they will lose money. And if they only cover their expenses, how do they make a living? They decide on a percentage mark-up and apply this to their calculations before providing a quote for a job.

Applying percentage increase and decrease

Example 12 Applying a percentage increase

A worker receives a 3% pay increase. If they were receiving $20 per hour, find their new hourly rate.

THINKING	WORKING
STEP 1	
List the known information. What is the current pay rate? What is the percentage increase?	Current hourly rate: $20 Percentage increase: 3%
STEP 2	
To find the increase in hourly rate, calculate 3% of $20.	Increase in hourly rate $= 3\% \times \$20$ $= \$0.6$ $= 60$ cents
STEP 3	
Add the increase to the hourly rate.	New hourly rate $= \$20 + 60$ cents $= \$20.60$

... continued

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 4	
Write your answer.	When a 3% increase is applied to a $20 hourly rate, the new hourly rate is $20.60.

Example 13 Applying a percentage decrease

Find the sale price when a $225 jacket is discounted by 24%.

THINKING	WORKING
STEP 1	
List the known information. What is the original price? What is the percentage discount?	Original price: $225 Percentage discount: 24%
STEP 2	
To find the amount of the discount, calculate 24% of $225.	$\text{Amount of discount} = 24\% \times \$225$ $= \$54$
STEP 3	
Subtract the discount to get the sale price.	$\text{Sale price} = \$225 - \$54$ $= \$171$
STEP 4	
Write your answer.	When a 24% discount is applied to a jacket priced at $225, the sale price is $171.

Applying a percentage mark-up

A shopkeeper applies a percentage mark-up on the wholesale prices they have paid for items to ensure that they can cover all of their business costs – this is called the retail price. The formula used is:

$$\text{Retail price} = \left(\frac{\text{percentage mark-up}}{100} \times \text{wholesale price} \right) + \text{wholesale price}$$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 14 Applying a percentage mark-up to calculate the retail price

If a shopkeeper applies a 75% mark-up on an item bought wholesale for $160, calculate the retail price.

THINKING	WORKING
STEP 1	
List the known information. What is the wholesale price? What is the percentage mark-up?	Wholesale price: $160 Percentage mark-up: 75%
STEP 2	
To calculate the retail price, substitute the information into the formula: $\text{Retail price} = \left(\frac{\text{percentage mark-up}}{100} \times \text{wholesale price}\right)$	$\text{Retail price} = \left(\frac{75}{100} \times 160\right) + 160$ $= \$280$
STEP 3	
Write your answer.	When a 75% mark-up is applied to a wholesale price of $160, the retail price is $280.

If you know the wholesale and retail prices, you can calculate the percentage mark-up using this formula:

$$\text{Percentage mark-up} = \frac{\text{difference in price}}{\text{wholesale}} \times 100$$

Example 15 Calculating a percentage mark-up

If a shopkeeper buys an item at $130 wholesale and sells it at a retail price of $214.50, what percentage mark-up has been applied?

THINKING	WORKING
STEP 1	
List the known information. What is the retail price? What is the wholesale price?	Retail price: $214.50 Wholesale price: $130
STEP 2	
Calculate the difference in price.	$\text{Difference in price} = \$214.50 - \$130$ $= \$84.50$

... continued

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 3	
To calculate the percentage mark-up, substitute the information into the formula: Percentage mark-up $= \frac{\text{difference in price}}{\text{wholesale price}} \times 100$	$\text{Percentage mark-up} = \frac{84.5}{130} \times 100$ $= 65\%$
STEP 4	
Write your answer.	When an item bought wholesale at $130 and sold at $214.50, the mark-up is 65%.

Before a tradesperson can apply a percentage mark-up, they first need to identify income and expenses. **Income** is the money that will be generated by the job, and **expenses** is the money that it will take to get the job done. This formula used is:

$$\text{Percentage mark-up} = \frac{\text{income} - \text{expenses}}{\text{expenses}} \times 100$$

Example 16 Calculating a percentage mark-up

A plumber charges a customer $2,500 to complete a job. The cost of equipment and materials for this job is $2,000.
Find out what percentage mark-up the plumber has applied to the job.

THINKING	WORKING
STEP 1	
List the known information. What expenses are involved with this job? What is the income?	Expenses: $2,000 Income: $2,500

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 2 To calculate the percentage mark-up, substitute the information into the formula: Percentage mark-up $= \frac{\text{income} - \text{expenses}}{\text{expenses}} \times 100$	Percentage mark-up $= \frac{\$2{,}500 - \$2{,}000}{\$2{,}000} \times 100$ $= 25\%$
STEP 3 Write your answer.	When a tradesperson has quoted \$2,500 for a job, knowing that \$2,000 will be expenses, a 25% mark-up has been applied.

Percentage calculations on your calculator

If you need to work out percentages, you can also use a calculator. Most calculators have a % button. This is very useful, especially if you need to work out difficult percentages like 4.3% or 12.75% or percentages of large amounts.

And on most calculators, you can also use the % button to add or subtract a percentage as well. This is useful for a percentage **increase** (use the + button) or a percentage **decrease** (use the – button). The calculator automatically adds on or subtracts the percentage to the original amount.

Checking how your calculator does percentages

Let's look at Example 13 about finding the sale price when a \$225 jacket is discounted by 24%. How much would the reduced price be? This means that we need to take off (or subtract) the 24% from the \$225. And 24% of \$225 was \$54. The final, discounted price was therefore \$225 – \$54 = \$171.

Use the % button so you can check how your calculator works this out. Note that some calculators require you to press the '=' key to see the final answer, while others don't.

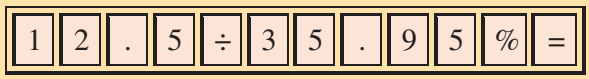
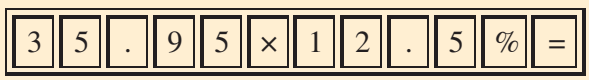
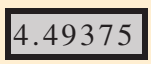
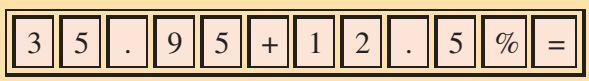
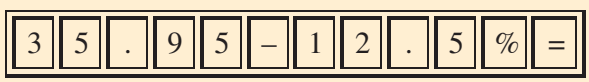
Use your calculator to enter this problem: 225 – 24% =

- Did you, or can you, get the answer of 171?
- Did you need to press the '=' key or not?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Other percentage calculations

Below are some more examples of different percentage calculations that you can do on your calculator using the % key. Check that your calculator can do these too.

Percentage calculation	Buttons to press
Find a percentage based on a fraction: e.g. 12.5 as a percentage of 35.95	Use ÷ and % keys (and maybe the = key)  Therefore, 12.5 as a percentage of 35.95 is 34.8% when rounded to 1 decimal place.
Find a percentage of an amount: e.g. 12.5% of $35.95 *Note:* It is best to enter the original amount first. This enables you to keep calculating 12.5% of other values too.	Use × and % keys (and maybe the = key)   Therefore, 12.5% of $35.95 is $4.49 when rounded to 2 decimal places or cents.
Find a percentage increase: e.g. 12.5% increase on $35.95 This adds on the % to the price.	Use + and % keys (and maybe the = key)  Therefore, a 12.5% increase on $35.95 is $40.44 when rounded to 2 decimal places or cents.
Find a percentage decrease: e.g. 12.5% decrease on $35.95 This takes off the % from the price.	Use – and % keys (and maybe the = key)  Therefore, a 12.5% decrease on $35.95 is $31.46 when rounded to 2 decimal places or cents.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Note: You can still do percentage calculations on your calculator without using a % button. It simply requires you to enter the calculations carefully and remember BODMAS, as if you were doing it with pen-and-paper.

For example:

Percentage calculation	Buttons to press
Find a percentage based on a fraction: e.g. 12.5 as a percentage of 35.95	Use ÷ and × keys (and maybe the = key) 1 2 . 5 ÷ 3 5 . 9 5 × 1 0 0 = 34.77051460361613 Therefore, 12.5 as a percentage of 35.95 is 34.8% when rounded to 1 decimal place.

3G Tasks and questions

Thinking task

1 Conduct some research of advertisements or articles on various media sources that use or include percentages. This might be television, social media, newspapers or magazines etc. Find as many examples of percentages as you can and then share with your classmates. Can you categorise the uses of percentages into themes? Do you think that any of the information you have found is easy to understand or misleading in anyway?

Skills questions

2 Calculate the new sale price for the following items, rounding appropriately.

- **a** Recommended retail price (RRP) $200, and on sale with 18% off
- **b** RRP $320, discounted by 5%
- **c** RRP $49.99, discounted by 12.5%
- **d** RRP $98.95, Black Friday sale with 40% off

3 Calculate the new amount for the following, rounding appropriately.

- **a** Original price $300, percentage increase of 15%
- **b** Original price $78.50, percentage increase of 2%
- **c** Hourly wage of $17.50, wage increased by 4%
- **d** Yearly salary of $63,000, wage increased by of 3.5%

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4 Use the following information to find the percentage mark-up. Round your answers to 1 decimal place.

a Income of $1,000, and expenses of $850

b Item has a retail price of $99.50 and had a wholesale price of $60.00

c Wholesale price is $265 and item sells at a retail price of $399.99

d Expenses of $24,500 and income of $27,000

Mixed practice

5 Find the discounted price for an item with recommended retail price (RRP) of $190, and on sale at 30% off.

6 Find the percentage mark-up on an item that has a retail price of $1,250.00 and had a wholesale price of $850.00.

7 Calculate the new amount for an item with an original price of $136.50, with a percentage increase of 15%.

8 Determine the percentage mark-up applied when there is an income of $450 and expenses of $325.

9 Find the discounted price for an item with a recommended retail price (RRP) of $90, and on sale at 12% off.

Mathematical literacy

10 Use the words in the box to fill in the blanks in the sentences below:

income	retail	mark-up	discount
expenses	wholesale	increase	profit

a When a shopkeeper buys an item, they pay the _____ price.

b To calculate the _____ price, a percentage _____ is applied. This is to ensure that they make a _____.

c When we buy items that are on sale, we are getting a percentage _____.

d When preparing a quote, a tradesperson will calculate the _____ and expected _____ from a job before applying a percentage _____.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Application task

11 You are thinking of running a catering business offering these two packages.

Package A	**Package B**
Set menu for 100 people.	Each tray serves 25 people.
100 party pies 100 dim sims 100 mini sausage rolls 120 spring rolls 120 vol-au-vents	Cost to customer: 1 tray Gyro (chicken or lamb) $100 1 tray chicken kebab $110 1 tray chicken shawarma $110 1 bowl hummus or baba ghanouj $70 1 tray Greek salad $60 1 tray pieces Saganaki $140 Pita $1 per person
2 waiters for 2 hours at $20 per waiter per hour.	2 waiters for 2 hours at $20 per waiter per hour.
Delivery fee $50 Clean-up fee $75	Delivery fee $50 Clean-up fee $75

a Use the internet to search for the prices of the items in Package A.

b Calculate the total expenses for Package A for 100 people. (Assume that you will be paying contractors for the waiting, cleaning and delivery and therefore these are all expenses.)

c Decide how much profit you want to make on Package A, and what income you will receive. What will you charge the customer?

d Calculate the percentage mark-up that you will apply to Package A.

e Calculate the income you will receive if a customer wants Package B for 100 people (i.e. selects 4 trays from the list).

f If the same percentage mark-up as calculated in part **d** were applied to this quote, what would be the total expenses for this option?

g As a customer, which option would you select? Why?

h Explain any issues with pricing the mark-up too low.

i Explain any issues with pricing the mark-up too high.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3H Percentage error

Percentage error is used to compare the difference between an estimated, expected or observed value, and the actual final value. It is expressed as a percentage of the actual value. In other words, percentage error is how big your error is when you estimate a value or measurement.

The way you calculate percentage error is similar to how you calculate percentage change.

Some examples of where you might want to estimate the amount of error (as percentage error) include:

- the difference between how much something weighs at home versus a more accurate and official measurement (such as weighing parcels before you post them compared to the measurement on the scales at the post office, or your own weight compared to what it is when measured in a doctor's surgery)
- the difference between how much you estimate going out to dinner is going to cost versus how much it actually costs
- the difference between what time you might arrive somewhere versus the time you actually arrive.

Percentage error is quite critical in relation to measurement, accuracy, precision and tolerance, and we will look at it further in section 13G.

The range of values expected in percentage error

If you planned to meet some friends at a campsite at midday but left home more than an hour later than you expected, you would probably end up being at least an hour late when you arrive at the campsite. Would this be a big problem? Probably not. But if we changed the situation to attending one of your friend's wedding, then there is a problem as you'd miss most of the ceremony. Therefore, any error, or percentage error, in the first situation is not critical and can be quite large, but for the wedding situation, you probably want the percentage error to be very small.

Percentage error will also be more critical in relation to goods being manufactured in workplaces and in areas such as health and medicine, than compared with in our lives such as when posting parcels or estimating the time to get to somewhere or paying a restaurant bill.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

You would want your piece of replacement glass you measured to fit in a window to be accurate with very little error. The same with the measurement of medicines – you would want medications to be measured accurately and to only allow for small errors in how it is measured. In such cases, you do not want there to be big errors – you would want very small percentage errors.

Therefore, percentage error is not just about doing a calculation with percentages – it is also looking at the situation and deciding what percentage error is acceptable, and what is not.

Think about a family pack of fun-sized lollies. It is unlikely that every packet is exactly the same weight and has exactly the same number of lollies. But if one packet is way too small, or way too big, the large percentage error is unacceptable – the first to you as the customer, and the second to the manufacturer.

In a hospitality setting, preparing too many meals would lead to wasted food. Not being able to supply enough meals would cause the business to lose money.

In medication, not getting the dosage accurate can have serious and unacceptable medical consequences. In making and fitting products and materials accuracy is also important, as a large percentage error may mean the item or product cannot be used.

Acceptable percentage error is when the error is unlikely to create a significant problem.

Unacceptable percentage error is when the error is likely to create a significant problem.

Calculating percentage error

Percentage error is all about comparing a guess, estimate or measured value to the actual, exact or expected value. The estimated value sometimes relates to the stated quantity or measurements, such as the amount in a packet or bottle of goods you buy.

To calculate percentage error, we use the formula:

$$\text{Percentage error} = \frac{\text{estimated number} - \text{exact number}}{\text{exact number}} \times 100$$

Note: When we subtract the exact number from the estimated number, we can get a negative number, depending on whether the estimated number was bigger or smaller than the actual number. For our calculations, we ignore any minus signs.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 17 Calculating the percentage error – catering in hospitality

A chef estimated that there would be 120 servings of chicken parmigiana ordered for dinner that night, and ordered chicken based on this estimate. However, only 74 patrons ordered the chicken parmigiana. What is the percentage error?

THINKING	WORKING
STEP 1	
List the known information. What was the estimated number? What was the exact number?	Estimated number: 120 Exact number: 74
STEP 2	
To calculate the percentage error, substitute into the formula: Percentage error = $\frac{\text{estimated number} - \text{exact number}}{\text{exact number}} \times 100.$ Round the value appropriately.	$\text{Percentage error} = \frac{120 - 74}{74} \times 100$ $= 62.162162\ldots\%$ $\approx 62\%$
STEP 3	
Write your answer.	If 120 meals were expected but only 74 were sold, the percentage error is 62%.

Example 18 Calculating the percentage error – estimated number of people attending

A local community group hired a hall for 140 people to hear a local member of parliament speak on an issue. To their surprise, 212 people turned up and had to stand outside the venue to hear the speaker. What is the percentage error?

THINKING	WORKING
STEP 1	
List the known information. What was the estimated number? What was the exact number?	Estimated number: 140 Exact number: 212

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 2	
To calculate the percentage error, substitute into the formula: Percentage error = $\frac{\text{estimated number} - \text{exact number}}{\text{exact number}} \times 100$. Round the value appropriately.	$\text{Percentage error} = \frac{140 - 212}{212} \times 100$ $= -33.9622\ldots\%$ $\approx -34\%$
STEP 3	
Ignore the negative sign and consider the percentage error to be a positive number.	Ignoring the negative sign, percentage error ≈ 34%.
STEP 4	
Write your answer.	When 140 people were expected but 212 showed up, the percentage error is 34%.

Example 19 Calculating the percentage error – time

A student sleeps in and wakes up 10 minutes before school starts. They estimate it will take them 8.5 minutes to get ready and run all the way to school. It actually takes them 12 minutes and 15 seconds. What is the percentage error of their estimate?

THINKING	WORKING
STEP 1	
List the known information. What was the estimated time? What was the exact time? *Note*: Show the times in seconds so both numbers have the same units.	Estimated time: 8.5 mins = 8.5 × 60 = 510 s Exact time: 12 mins, 15 secs = 12 × 60 + 15 = 735 s
STEP 2	
To calculate the percentage error, substitute into the formula: Percentage error = $\frac{\text{estimated number} - \text{exact number}}{\text{exact number}} \times 100$. Round the value appropriately.	$\text{Percentage error} = \frac{510 - 735}{735} \times 100$ $= -30.6122\ldots\%$ $\approx -31\%$

... continued

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 3	
Ignore the negative sign and consider the percentage error to be a positive number.	Ignoring the negative sign, percentage error ≈ 31%.
STEP 4	
Write your answer.	When a trip was expected to take 8.5 minutes, but it took 12 minutes and 15 seconds, the percentage error is 31%.

Example 20 Calculating the percentage error – in measurements

A painter estimates the dimensions of a wall to plan for the amount of paint they will need to purchase. Their initial estimate was that the length was 2.5 m and height was 2 m. When they measured the room prior to starting the work, they found that the actual length was 2.65 m and the height was 2.1 m. What is the percentage error of the painter's estimate of the area of the wall compared with the actual area?

THINKING	WORKING
STEP 1	
What was the estimated area of the wall? (Use Area = length × width)	$\text{Estimated area of wall} = 2.5 \times 2$ $= 5 \text{ m}^2$
STEP 2	
What was the actual area of the wall?	$\text{Actual area of wall} = 2.65 \times 2.1$ $= 5.565 \text{ m}^2$
STEP 3	
To calculate the percentage error, substitute into the formula: $\text{Percentage error} = \dfrac{\text{estimated number} - \text{exact number}}{\text{exact number}} \times 100.$ Round the value appropriately.	$\text{Percentage error} = \dfrac{5 - 5.565}{5.565} \times 100$ $= -10.1527\ldots\%$ $\approx -10\%$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 4	
Ignore the negative sign and consider the percentage error to be a positive number.	Ignoring the negative sign, percentage error ≈ 10%.
STEP 5	
Write your answer.	When a painter estimated the area of a wall to be 5 m^2 but it was actually 5.565 m^2, the percentage error was 10%.

3H Tasks and questions

Thinking task

1 Given a percentage error of 20%, think of a situation where this would be acceptable, and another where it would not be acceptable. Share and compare these examples with your classmates.

Skills questions

2 Find the percentage error given the following values, correct to the nearest whole per cent.

- **a** estimated = 164 people, exact = 150 people
- **b** estimated = 60 people, exact = 72 people
- **c** estimated = 14 500 people, exact = 7500 people

3 Find the percentage error given the following values, correct to 1 decimal place.

- **a** estimated weight = 55 g, exact weight = 52.3 g
- **b** estimated length = 1346 mm, exact length = 1352 mm
- **c** estimated weight = 34 mg, exact weight = 36 mg
- **d** estimated volume = 370 mL, exact volume = 375 mL

4 Find the percentage error given the following values, correct to 1 decimal place.

- **a** estimated travel time = 1 hour 15 minutes, actual travel time = 1.5 hours
- **b** estimated travel time = 4 hours, actual travel time = 3 hours 55 minutes
- **c** estimated travel time = 2.5 hours, actual travel time = 2 hours 10 minutes.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mixed practice

5 A tradesperson quoted a job at $1,580 but the actual cost was $1,250. Calculate the percentage error and explain whether this would be a problem.

6 A netball player estimated that it would take 90 minutes to get to a game on time. In fact, it took 110 minutes. Calculate the percentage error and explain whether this would be a problem.

7 A family budgeted $120 per month for their electricity bill but when the winter bill arrived it was $675 for three months. Calculate the percentage error and explain whether this would be a problem.

8 The estimated length of a piece of timber required for an item of furniture was 1255 mm. The exact length was in fact 1260 mm. Calculate the percentage error and explain whether this would be a problem.

Application tasks

9 For each of the situations below, calculate the percentage error and explain whether you think it is acceptable or unacceptable.

- **a** A café catering for 320 customers but 350 customers come in.
- **b** A packet of potato chips that is stated to weigh 170 grams but weighs 185 grams.
- **c** A dose of insulin should be 0.2 mL, but 2 mL was given.
- **d** A cabinet drawer that should be 560 mm wide was actually made to be 555 mm wide.

10 Calculate the percentage error for the following situations, correct to 1 decimal place.

- **a** Find the percentage error on a packet of lollies where the weight is stated to be 30 grams, but which actually weighs 28.9 grams.
- **b** A car part should be 1.13 mm but measures 1.05 mm.
- **c** Find the percentage error on a packet of soap labelled 100 g which has an actual weight of 108 g.
- **d** An airline accepts 335 bookings for a flight when the aircraft has 314 seats.
- **e** A restaurant plans to cater for 75 diners but, due to a booking error, 85 diners turn up.

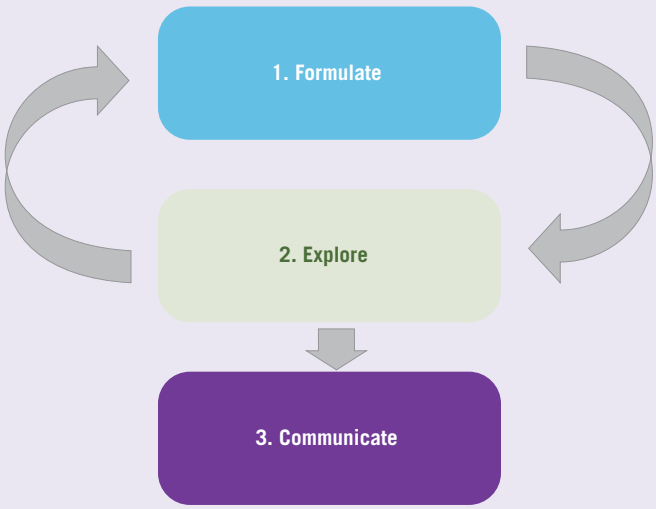
11 For each situation in question **10**, explain whether you think the percentage error is acceptable or unacceptable, and why.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Investigations

When undertaking your investigations, remember the problem-solving cycle steps:

- **Formulate** – Sort out and plan what you need to know and need to do to solve the problem.
- **Explore** – Use and apply the mathematics required to solve the problem.
- **Communicate** – Record and write up your results.



1 Garden fertilisers

Many different types of chemicals are used in the garden including fertilisers, insecticides, pesticides, fungicides and weed killers. This investigation will focus on fertilisers that are commonly used in the garden and will answer the question:

- Which fertiliser would I use for which purpose, and why?

Whenever these chemicals are used there is a range of critical information that needs to be considered. Fertilisers often come in liquid, powder or pellet form.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Here are two examples of the sorts of information you will see on fertiliser labels.

DIRECTIONS FOR USE
Shake well before use
Never apply direct from the bottle
Never apply in the heat of the day. Early morning or late evening is best.
STANDARD DILUTION RATE:
10 mL to 1 litre of water
(1 litre bottle cap = 10 mL)
STANDARD WATERING CAN (9 litre) RATE:
90 mL to 9 litres of water - covers 10 m²

APPLICATION	RATE PER 1 L OF WATER	FREQUENCY
APPLY TO FOLIAGE UNTIL POINT OF RUN-OFF		
Established Gardens, Trees & Roses	10 mL	Monthly
Ferns & Indoor Plants	3 mL	2-4 weeks during growing season
Lawns	5 mL	Monthly during growing season
Natives	5 mL	Monthly
Fruits, Vegetables, Herbs & Annuals	5-10 mL	2-4 weeks during growing season
Camelias, Azaleas & Rhododendrons	5 mL	Monthly during growing season
Seedings	5 mL	2-4 weeks during growing season
Transplanting & planting	5 mL	At planting and again 2 weeks later

TYPICAL ANALYSIS	%w/v
NITROGEN (N)	10.0
PHOSPHORUS (P)	1.0
The phosphorus % dilution rate is 0.01%	
POTASSIUM (K)	6.0

Flower beds & bulbs	**Potted trees, shrubs & flowers**	**Fruit, citrus & nut trees**	**Fruiting vegetables**
Dissolve one heaped spoonful (9 grams) into 4.5 litres of water. Apply weekly before buds form until flowering has finished. Continue to feed bulbs until leaves die down. 4.5 litres feeds 2 square metres.	Dissolve one heaped spoonful (9 grams) into 4.5 litres of water. Apply fortnightly. Drench pots before buds form until flowering/fruiting has finished. Apply 1 litre per 15 cm pot. 4 litres per 30 cm pot.	Dissolve two heaped spoonful (18 grams) into 4.5 litres of water. Apply liberally every fortnight. 10 litres per small tree, 52 litres per large tree.	Dissolve one heaped spoonful (9 grams) into 4.5 litres of water. Apply weekly before buds form until fruiting has finished. 4.5 litres feeds 2 square metres.
Flowering shrubs	**African violets**	**Seedlings**	**Leafy vegetables, palms & lawns**
Dissolve one heaped spoonful (9 grams) into 4.5 litres of water. Apply fortnightly and water liberally around the roots. Apply 4.5 litres per 1 metre shrub height.	Dissolve one level spoonful (4.5 grams) into 4.5 litres of water and apply every 4 weeks. 4.5 litres feeds 2 square metres or 10 × 20 cm pots.	Dissolve 1 heaped spoonful (9 grams) into 9 litres of water. Apply fortnightly to soak seedlings and surrounding soil. 9 litres feeds 4 square metres.	For feeding leafy vegetables, palms and lawns, we recommend you use an All Purpose Soluble Fertiliser.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Formulate

a Select two commonly available, but different, brands of fertiliser to investigate.

b Where and how will you find the information about the fertilisers?

c What different applications are fertilisers used for? Which applications are you interested in investigating? These could include lawns, vegetables, native plants or flowering plants.

d How can you make sure you are comparing the same or similar properties of the different brands? (What if they come in different quantities in their containers or packages, or if one is a liquid and one is a solid?)

e What is an NPK ratio and why is it important?

f What mathematics are needed to understand and interpret the information about the fertilisers? What calculations will you need to undertake to complete your research? Some relevant mathematical knowledge and skills you might need to use include:

- percentages
- rates
- proportions – are there examples of both direct and indirect variation?
- ratios
- different measurements
- costs
- different technologies and tools you might need to use to analyse and calculate.

g How will you record your research including hyperlinks, findings, and the outcomes?

Explore

Undertake the mathematical tasks required to investigate and compare the two fertilisers, their usage and applications. Keep in mind that you want to decide which one you would prefer to use and justify why, based on your mathematical analysis.

h What is the cost of each fertiliser?

i What are the mixing and dilution rates for making up fertilisers for use in the garden?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

j What tools or technology might you use to mix up specific quantities of fertiliser and use them on the garden?

k What are the NPK ratios for each fertiliser?

Communicate

l Write up and present the findings of your investigation into comparing the two fertilisers and their usage and applications, including their NPK ratios. You could choose to write up a report or create a presentation that explains what you found out and your results. Address the question as to which one you would prefer to use, and justify your choice based on your mathematical analysis. Explain your results based on the mathematical outcomes of your research.

You should:

- include the mathematics and calculations you undertook to do your comparisons
- reflect on your research and your recommendations – do you think they are justified and valid?
- reflect on the tools or technologies that are used in working with fertilisers
- consider how you might improve your investigation if you did it again.

2 Unit prices

How does unit pricing work? Is it useful, and why?

Formulate

The purpose of this investigation is to research the use and application of unit pricing.

a In a small group or as a class, conduct a brainstorm to identify where you may have seen unit pricing being used. How was the unit price communicated? What mathematics might you need to know to understand the unit prices?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

b Plan your investigation and consider the following questions.

- How does unit pricing work?
- Where and how will you find the information you need?
- How will you record your investigation and the outcomes?

Your investigation and mathematical analysis need to demonstrate how unit pricing works, based on a number of examples ranging across:

- different products and brands
- products that are packed in different quantities
- products that use different unit pricing values such as $/kg or cents per 100 grams or $/litre and more.

Explore

c Undertake the mathematical tasks required to investigate and explain how unit pricing works with a range of different examples and explain whether unit pricing is useful.

d You will need to explain and demonstrate this using a range of mathematical knowledge and skills, especially related to undertaking calculations based on rates and metric conversions.

e Consider what technological tools may be useful to conduct this investigation.

Communicate

f Write up and present the findings of your investigation. You can choose the format of your presentation. Ensure your presentation includes how unit pricing works, using different examples across different products that are packed in different sizes.

g Include a summary to highlight the mathematics and what calculations you undertook to do your comparisons. Explain your results based on the mathematical outcomes of your research.

h Reflect on the tools and technologies that you used in your investigation. How did they assist you in performing the mathematics required to conduct the investigation?

i If you did the investigation again, how might you improve it?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key concepts

- **Ratios** are a way of comparing two or more quantities.
  - If there are 4 dogs and 3 cats, the ratio of the number of dogs compared to cats is written as 4 : 3. Ratios are written in simplest form (with the smallest whole numbers) and without units.
- **Proportion** statements show that ratios are equal.
  - For example, if one batch of cordial has 1 litre of cordial syrup and 4 litres of water (1 : 4) and a different batch has 3 litres of cordial syrup and 12 litres of water (3 : 12, which simplifies to 1 : 4), the ratios of cordial syrup to water are equal, so they are in proportion.
- In **direct variation** relationships – as one amount **increases**, another amount **increases** at the same rate starting from zero in both cases – from (0, 0) on a graph.
- In **indirect variation** relationships – as one amount **increases**, another **decreases** at the **reciprocal** rate.
- A **percentage** is the rate, number or amount of something in each hundred.
  - To calculate a percentage given the amount and the total, use:

$$\text{Percentage} = \frac{\text{amount}}{\text{total}} \times 100$$

  - To calculate the amount given the percentage and the total, use:

$$\text{Amount} = \frac{\text{percentage}}{100} \times \text{total}$$

  - To calculate a new value given a percentage increase or decrease:
    - Calculate the amount of the increase or decrease using

$$\text{Amount} = \frac{\text{percentage}}{100} \times \text{original value}$$

    - For percentage increase, add this amount to the original value.
    - For percentage decrease, subtract this amount from the original value.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- To calculate the percentage mark-up, we can use either of these two formulas, depending on the application:

$$\text{Percentage mark-up} = \frac{\text{difference in price}}{\text{wholesale price}} \times 100$$

$$\text{Percentage mark-up} = \frac{\text{income} - \text{expenses}}{\text{expenses}} \times 100$$

- **Percentage error** is a measure of the difference between what was estimated and what actually happened, expressed as a percentage.

$$\text{Percentage error} = \frac{\text{estimated number} - \text{exact number}}{\text{exact number}} \times 100$$

- An acceptable percentage error is when the error is unlikely to create a significant problem.
- An unacceptable percentage error is when the error is likely to create a significant problem.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Success criteria and review questions

☐ I can write comparisons of numbers as ratios.

1 Write the following as ratios in simplest form.

a 12 : 21 : 9

b 1200 : 360

c 3.5 : 8

d the length of a rectangle is 24 cm, and the width is 38 cm

2 For the following table, write down the ratio of the top number (a) to the bottom number (b), and use this to calculate the missing numbers in the table.

Ratio _____ : _____

a	1	5	10	15	25	
b		15				90

3 Complete the following table if the ratio of the top number (c) to the bottom number (d), is in the ratio given.

Ratio 2 : 5

c	2	4	10	20	50
d					

4 Which of the following pairs of ratios are in proportion?

a 2 : 3 and 4 : 8

b 1 : 5 and 5 : 25

c 2 : 4 : 5 and 8 : 16 : 24

d 1.5 : 1 and 3 : 2

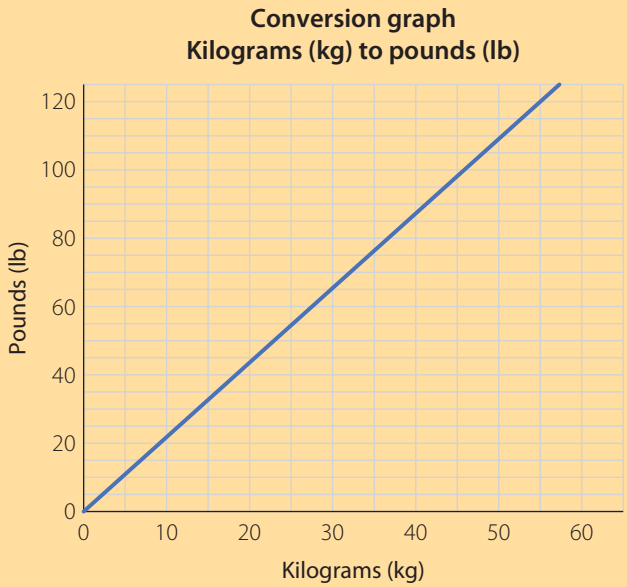
5 TVs have a width to height ratio of 16 : 9. A TV cabinet can hold a TV that has a maximum width of 120 cm. What is the maximum height of the TV that can fit in this cabinet?

6 A cleaning product comes as a concentrate bottle. The instructions for making up the cleaning solution is that you need to mix the concentrate with water in a ratio of 60 mL of concentrate to 2 L of water. How much cleaning concentrate should be added to a 5 L bucket of water?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

I can calculate direct and indirect variation.

7 The graph opposite shows the conversion for kilograms to pounds. Is the graph an example of direct variation, indirect variation or neither?



8 A scale diagram of a garden is drawn on a scale of 1 : 50. A feature wall is drawn on this diagram with a length of 4 cm. Calculate the actual length of the feature wall.

9 The label from a tin of stock powder shows the proportions of stock powder and water required to make liquid stock as '1 teaspoon to 4 cups of hot water'.

a How much stock powder is required to make up 2 cups of liquid stock?

b How much stock powder is required to make up 6 cups of liquid stock?

c Is this direct or indirect variation? Why?

10 A catering company is making 300 sandwiches for an event. One person can make, wrap and pack 30 sandwiches in an hour.

a Use this information to complete the table for catering for the event.

Number of people	1	2	3	5	10	20
Time (in hours)						

b Is this direct or indirect variation? Why?

11 Fuel for a jet ski is mixed in the ratio of petrol to marine oil of 50 : 1. Draw up a table that shows the correct quantities of petrol and oil for jet skis with fuel tanks of 18 L, 30 L, 50 L, 62 L and 78 L. Round values to 1 decimal place.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

☐ I can perform calculations involving percentages.

12 Calculate the following:

- **a** the percentage of vehicles in a parking lot that are bikes, if there are 45 bikes and 250 vehicles in total
- **b** the recommended daily intake of sugar, if a snack food that contains 6 g of sugar contains 25% of the recommended daily intake
- **c** a new yearly salary when the original salary of $75,000 is increased by 4%
- **d** the percentage mark-up on a job with expenses of $1,200 and an income of $1,500.

☐ I can calculate percentage error.

13 Calculate the percentage error for these situations, correct to 1 decimal place.

- **a** It is estimated that 200 people will attend a conference but only 180 attend.
- **b** A bag of lollies should weigh 500 g but it actually weighs 490 g.

☐ I can decide whether a percentage error is acceptable or unacceptable.

14 Explain whether the percentage error in these situations is acceptable or unacceptable.

- **a** An engineering machine is calibrated to produce a part that is 0.35 mm long, but actually produces the part as 0.38 mm long.
- **b** A bottle of detergent is meant to have a volume of 500 mL, but actually has a volume of 495 mL.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mathematical toolkit

1 Reflect on the range of different calculations, technologies and tools you used throughout this chapter, and how often you used them for undertaking your work and making calculations. Indicate how often you used and worked out results and outcomes for each of these methods and tools.

Method and tools/ applications used	**How often did you use this?**
• Calculating and working in your head, and using algorithms	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using pen-and-paper	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using a calculator	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using a spreadsheet	Not at all: ☐ A little: ☐ Quite a bit: ☐
• Using measuring tools – name the tool, technology or application: _____	Not at all: ☐ A little: ☐ Quite a bit: ☐
_____	Not at all: ☐ A little: ☐ Quite a bit: ☐
• Using other technology or apps – name the technology or application: _____	Not at all: ☐ A little: ☐ Quite a bit: ☐
_____	Not at all: ☐ A little: ☐ Quite a bit: ☐

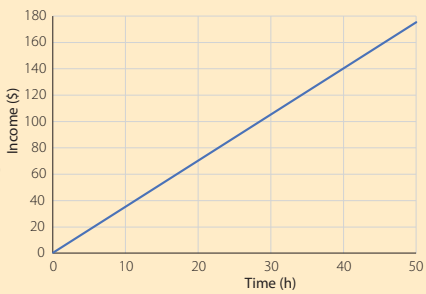
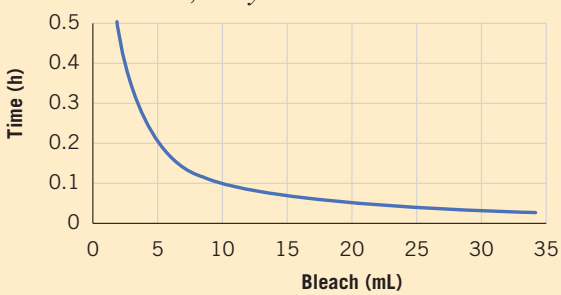
2 Did this chapter and the activities help you to better understand how you use different tools and technologies in using and applying mathematics in our lives and at work? In what areas and ways? Write down some examples.

3 In one sentence, explain something relating to tools and technologies that you learned in the chapter. Write an example of what you learned.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key vocabulary

Here is a list of this chapter's key maths terms and their meanings.

Term	Meaning
Acceptable percentage error	The error is unlikely to cause a significant problem.
Algorithm	A process or set of rules that is followed to complete a calculation or process.
Direct variation (or direct proportion)	Two variables are in direct variation or direct proportion if as one increases, the other increases, and vice versa. They change by the same ratio or factor. As a graph, direct variation values form a straight line starting from the origin (0, 0). 
Goods and Services Tax (GST)	A tax added to most goods sold (except for fresh food) and to services. It adds 10% to the original cost.
Hyperbola	A curved graph that shows inverse or indirect variation: as the x value increases, the y value decreases. Also see *Indirect variation*. 
Indirect variation (or indirect proportion)	Indirect variation (or indirect proportion) is when one component or variable goes up, the other goes down, and vice versa. This is the opposite to what happens in *direct variation* or direct proportion. As a graph, indirect variation values form a hyperbola curve that does not ever pass through the origin (0, 0).

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Term	Meaning
Inverse variation (or inverse proportion)	See *Indirect variation*.
Notation	The system of written symbols used to represent numbers or amounts in mathematics.
Percentage	Percentage or per cent means 'per hundred' or 'out of a hundred'. We use the symbol % for percentages.
Percentage error	Used to compare the difference between an estimated, expected or observed value and the actual final value. It is expressed as a percentage of the actual value.
Proportion	A part, share or number considered in comparative relation to a whole. Mathematically, proportion is defined that if two ratios are equivalent, they are in proportion.
Ratio	A comparison between two variables. A ratio is written using a colon, e.g. 12 : 10, which simplifies to 6 : 5.
Reciprocal	To obtain the reciprocal of a number, divide 1 by that number, e.g. the reciprocal of 4 is one-quarter, which is $1 \div 4$.
Representation	A way of presenting mathematical information, such as a graph, a formula, a table or in words.
Retail price	The price we see advertised which has had a percentage mark-up applied.
Terminology	The technical language used in a subject, where the meaning may differ from everyday use, e.g. 'volume' as the space filled by an object (mathematics) vs. the loudness of sounds (everyday).
Unacceptable percentage error	The error is likely to cause a significant problem.
Unit price	A method of comparing prices for goods sold in different size packages, e.g. $ per kilogram, or $ per 100 g, or $ per litre.
Wholesale price	The price at which the business owner buys an item.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4 Using and applying algebraic thinking

Brainstorming activity: Where's the maths?

Using this photo as a stimulus, brainstorm the type of maths we need to know to undertake this task or activity. Think especially about any maths skills related to the content of this chapter – using algebraic thinking and applying and using formulas. Prompt questions might be:

- What sorts of numbers might be encountered or needed?
- What formulas might be needed and what algebraic thinking might be needed?
- What mathematical calculations might be needed?
- What different measurements, amounts, costs and charges might be involved?
- What different tools, technologies or software might be used?

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter contents

Chapter overview and Spotlight

4A Starting activities
4B Tuning in
4C Writing algebraic expressions
4D Writing and solving equations
4E Transposing equations and formulas
4F Seeing equations and formulas visually
4G Using and applying simultaneous equations

Investigations
Chapter review

From the Study Design

In this chapter, you will learn how to:

- use and apply the conventions of mathematical notations, terminology and representations
- make estimates and carry out relevant calculations using mental and by-hand methods
- use different technologies effectively for accurate, reliable and efficient calculations
- solve practical problems which require the use and application of a range of numerical and algebraic computations involving rational and real values of variables
- solve practical problems requiring graphical and algebraic processes and applications, including substitution into, transposition of, formulas and finding a break-even point using simultaneous equations
- evaluate the mathematics used and the outcomes obtained relative to personal, contextual and real-world implications (Units 3 and 4, Area of Study 1)

© Victorian Curriculum and Assessment Authority 2022

ISBN 978-1-009-11065-5 Sakurai et al.

© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter overview

Introduction

The term ‘algebra’ can sometimes look like a jumble of letters and numbers that do not make sense and are completely disconnected from the real world. However, in the real world there are many instances where algebra can help make sense of situations.

Algebra is used in workplaces and across different industries – from calculating the materials for a particular job, for large supermarket warehouses to manage the logistics of how much of each product to send to stores and at what times, to the provision of public transport to suit the needs of commuters, and so much more.

Algebra allows us to solve contextualised problems using formal mathematics. Through using algebraic models, problems can be examined, and decisions can made based on clear evidence. Tools such as online calculators and applications will have algebraic rules sitting behind their public interface.

Learning intentions

By the end of this chapter, you will be able to:

- see where algebra is used at work and in life
- identify algebraic terms
- write algebraic expressions
- solve informal and formalised algebraic equations
- solve simultaneous equations using graphs and algebra.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Spotlight: Alison Parkinson

An interview with an artist

Tell us about some of the work you have done and have been doing in your job.
At the moment, I make ceramics and bronze sculptures as an artist. I work with a lot of clay and have my own kiln at home. In the past, I used to work as a French furniture polisher, restorer and builder.

What maths do you use regularly in your job?
I use maths all the time and my art involves a lot of measuring. For example, I need to consider how much my clay sculpture will shrink in the drying, firing, glazing, then second firing processes. Clay often shrinks about 12–14%, so I need to scale up my initial making of the sculpture by that percentage to ensure my desired dimensions are achieved after shrinkage. When I run the kiln to fire my clay, I create a graph of a 'running guide' to project how long it will take to reach the desired temperature (about 1300°C). This guide takes into consideration factors such as temperature readings (from internal probes), the number of burners and pilots that are being used, the amount of air that is flowing in, and the pressure inside the kiln.

What is the most useful maths-related tool or piece of technology that you use regularly in your job?
I often use a centring rule in my measurements, especially on my drawings of plans for my sculptures. This ruler has the 0 in the middle, and then increases by 1 cm (or 1 inch) on either side. By taking my measurements from the centre outwards, it helps keep my measurements constant and in line. I also use measuring and angle tools such as calipers, compasses and bevels.

What was your attitude towards maths when you were in school? Has your attitude towards maths changed over time?
I liked maths and I was quite good at it until I lost my confidence in my later years of school (I remember not realising I had lost 12 marks in an exam because I forgot to turn the page over!). I ended up pulling the pin on maths in my final years and chose to pursue art school. The irony is that everything we do, even art, has some kind of mathematical attachment. I still love the problem-solving aspect of maths that I get to use in my work though.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4A Starting activities

Activity 1: Canteen menu

CANTEEN SUMMER MENU

Main Menu available Monday, Tuesday, Thursday and Friday.

SANDWICHES, ROLLS & WRAPS AVAILABLE DAILY

	S/WICH	WRAP
(G) Chicken	$3.50	
(G) Chicken & Salad	$4.00	$4.70
(G) Ham	$3.00	
(G) Ham & Salad	$3.50	$4.20
(G) Cheese	$3.00	
(G) Cheese & Salad	$3.50	$4.20
(G) Salad	$3.00	$3.70
(G) Tuna	$3.50	
(G) Tuna & Salad	$4.00	$4.70
(G) Vegemite	$2.00	
(G) Mrs Hall	$4.50	$5.00

Ham or Chicken, Beetroot, Tomato, Lettuce, Cucumber Carrot and Cheese on Wholemeal Bread.

COMBO OPTIONS

A Ham/cheese/salad/vegemite sandwich, Fruit box and Frozen yoghurt $6.00

B Chicken/tuna/ham/cheese sandwich, Fruit box and Paddlepop $7.00

C Chicken strip wrap, Bottled water, Vanilla bucket $8.50

HOT FOOD AVAILABLE DAILY

(G) Chicken Strip Sub $4.50
3 Breast Portions, Cheese, Lettuce, Mayo, on a Roll.

(G) Chicken Strip Wrap $5.00
3 Breast Portions, Cheese, Lettuce, Mayo, on a Wrap.

(G) Paton Pizza $3.50
Homemade Sauce, Ham, Cheese.

(G) Veggie Pizza $3.50
Homemade Sauce, Pine, Seasonal Veggies, Cheese.

(G) Hawaiian Pizza $4.00
Homemade Sauce, Ham, Pine, Cheese.

(G) Chicken Nuggets (4) $4.00
4 Crumbed 100% Breast nuggets (Baked) -Made On site.

(G) Mac & Cheese $4.00

TOASTED SANDWICHES

(G) Ham	$3.00
(G) Cheese	$3.00
(G) Chicken	$3.50
(G) Ham & Cheese	$3.50
(G) Cheese & Tomato	$3.50
(G) Chicken & Cheese	$4.00
(G) Ham, Cheese & Tomato	$4.00

RECESS ITEMS

(G) Pikelets	$0.10
(G) Mini Muffin	$0.50
(G) Apple Slinky	$0.80
(G) Fruit & Yoghurt	$1.00
(G) Cheesie	$1.20
(G) Pizza Scroll	$1.50

DRINKS

(G) Cup of Milk	$1.20
(G) Milo (Cold/Warm)	$1.50
(G) Bottled Water	$1.60
(A) Asstd. Fruit Boxes	$1.70
(G) Flavoured Milk	$2.50
(A) Up & Go	$2.50

LUNCHTIME FROZEN TREATS

(A) Icy Pole	$0.80
99% Fruit Juice	
(A) Calippo	$1.50
(A) Vanilla Bucket	$2.00
(A) Paddlepop	$2.00
(A) Frozen Yoghurt	$2.00

DAILY SPECIALS

On Wednesdays SPECIAL MENU ONLY applies.

MONDAY

(G) Chicken Sushi	$4.00
(G) Tuna Sushi	$4.00
(G) Vegetarian Sushi	$3.50

TUESDAY

(G) Bento Box Special $4.50
Comes with 2 Nuggets, Half Vegemite s/w, Mini Muffin, Mini Fruit Cup, plus Cheese & Crackers.

WEDNESDAY :

ONLY THESE LUNCH ITEMS AVAILABLE TODAY

(A) Pie	$4.00
(A) Sausage Roll	$3.00

THURSDAY

Burgers are served with Patty, Tomato, Lettuce & Carrot. (Beef has Homemade Tomato Sauce) (Chicken has Mayo)

(G) Beef Hamburger $4.50

(G) Chicken Burger $4.50

FRIDAY

Chicken/Beef, Lettuce, Tomato, Cheese, Veggie Tomato Salsa

(G) 2 Chicken Soft Tacos $4.50

(G) 2 Beef Soft Tacos $4.50

Keep an eye out on the P & C Facebook group for weekly specials.

****TRAFFIC LIGHT SYSTEM****
(G) Green (A) Amber (R) Red
Canteen does not sell Red Items.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Consider the school canteen menu on the previous page.

Imagine you have been given $20 to buy lunch at school for three days this week.

1. Write out what you will have on each of these days and include the costs.
2. How much will each day cost and what change will you have at the end of each of the three days?
3. Write these calculations out in a mathematical sentence.
4. Are each of the combos cheaper than buying items individually? Prove it.
5. Design your own 'combo' option on the menu and allocate a price to it. Explain mathematically how you arrived at your pricing decision.
6. If $59.50 worth of Combo C has been ordered, how many chicken strip wraps should the canteen worker prepare?

Activity 2: Wasp nest removal

You need to pay for a beekeeper to remove a wasp nest from the wall of your house. The beekeeper charges a fixed cost of $75 for visiting the property to assess the situation, and they charge an hourly fee of $150 per hour for the time they spend on the job.

1. Write a mathematical sentence or equation in words to represent how you could calculate the total cost of hiring the beekeeper to remove the wasp nest.
2. Write your sentence as an algebraic equation (formula) using more formal mathematical terms and symbols. Include stating any letters (called pronumerals) that you use in your formula.
3. Use your formula to work out what the cost would have been if the beekeeper had to spend 90 minutes at your house removing the wasp nest.
4. How much time would this beekeeper have worked on a job if they were paid $150 in total? Explain the thinking that you used to work out your answer.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4B Tuning in

Have you ever wondered how warehouses for large supermarket chains know how much of each product to send to stores and at what times? The answer is by using algebra! Logistics uses computer-based algebra to make these calculations.

In warehouse logistics there are huge amounts of data coming in every second, and so the computer handles the maths. However, the maths needs to be programmed and to be read and understood by management and the workers.

A farmer will need to consider a range of factors when planting, fertilising, treating and harvesting his crops. This requires knowledge about crop yields, spraying requirements and coverage rates, and more. They may need to analyse the most cost-effective fertiliser. When planning for a bulk order involving large amounts of money, making the most cost-effective choice could save thousands of dollars. In this scenario the farmer may consider the spread, the coverage of the fertiliser and the cost per tonne. Using algebra and formulas underpins many of the actions and can make these questions quicker and more efficient to answer.

Understanding how algebraic conventions work, using formulas and being able to think algebraically, can help workers solve complicated problems.

Epic Success: The first book about algebra

In the 9th century, the Islamic world was steeped in maths and science. A renowned Islamic mathematician in Bagdad, Abu Ja'far Muhammad ibn Musa al-Khwarizmi, compiled mathematical works assembled from Greek, Roman, Persian and Indian civilisations, largely drawn from the Classical era.

Al-Khwarizmi wrote using Hindu–Arabic numerals. He wrote the first mathematical book on algebra. Its systematic approach distinguished it from earlier treatments of the subject. The book contained sections on calculating areas and volumes of geometric figures and on the use of algebra to solve inheritance problems according to proportions prescribed by Islamic law. Because of the importance of his mathematical writings, the word 'algebra' is derived from his name.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

The book was called *Hisab al-jabr w'al-muqabala* and is translated to *The Compendious Book on Calculation by Completion and Balancing*.

Where do we use the algebra that al-Khwarizmi pioneered?

Algebraic equations and formulas are found in most industries. Digital technologies have overtaken many of these calculations, but there are still many instances where the worker must set up the mathematics first before they can use the digital technology to solve the problem.

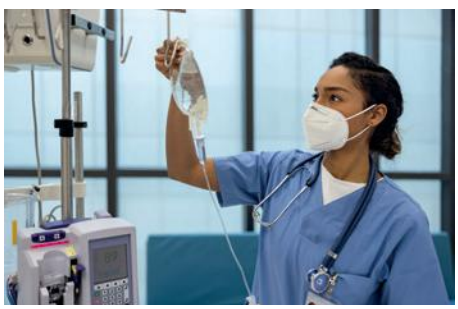
Discussion questions

1 Work with other students from your class to identify how algebra may help in the scenarios depicted in the following pictures. What formulas might be used?

2 Use the internet to find apps or specific calculators that do the required algebraic calculations for each of the scenarios.

A

B



C

D

... continued

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

E

F

G

H

Practice questions

1 For each of the following terms, write down the mathematical meaning.

Term	Mathematical meaning
Algebraic expression	
Calculate	
Divide	
Equation	
Estimate	
Formula	
Multiply	
Operation	
Product	
Rule	
Unknown	
Variable	

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

2 Work with a small group of fellow students and write down all the formulas you can collectively remember. What were they used for? Do you know what all the terms mean and what they represent?

3 Write mathematical sentences for the following problems to help you answer the question.

a You have $420 in $5 notes and need to know how many notes there are.

b You have a packet of 200 seeds and need to plant 4 seeds in each hole. How many holes should you dig?

c You are stacking a supermarket shelf with 2-L bottles of milk. Each shelf takes fifty 2-L bottles. If the milk comes in crates of 9 bottles, and you need to stock 5 shelves, how many crates should you unload from the cool room?

d A delivery driver travels 68 km and makes 14 stops. How far on average between stops?

e Six friends go to the movies. Movie tickets cost $19.95 each and you also buy 3 large popcorns to share at $11.35 each. What is the total cost?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4C Writing algebraic expressions

Algebraic expressions or sentences, and formulas, are written formally using mathematical conventions and notations. You will have written some down in the earlier sections. This topic was covered extensively in Chapter 4 of the Units 1 & 2 textbook, where the world of algebraic thinking was introduced. You can refer to that chapter if you need a refresher on this topic.

Here are some examples of algebraic sentences: the first two are formulas, while the third one is an abstract algebraic equation.

1 Scoring in Australian rules football

In AFL, a team gets:

- **6 points** for each **goal**
- **1 point** for each **behind**.

The team with the highest number of total **points** wins the game.

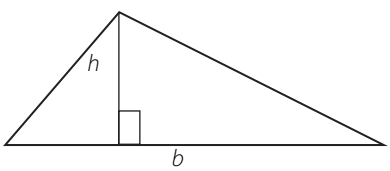
We can write this calculation as a formula, where p is the total number of points scored for g goals and b behinds:

$$p = 6g + b$$

2 Area of a triangle

The area of a triangle with perpendicular height h and base b is:

$$A = \frac{1}{2} \times b \times h \text{ or } A = \frac{1}{2}bh$$



3 An algebraic equation

This is an example of what is called a quadratic equation – we will look at them a bit more in a later section.

$$y = 3x^2 + 2x + 1$$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

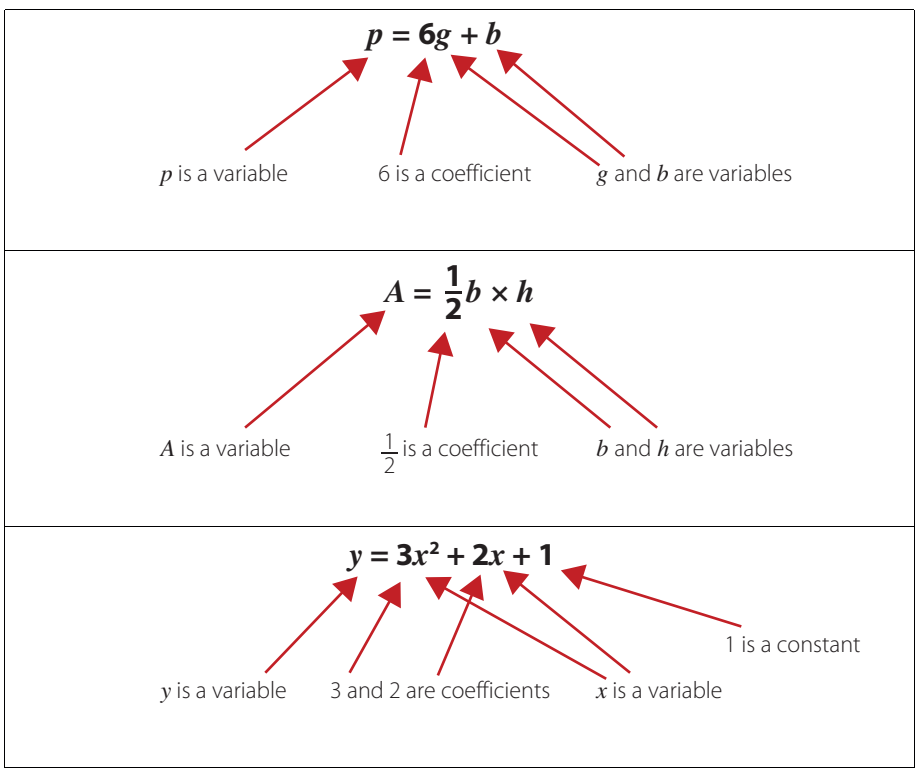
Mathematical conventions and notations

In algebraic expressions or equations, we use words or letters (also called **pronumerals**) in place of numbers. These represent the **variables** in a **formula** or **equation**. In the examples on the previous page, the letters, *p, g, b, A, b, h, y* and *x* are all pronumerals and are all variables. We usually *italicise* variables in mathematics.

An **algebraic expression** is a mathematical statement that uses pronumerals or variables, but generally does not have an equals sign (=). An equation says that two things are equal. It will have an equals sign (=), like in each of the three examples above. An equation says that what is on the left is equal to what is on the right.
A formula is a fact or rule that uses mathematical symbols and connects different variables, usually connected to applications such as calculating areas or the football scores above.

Algebraic equations or formulas may also contain constants. As the name suggests, the value of a **constant** does not change in an equation or formula. When a constant is multiplied by a variable it is called a **coefficient**.

Using the three examples above, here are examples of what these terms relate to for each one.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 1 Writing an algebraic expression with coefficients and variables

Write an algebraic expression for the cost for a family to go to the movies if adult tickets are $19.50 and children's tickets are $14.50.

THINKING	WORKING
STEP 1	
Write a mathematical sentence for this scenario.	Total cost for a family is: total cost of adult tickets + total cost of children's tickets
STEP 2	
Use appropriate pronumerals to represent the variables in the expression. The number of adults and the number of children can vary, so these are our variables.	A: number of adults C: number of children
STEP 3	
Determine the coefficients of the pronumerals.The cost of an adult ticket is $19.50, so this will be the coefficient of A.	Total cost of adult tickets $= 19.50 \times A$ $= 19.50A$
The cost of a children's ticket is $14.50, so this will be the coefficient of C.	Total cost of children's tickets $= 14.50 \times C$ $= 14.50C$
STEP 4	
Write the expression to represent the total cost for a family to go to the movies.	Algebraic expression for the total cost (in dollars) is $19.50A + 14.50C$.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 2 Writing an algebraic equation with constants, coefficients and variables

Write the algebraic equation for the total charge to hire a venue for an event when the venue costs $750 to hire, plus $40 per person attending an event.

THINKING	WORKING
STEP 1	
Write a mathematical sentence for this scenario.	Total charge = venue cost + cost for people attending
STEP 2	
Use appropriate pronumerals to represent the variables in the equation. The number of people attending, and the total charge can vary, so these are our variables.	C: total charge P: number of people attending the event
STEP 3	
Determine the terms in the equation. The cost of hiring the venue is a constant, which is $750. The cost per person is $40, so this will be the coefficient of P.	Venue cost = $750 Cost for P people attending = $40P$
STEP 4	
Write the equation for the total charge of hiring the venue for an event.	Algebraic equation for the total charge is $C = 750 + 40P$.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4C Tasks and questions

Thinking task

1 Match each word expression on the left (a–g) with its algebraic expression on the right (A–G).

Word expression	
a	Add a and b and divide both by c
b	Multiply a and c then subtract b
c	Subtract c from b then multiply by a
d	Multiply c by the constant π and then add b
e	Add 10 to b then multiply by c
f	Multiply a by 2 and add 3 times b
g	Divide b by a and add c plus d

Algebraic expression	
A	$(b - c)a$
B	$\frac{b}{a} + (c + d)$
C	$2a + 3b$
D	$\frac{(a+b)}{c}$
E	$\pi c + b$
F	$(b + 10)c$
G	$ac - b$

Skills questions

2 Identify the value of the coefficient in the following formulas.

a $P = 2(l + w)$

b $A = \pi r^2$

c $C = \frac{5}{9}(F - 32)$

d $V = \frac{1}{3}(l \times w \times h)$

3 Identify the variable(s) in the following formulas.

a $P = 2\pi r$

b $V = ah$

c $D = \frac{m}{v}$

d $V = \frac{1}{3}\pi r^2 h$

4 For each of the following, identify the variable(s), the coefficient(s) and the constant(s).

a $3x + 10 = 28$

b $5m - 8 = 22$

c $2a + 5b + 120 = c$

d $12p + 6 = 4x^2$

5 Write an algebraic expression for each financial scenario below.

a Your grandparent gives you $100 for your birthday. You buy two pairs of jeans at the same cost and a hoodie.

b You buy a gold pass at the cinema for you and a mate, and you spend a total of $45 on drinks and food.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

c You buy 6 chicken nuggets, 2 hash browns and a soft drink for lunch, and then you paid back the $2 that you owed your friend.

d Orange and avocado trees are planted in rows in an orchard to generate income for a farm. There are 12 orange trees per row, and 15 avocado trees per row.

Mixed practice

6 Write an algebraic expression for the cost of buying four identical shirts and two identical jumpers.

7 A family group of three adults and two children go out to the movies. What is an algebraic expression for the total cost for the family if the tickets are $\$A$ each per adult and $\$C$ each for a child?

8 Write an algebraic expression for the total cost of putting p litres of petrol at $2.35 per litre into a car.

Application tasks

9 Use the information in the table to write algebraic equations for each scenario below.

Flights between Melbourne and Sydney Economy class	One-way $99 Return $190 Child 50% of adult price Luggage $35 per bag Snack $18
Flights between Melbourne and Brisbane Economy class	One-way $199 Return $378 Child 50% of adult price Luggage $45 per bag Snack $28
Flights between Melbourne and Perth Economy class	One-way $299 Return $540 Child 50% of adult price Luggage $55 per bag Snack $38
Flights between Melbourne and Cairns Economy class	One-way $220 Return $400 Child 50% of adult price Luggage $68 per bag Snack $29

a Cost for an adult with luggage flying from Melbourne to Sydney.

b Cost for two adults with luggage, each having a snack, flying from Melbourne to Brisbane.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

c Cost of an adult and a child with luggage flying from Melbourne to Perth.

d Cost of two adults and a child with luggage and each having a snack, flying from Melbourne to Cairns.

e Cost of three adults with luggage flying from Melbourne to Sydney return.

f Cost of one adult with luggage and a snack on each leg of the journey flying from Sydney to Melbourne, then on to Perth.

10 A cacao tree grows cacao pods that are ground to make cocoa powder.

- Each tree has approximately 30 pods a year and each pod contains roughly 40 beans.
- Approximately 1000 cocoa beans are needed to produce 1 kg of chocolate.

The following farms have plantations with these numbers of cacao trees.

Farm A	50 trees
Farm B	120 trees
Farm C	800 trees
Farm D	1200 trees

The cacao from these farms is used to make *Chocolate Champ* bars. The bars come in 50-g bars or 250-g blocks. Use equations for the following calculations.

a How many beans are needed for a 500 kg order from a manufacturer?

b How many trees are needed for a 500 kg order from a manufacturer?

c How many trees are needed for an order of any size, N kg, from a manufacturer?

d How many 50-g bars can be manufactured from farm A in one year?

e How many 50-g bars can be manufactured from farm B in one year?

f How many 50-g bars can be manufactured from farm D in one year?

g How many 250-g bars can be manufactured from farm C in one year?

h How many 250-g bars can be manufactured from farm D in one year?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4D Writing and solving equations

If you work in a sales position, your pay is often a combination of the payment for the hours you work, plus commission. Knowing your hourly rate, how many hours you worked in the week and how much commission you earned, you can calculate how much you should be paid for the week.

When you take out a personal loan, knowing how much you must pay for each instalment and the number of instalments lets you calculate the total cost of the loan.

Solving equations or formulas requires the **substitution** of values in place of the variables in an equation to work out the answer.

One formula you will be familiar with over your years of schooling is:

$$\text{Area of a rectangle} = \text{length} \times \text{width}$$

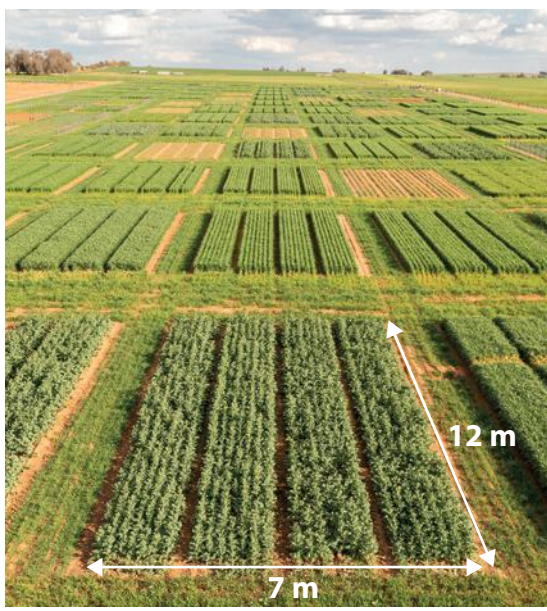
Using mathematical notation, this is:

$$A = l \times w$$

To solve this formula for the area of a rectangle, we need to know:

- the length (l)
- the width (w).

For example, a farmer wants to work out the area of a section of a paddock so that they know how much fertiliser they need to feed this section.



The length of a section of a paddock is 12 m, and the width is 7 m. Substituting these into the formula gives us:

$$\begin{aligned} A &= 12 \times 7 \\ &= 84 \end{aligned}$$

The area for fertilising is 84 m^2.

We have **substituted** into the formula to calculate the answer required.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 3 Writing and solving an equation with a constant and a variable

You are hiring a truck to help a mate move. The truck will cost $350 plus a fuel charge of $1.85 per kilometre.

a Write an equation to represent the total cost of hiring the truck.

b If you know that the distance you will travel is 60 kilometres, use the equation to calculate the total cost of this hire.

THINKING	WORKING
STEP 1	
Write the mathematical sentence for this scenario.	**a** Total cost of hiring the truck = truck cost + fuel charge for km travelled
STEP 2	
Use appropriate pronumerals to represent the variables.	C: total cost (in dollars) k: number of kilometres travelled
STEP 3	
Determine the terms in the equation. The cost of hiring the truck is a constant which is $350.	Truck cost = 350
The cost per kilometre travelled is $1.85 so this will be the coefficient of k for the fuel charge. ($1.85 \times k = 1.85k$)	Fuel charge = $1.85k$
STEP 4	
Write the equation for the total cost of hiring the truck.	$C = 350 + 1.85k$
STEP 5	
How many kilometres will be travelled? Write the value for k.	**b** $k = 60$
STEP 6	
Substitute this value into the equation and evaluate the total cost.	$C = 350 + 1.85 \times 60$ $= 461$
STEP 7	
Write your answer.	The total cost of hiring the truck to travel 60 kilometres is $461.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 4 Writing and solving an equation with variables and coefficients

A Melbourne exhibition has an entry charge of $35 for adults and $23 for children. Write an equation to calculate the total price for a group of adults and children and use it to work out the price for four adults and six children.

THINKING	WORKING
STEP 1	
Write a mathematical sentence for this scenario.	Total price = total cost of adult tickets + total cost of children's tickets
STEP 2	
Use appropriate pronumerals to represent the variables.	P: total price (in dollars) a: number of adults c: number of children
STEP 3	
Determine the terms in the equation. The cost of an adult ticket is $35, so this will be the coefficient of a. ($35 \times a = 35a$)	Total cost of adult tickets = $35a$
The cost of a children's ticket is $23, so this will be the coefficient of c. ($23 \times c = 23c$)	Total cost of children's tickets = $23c$
STEP 4	
Write the equation for the total price to attend the exhibition.	$P = 35a + 23c$
STEP 5	
How many adults and children are attending? Write the values for a and c.	For $a = 4$ and $c = 6$,
STEP 6	
Substitute these values into the equation and evaluate the total price.	$P = 35 \times 4 + 23 \times 6$ $= 278$
STEP 7	
Write your answer.	The total price for the group to attend the exhibition is $278.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 5 Substituting into a formula to solve for the unknown variable

The Widmark formula for calculating the blood alcohol content (BAC) for males is:

$$\text{BAC} = \frac{\text{alcohol consumed in grams}}{\text{body weight in grams} \times 0.68} \times 100$$

If a male weighs 74 kg and has consumed 64 g of alcohol, what is their BAC?

THINKING	WORKING
STEP 1	
Write the values of the known variables.	Alcohol consumed = 64 g Body weight = 74 kg
STEP 2	
Convert the body weight from kilograms (kg) to grams (g) as the formula requires the body weight to be in grams.	74 kg × 1000 = 74 000 g
STEP 3	
Substitute the variables into the formula to evaluate the BAC.	$\text{BAC} = \frac{64}{74\,000 \times 0.68} \times 100$ $= 0.127$ (to 3 decimal places)
STEP 4	
Write your answer.	The blood alcohol content (BAC) of a 74-kg male that has consumed 64 g of alcohol is 0.127.

4D Tasks and questions

Thinking task

1 Make a list of five different sports, industries or workplaces. Next to each give one example of an algebraic equation or formula that would be used in that situation. Share and compare these with your classmates.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Skills questions

2 Determine the value of the following algebraic expressions by substituting the values for the variables x and y.

a $5x + 3y$ where $x = 4$ and $y = 2$

b $3x^2 + y - 2x$ where $x = 3$ and $y = 5$

c $\sqrt{x} + \frac{y}{x} + 2$ where $x = 4$ and $y = 10$

d $3(y^x + 2)$ where $x = 3$ and $y = 2$

3 Determine the value of the following algebraic expressions by substituting the given values.

a $a^2 + b^2$ where $a = 11$ and $b = 13$

b $50(p + a + k - 5)$ where $p = 7$, $a = 3$ and $k = 4$

c $(f + 6) \times (g + 9) \div 2$ where $f = 14$ and $g = 1$

d $\frac{h}{3} + 5p + 150$ where $h = 12$ and $p = 15$

4 Solve the following by writing equations and substituting the given values.

a Living with four housemates, your electricity bill for a 3-month period is $450. How much is your share of this expense?

b What is the cost of the Uber trip when the booking fee is $3.50, and the trip of 15 km is charged at $2.40 per km?

c What is the total cost when 6 adults and 8 children eat at a restaurant that charges $52 per adult and $40 per child?

d A retaining wall should have supports 1.2 m apart and needs a support on each end. How many supports will you need for a wall that is 10 m long?

5 Solve the following by substituting into the given formulas.

a Given that the formula for calculating the area of a circle is $A = \pi r^2$, where r is the radius, what is the area of a circle with a radius of 5 mm? (Round to 1 decimal place.)

b Given that the formula for calculating the distance (d) covered when travelling at a set speed (s) for a time (t) is $d = s \times t$, how far will you travel if your speed is 80 km/h for $2\frac{1}{2}$ hours?

c Given that the formula for calculating the volume (V) of a pyramid with length (l), width (w) and height (h) is $V = \frac{1}{3} \times l \times w \times h$, what is the volume when the length is 12 cm, the width is 10 cm and the height is 15 cm?

d Given that the formula to convert degrees Fahrenheit (F) to degrees Celsius (C) is $C = \frac{5}{9}(F - 32)$, what is the temperature in degrees Celsius when it is 86 degrees Fahrenheit?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mixed practice

6 Given that the formula for the area of a circle is $A = \pi r^2$, where r is the radius, calculate the remaining area when a small circle of radius 5 cm is subtracted from a large circle of radius 10 cm. Round your answer to 1 decimal place.

7 What is your share of the total cost when you and three mates order pizzas costing $68 with a $5 booking fee and $18 delivery fee?

8 Determine the value of the following algebraic expressions by substituting the given values. Round your answers to 1 decimal place.

a $\frac{4}{3}\pi r^3$ where $r = 7.8$ **b** $\frac{(n-m)}{m} \times 27 + 3n$ where $m = 9.2$ and $n = 4.6$

Application tasks

9 The school needs to lay a new concrete path for its students to walk safely to the bus area. The path needs to be a rectangular prism shape which is 35 m long, 2.5 m wide and 0.7 m deep. The maximum capacity of a concrete truck is 8 cubic metres. How many trucks will be needed?

a Write an equation for the number of concrete trucks needed to fill a rectangular prism of dimensions l, w and h.

b Substitute the values for the dimensions of the path into your equation to calculate how many trucks will be needed.

c Reflect on your answer to the equation. Does it make sense?

d What is your final answer to this question?

10 A boarding kennel feeds its dogs and cats twice a day, and its puppies and kittens three times a day.

a Write an equation for how many feeds are required each day for:

i cats and kittens **ii** dogs and puppies

b Write an equation for the total number of feeds that are required each day.

c Change your equation to reflect how many feeds there will be in a 2-week period.

Over a holiday period of 2 weeks, the boarding kennel had many animals in its care as shown in the list on the right:

Cats	49
Kittens	6
Dogs	30
Puppies	4

d Use your answer to part **c** to calculate the total number of feeds in the 2-week holiday period.

e Given that the boarding kennel pays $10 per feed for dogs and puppies, and $8 per feed for cats and kittens, calculate the total feed bill for the 2-week period.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4E Transposing equations and formulas

Working as a waiter, your pay is a combination of payment for your hours worked plus your share of the tips. When you know how much you have been paid in total for the week, you could work backwards to check if the amount you have received in tips is right.

In Australian rules football, if you know a team scored 100 points and kicked 14 goals, you can work backwards to calculate how many behinds the team kicked.

So, sometimes when using an equation or formula we need to work in reverse. This method of working backwards – from knowing the answer to the formula (the number of points, p) to calculate one of the other values in the formula (the number of goals, g, or the number of behinds, b) leads us to what we call transposing a formula in mathematics.

This happens when we know the end result from the calculation to an equation or formula, and we want to work out what values we need to get that answer.

In another example, when you have 20 m of chicken fencing to rebuild your chicken coop that is 5 m wide, you can work backwards and **transpose** the perimeter formula to calculate the maximum width of the new chicken coop.

How to transpose

Let's look at two formulas from a previous section:

$$p = 6g + b$$

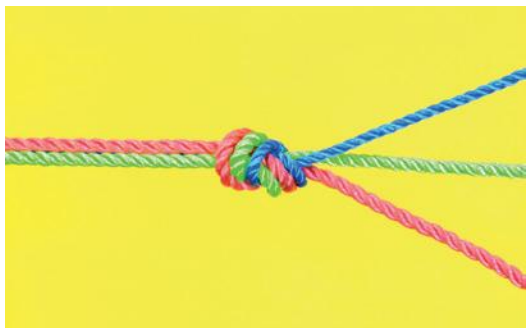
$$A = \frac{1}{2}bh$$

The variable on the left-hand side of the equals sign (=) is called the **subject** of the equation or formula. This is the single variable written by itself that is equal to everything else in the formula.

When we transpose an equation, we reorganise it so that a different variable becomes the subject of the formula.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

In the Australian rules football example, if you know a team scored 100 points and kicked 14 goals, you can work backwards to calculate how many behinds the team kicked. This means you want to change the formula $p = 6g + b$ so that the variable we are trying to find (the number of behinds), b, becomes the **subject** of the formula.



Transposition is like untying a knot. Everything that has been done to tie the knot needs to be undone, working from the outside to the inside. To keep the truth of the equation or formula, everything that we do to one side of the equals sign, we must do to the other side.

To be able to transpose formulas to solve equations, we need to understand the relationships between the operators (+, −, ×, ÷):

- Addition is the opposite of Subtraction
- Division is the opposite of Multiplication.

This is handy to know when we are transposing. Let's look at some examples.

Example 6 Transposing an equation that has addition and subtraction

Make c the subject of the equation $c - d + 5 = 7$.

THINKING	WORKING
STEP 1	
Write the equation.	$c - d + 5 = 7$
STEP 2	
Subtract 5 from both sides to undo the + 5.	$c - d + 5 - 5 = 7 - 5$
STEP 3	
Simplify the equation.	$c - d = 2$
STEP 4	
Add d to both sides to undo the $- d$.	$c - d + d = 2 + d$
STEP 5	
Write the transposed equation.	$c = 2 + d$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 7 Transposing an equation that has division

Make h the subject of the equation $2f = \frac{h}{3}$.

THINKING	WORKING
STEP 1	
Write the equation.	$2f = \frac{h}{3}$
STEP 2	
Multiply both sides by 3 to undo the divide by 3 operation.	$2f \times 3 = \frac{h}{3} \times 3$
STEP 3	
Simplify the equation.	$6f = h$
STEP 4	
Make h the subject of the equation.	$h = 6f$

Example 8 Transposing an equation then using substitution to solve a problem

In Australian rules football, if you know a team scored 100 points and kicked 14 goals, use the formula $p = 6g + b$ to calculate how many behinds the team kicked.

THINKING	WORKING
STEP 1	
Write the equation.	$p = 6g + b$
STEP 2	
Transpose the equation to make b the subject. Subtract $6g$ from both sides to undo the $+ 6g$.	$p - 6g = 6g - 6g + b$
STEP 3	
Simplify the equation.	$p - 6g = b$
STEP 4	
Make b the subject of the equation.	$b = p - 6g$

... continued

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 5	
Substitute the values for number of points (p) and number of goals (g) into the equation and evaluate.	Since $p = 100$ and $g = 14$, $b = (100) - 6 \times (14)$ $= 100 - 84$ $= 16$
STEP 6	
Write your answer.	The number of behinds kicked by an AFL team that scores 100 points and kicks 14 goals is 16.

Example 9 Transposing a formula with multiplication and division

Make b the subject of the formula $A = \frac{1}{2}bh$.

THINKING	WORKING
STEP 1	
Write the formula and include the multiplication symbols.	$A = \frac{1}{2} \times b \times h$
STEP 2	
Multiply both sides by 2 to undo the divide by 2 operation.	$A \times 2 = \frac{1}{2} \times b \times h \times 2$
STEP 3	
Simplify the formula.	$2A = b \times h$
STEP 4	
Divide both sides by h to undo the multiply by h operation.	$2A \div h = b \times h \div h$
STEP 5	
Simplify the formula.	$2A \div h = b$
STEP 6	
Make b the subject of the formula.	$b = 2A \div h$ or $b = \frac{2A}{h}$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4E Tasks and questions

Thinking task

1 Explain why we sometimes have to transpose equations and formulas. Give one example. Share and compare these explanations with your classmates.

Skills questions

2 Transpose the following equations to make y the subject.

a $y + 2 = 7$

b $y + 5 = 7 - z$

c $x = 4y - 8$

d $3x - 6y = 54$

3 Transpose the following formulas to make A the subject.

a $l = A \div w$

b $V = \frac{1}{3}(A \times h)$

c $r = \sqrt{A \div \pi}$

d $h = 2A \div (t + b)$

4 For $A = \frac{1}{2}b \times h$,

a transpose the formula to make b the subject

b use the formula to evaluate b when $A = 24$ and $h = 10$.

5 For $V - E + F = 2$,

a transpose the formula, to make E the subject

b use the formula to calculate E when $V = 8$ and $F = 6$.

Mixed practice

6 Transpose each of the following to make the pronumeral shown in red the subject.

a $y - 5x = 30$

b $a = 2\pi r(h + r)$

c $p = 2\pi r$

d $E = \frac{1}{2}mv^2$

7 For $F = m \times a$,

a transpose the formula to make a the subject

b use the formula to calculate a when $m = 5$ and $F = 9.8$.

Application tasks

8 You are paid $25.65 per hour, and also get 15% commission on the sales you made during the week.

a Using h for the variable number of hours worked and s for the variable amount of sales, write an equation to represent the total wage earned in a week (W).

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

b If you sold $1,475 worth of goods and worked for 38 hours during the week, what was your total wage?

c Transpose the equation to make the commission the subject.

d If your total pay for a week was $2,174.70 and you worked 38 hours, calculate how much of this was commission.

9 The recommended dose of paracetamol for children under the age of 12 months is 15 mg per kg of weight.

a Write this as a formula.

b How much paracetamol should be given to a child weighing 5 kg?

c Transpose the formula to make the weight of the child the subject.

d If 150 mg of paracetamol is given, calculate the weight of the child.

10 Jarvid has 26 m of fencing to make a dog enclosure in his yard. He decides that the shape of the enclosure will be a rectangle. The yard is quite short, so the width of the dog enclosure will be 3 m. The formula for the perimeter of a rectangle is $P = 2l + 2w$ where P = perimeter, l = length and w = width.

a Transpose the formula to make l the subject.

b Use the formula from part **a** to calculate the length of the enclosure.

11 The formula relating initial and final velocity, time and acceleration of an object moving at constant acceleration is:

$$v_f = v_i + at$$

where v_f = final velocity, v_i = initial velocity, a = acceleration, and t = time.

Ceril is performing a science experiment with a cart that moves at constant acceleration. They measure the initial velocity to be 2 m/s and the final velocity as 12 m/s. The time taken is measured as 25 seconds.

a Transpose the formula to make a the subject.

b Use the formula from part **a** to calculate the acceleration of the cart.

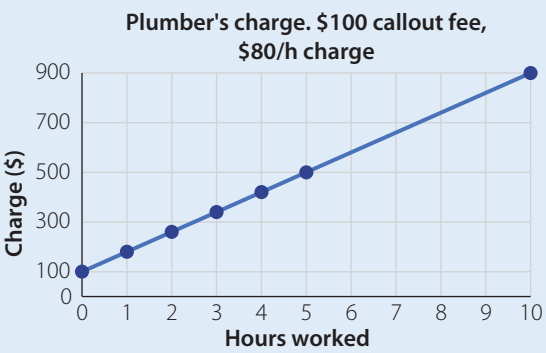
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4F Seeing equations and formulas visually

Have you heard the expression ‘A picture is worth a thousand words’?

Sometimes it is easier to understand and interpret a situation when it is presented graphically rather than as a table of values.

Here are some examples.

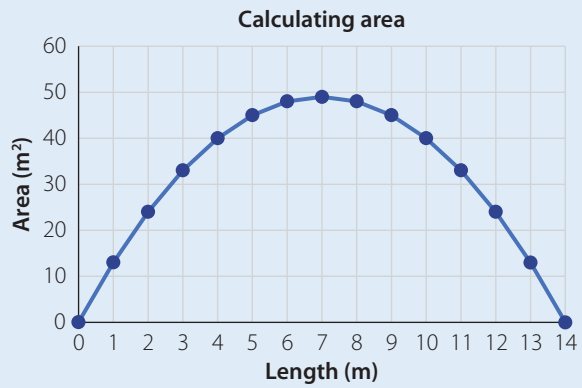


This is a **linear graph** because it is a straight line.

It is the graph for the charges of a plumber.

The formula is:

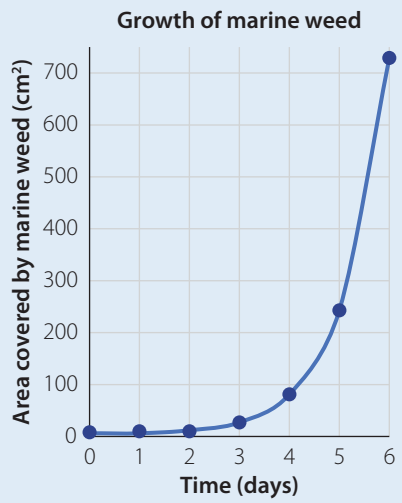
$C = 80h + 100$



Quadratic graphs are graphs of a quadratic function – that is, they include a squared term.

The shape of a quadratic graph is called a **parabola**. A parabola has one turning point – a minimum point or a maximum point.

The equation for this graph is $A = 14l - l^2$



Exponential graphs are graphs of equations that contain exponents or powers of the variable. They can be recognised as they include a k^x term where k is the base and x is the exponent (power).

The graph can be a growth curve when k is greater than 1 or a decay curve when k is between 0 and 1.

This is a graph showing the growth of marine weed with an equation of $y = 3^x$.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

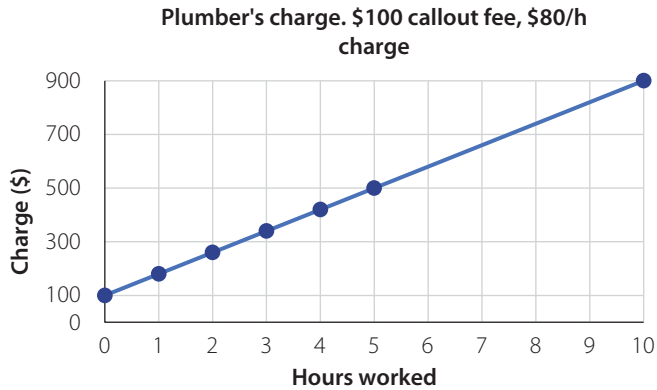
Linear relationships

Let's look at the graph for the charges of the plumber. The plumber charges a callout fee of $100, then $80 per hour they spend on the job.

Here is a table showing the charge for different hours worked.

Hours worked	0	1	2	3	4	5	10
Charge	$100	$180	$260	$340	$420	$500	$900

This is a graph for the charges of the plumber. The graph is **linear**.



We can work out the plumber's charges using an equation.

$$\text{Total charge}(\$) = \text{callout fee} + \$80 \times \text{number of hours worked}$$

Let's call the total charge y. It is on the y-axis (the vertical axis) of the graph (and it is on the bottom row of the table). This is what we're trying to calculate.

We know that the callout fee is $100. It doesn't change throughout the calculation, so it is a constant.

Let's call the number of hours worked x. This variable is on the x-axis (the horizontal axis) of the graph (and the top row of the table). It is what we need to know in order to calculate the total charge.

We can write the sentence above using algebra and get:

$$y = 100 + 80x$$

or we can swap the terms on the right side so it looks like this:

$$y = 80x + 100$$

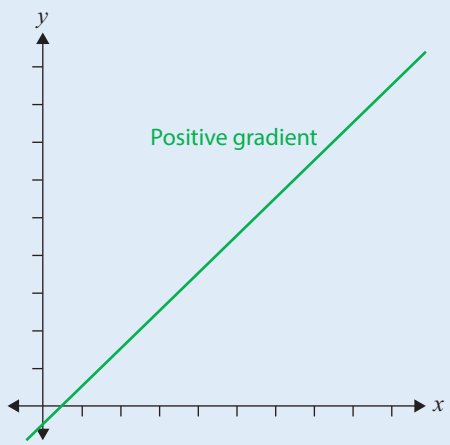
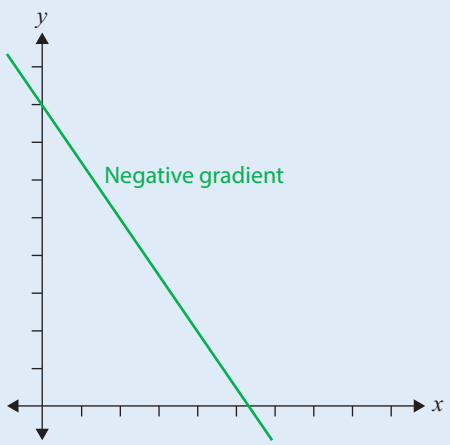
These types of equations give straight line graphs and are called **linear equations**.

The general equation for a linear graph can be $y = a + bx$ where a is the constant and b is the coefficient of x.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Sometimes this equation is written as $y = mx + c$ where m is the coefficient of x and c is the constant.

Each of these values relate to specific characteristics of the graph as shown below.

<table>
<tr><td>$x = mx + c$
gradient y-intercept</td><td>$y = a + bx$
y-intercept gradient</td></tr>
<tr><td colspan="2">The y-intercept (c or a) is where the line crosses the y-axis (the vertical axis).
The slope or gradient (m or b) of a line tells us how steep a line is. It tells us how many steps the line goes up for every step it goes across.
The higher the gradient, the steeper the line.</td></tr>
<tr><td>If the gradient is positive, the slope of the line is upwards:</td><td>If the gradient is negative, the slope of the line is downwards:</td></tr>
<tr><td> 
</td><td> 
</td></tr>
</table>

For the plumber's charges on the previous page, you can see that the graph crosses the vertical axis (y-axis) at 100, which matches the call-out fee that you get charged even if they don't work for any hours. So, this is the amount for 0 hours. This is the y-intercept.

The slope or gradient is the value of how much the amount increases for each hour – in this case it is the rate of $80 per hour. So, for every extra hour, the charge goes up by $80, and the graph therefore goes up by that amount every hour.

Linear equations trending downwards

Some situations show a relationship where the variable decreases over time.

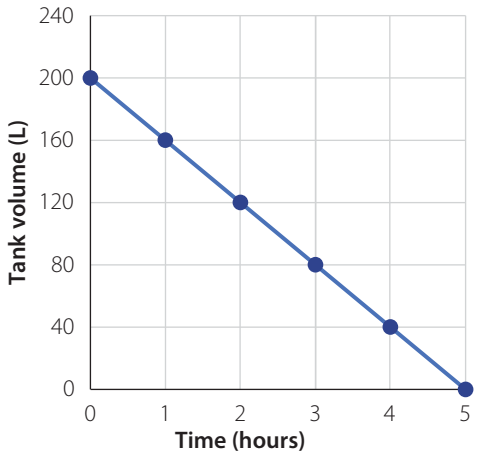
Zhi works at the aquarium and is cleaning one of the display fish tanks. The tank holds 200 litres of water and can be drained at a rate of 40 litres/hour.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Here is the table:

Time (hours)	0	1	2	3	4	5
Tank volume (litres)	200	160	120	80	40	0

Here is the graph:



The equation for this situation is:

$$y = 200 - 40h$$

which could also be shown as:

$$y = -40h + 200$$

Whichever form of the equation you prefer, the y-intercept is 200, and the slope or gradient is –40.

To summarise, for linear graphs:

- the higher the gradient, the steeper the line
- if the gradient is positive, the slope of the line is upwards
- if the gradient is negative, the slope of the line is downwards.

The following equations all have the same format as those above and are linear equations and would have straight line graphs.

$y = 5x + 4$ $\quad$ $y = 7x - 15$ $\quad$ $y = \frac{3}{4}x + 12$ $\quad$ $y = 3.7x - 4.2$

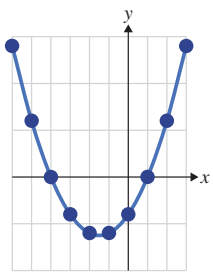
$y = -25 + 4x$ $\quad$ $y = 180 - 7x$ $\quad$ $y = -\frac{1}{10} - \frac{4}{5}x$ $\quad$ $y = -12.34 + 3.7x$

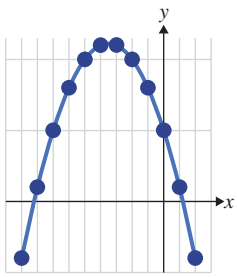
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

What do quadratic relationships look like?

The graphs of quadratic relationships form a parabola.

The general equation for a quadratic relationship is $y = ax^2 + bx + c$.



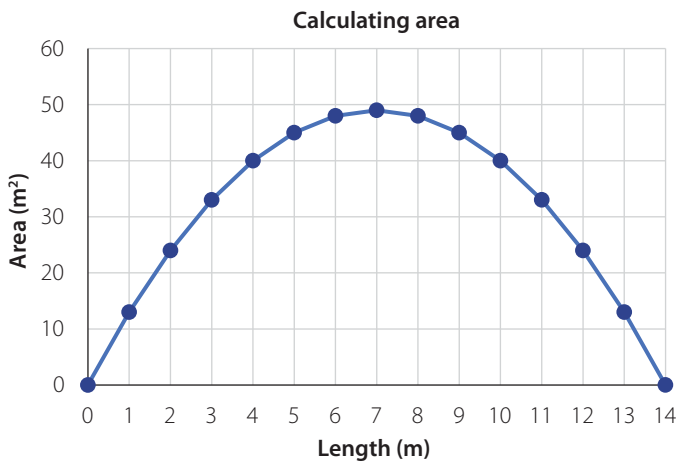


Example 1: Calculating a fence length

Josie has 28 metres of wire netting that she plans to use to enclose a rectangular vegetable patch. Here are the areas she can enclose with the 28 metres of wire netting.

Length, l (m)	1	2	5	7	9	12	13
Area, A (m^2)	13	24	45	49	45	24	13

The table of values can be displayed as a graph.



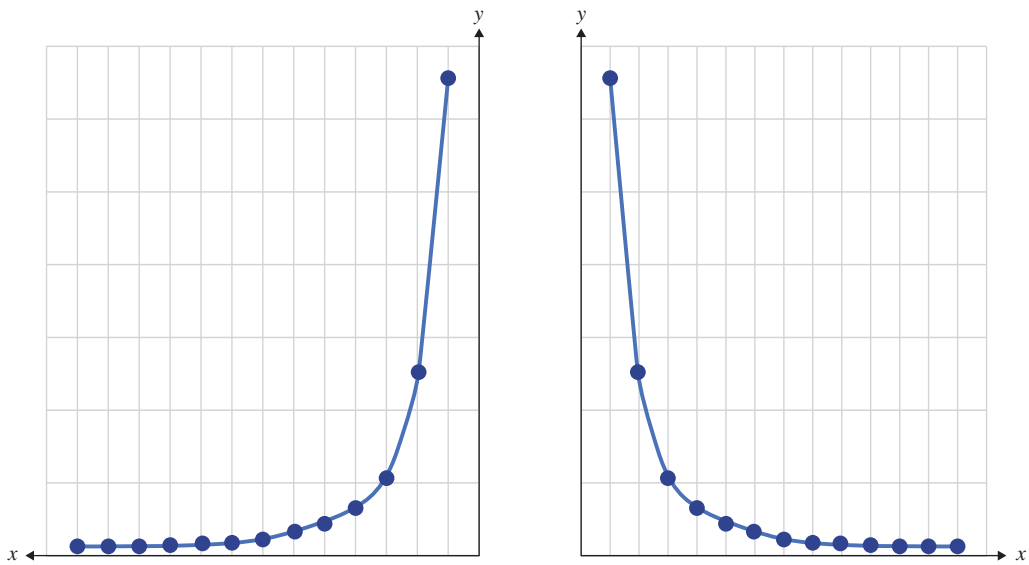
You can see from the graph that the maximum area that Josie can cover is 49 square metres (m^2), which is when the side length is 7 metres long (a square).

The equation for this graph is $A = 14l - l^2$.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

What do exponential relationships look like?

The typical shapes for the graph of an exponential relationship is a 'hockey stick'. The graph for showing growth is on the left, and for showing decay is on the right.



The general equation for an exponential relationship is $y = Ab^x$.

If the value of b is greater than 1, the situation has a positive growth graph – like the one above on the left.

If the value of b is between 0 and 1, the situation has a negative decay graph – like the one above on the right.

Examples of positive exponential growth situations include:

- Food spoilage. For example, mould on food will start from a small speck to covering most of the food in a few days.
- Compound interest. The rise might not be as steep as in the example, but compound interest will follow an exponential growth path, as over time you are 'earning interest on your interest' as well as on the original sum invested.

- Pandemics. For example, the growth of an infectious disease such as COVID-19.
- Population. For example, Google 'population clock' for details of world or Australian population growth.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

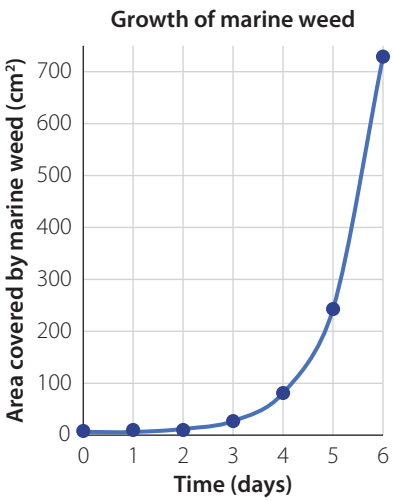
Examples of negative exponential decay situations include:

- Radioactive substances, such as uranium, are reported by half-life, which is the time it takes for an amount of the original mass of the substance to reduce by half. Some types of medical scans use radioactive isotopes.
- The amount of drug that remains in a person's system decreases exponentially with the time since the drug was administered.
- How a hot drink cools over time.
- Wound healing. The size of a wound decreases exponentially with the time since the wound was inflicted.

Example 2: Calculating a growth rate

A scientist records the growth of a marine weed in her laboratory tank. On day 0 (at the start of the observations) the weed covers an area of 1 cm^2 and triples its size each day. What area has the weed covered on day 5?

Time (days)	0	1	2	3	4	5	6
Area covered (cm^2)	1	3	9	27	81	243	729



The equation for this graph is $y = 3^x$.

A set of worked examples follows that shows you how to work with and recognise different equations and their graphs, particularly related to linear equations and working out gradients and y-intercepts.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 10 Identifying linear, quadratic and exponential equations

Identify which of the following equations are:

a linear
A $y = 2 + 3x$
D $x = y^2 + 5y + 4$
G $y = x^3$

b quadratic
B $y = 4x + 5$
E $y = 5 - 8x$
H $y + 3x = 9$

c exponential.
C $y = x^2 + 7x + 12$
F $y = 2^x$
I $4y = 4 + 12x$

THINKING	WORKING
STEP 1 Identify linear equations with the properties: • have only two variables • no variable is raised to a power greater than one • no variable is in the denominator of a fraction • no number is raised to a variable power • can be written as $y = a + bx$ or $y = mx + c$.	**a** The equations that are linear are: **A** $y = 2 + 3x$ **B** $y = 4x + 5$ **E** $y = 5 - 8x$ **H** $y + 3x = 9$ **I** $4y = 4 + 12x$
STEP 2 Identify quadratic equations with the properties: • have only two variables • have one term with a variable raised to the power 2 • no variable is in the denominator of a fraction • no number is raised to a variable power • may be written as $y = ax^2 + bx + c$.	**b** The equations that are quadratic are: **C** $y = x^2 + 7x + 12$ **D** $x = y^2 + 5y + 4$
STEP 3 Identify exponential equations with the properties: • have only two variables • have at least one term with a number raised to a variable power • may be written as $y = a^x$.	**c** The equation that is exponential is: **F** $y = 2^x$
STEP 4 Check for any remaining equations.	Equation **G** $y = x^3$ is neither linear, quadratic nor exponential.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 11 Constructing a table of values from an equation by hand

Construct a table of values by hand for each equation.

a $y = 2 + 3x$ **b** $y = 4x + 5$

THINKING	WORKING

STEP 1

Set up a table to show values for x and the corresponding values for y. The x is always in the top row and it is a good idea to include 0 in the table, as this will show where the graph will cross the y-axis (the y-intercept).

a $y = 2 + 3x$

x	0	1	2	3	10
y					

STEP 2

Calculate the value of y by substituting each x value in the table into the equation.

When $x = 0$, $y = 2 + (3 \times 0) = 2$
When $x = 1$, $y = 2 + (3 \times 1) = 5$
When $x = 2$, $y = 2 + (3 \times 2) = 8$
When $x = 3$, $y = 2 + (3 \times 3) = 11$
When $x = 10$, $y = 2 + (3 \times 10) = 32$

STEP 3

Write these values in the table.

x	0	1	2	3	10
y	2	5	8	11	32

STEP 4

Set up a table to show values for x and the corresponding values for y.

b $y = 4x + 5$

x	0	1	2	3	10
y					

STEP 5

Calculate the value of y by substituting each x value in the table into the equation.

When $x = 0$, $y = (4 \times 0) + 5 = 5$
When $x = 1$, $y = (4 \times 1) + 5 = 9$
When $x = 2$, $y = (4 \times 2) + 5 = 13$
When $x = 3$, $y = (4 \times 3) + 5 = 17$
When $x = 10$, $y = (4 \times 10) + 5 = 45$

STEP 6

Write these values in the table.

x	0	1	2	3	10
y	5	9	13	17	45

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Constructing a table of values from an equation using Excel

Spreadsheet technology is quite versatile, particularly for cases where you need to experiment with lots of different values.

We can use Excel for the equations in Example 11. You should try this for yourself.
Let's start with $y = 2 + 3x$.

The formula at cell C4 for $y = 2 + 3x$ is =2+3*B4, then select C4 to C8 and use CTRL-D to copy it down to C8.

	A	B	C	D
1				
2		$y = 2 + 3x$		
3		***x* values**	***y* values**	
4		0	2	
5		1	5	
6		2	8	
7		3	11	
8		10	32	
9				

Similarly for $y = 4x + 5$, simply change the formula at C4 to =4*B4+5, then select C4 to C8 and use CTRL-D to copy it down to C8 as before.

	A	B	C	D
1				
2		$y = 4x + 5$		
3		***x* values**	***y* values**	
4		0	5	
5		1	9	
6		2	13	
7		3	17	
8		10	45	
9				

When using Excel, the calculations are made automatically using the formula.

Example 12 Identifying the *y*-intercept from a table of values

Identify the *y*-intercept from the following tables and write the point where this occurs on the graph as an ordered pair.

a $y = 2 + 3x$

x	0	1	2	3	10
y	2	5	8	11	32

b $y = 4x + 5$

x	0	1	2	3	10
y	5	9	13	17	45

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 1	
The y-intercept is where the graph crosses the y-axis and occurs when the value of x is 0. In the table, locate where $x = 0$, and read the corresponding y value.	**a** $y = 2 + 3x$

x	0	1	2	3	10
y	2	5	8	11	32

When $x = 0$, $y = 2$.
The y-intercept is 2.

STEP 2

Write the point as an ordered pair (x, y). Remember that the x value is always 0 where the graph crosses the y-axis.

The y-intercept occurs on the graph at (0, 2).

STEP 3

In the table, locate where $x = 0$, and read the corresponding y value.

b $y = 4x + 5$

x	0	1	2	3	10
y	5	9	13	17	45

When $x = 0$, $y = 5$.
The y-intercept is 5.

STEP 4

Write the point as an ordered pair (x, y).

The y-intercept occurs on the graph at (0, 5).

Example 13 Identifying the slope (gradient) of a graph from its table of values

Identify the slope of the graph from the following tables.

a $y = 2 + 3x$

x	0	1	2	3	10
y	2	5	8	11	32

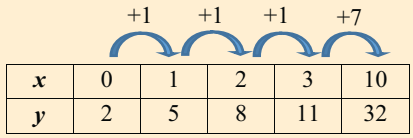
b $y = 4x + 5$

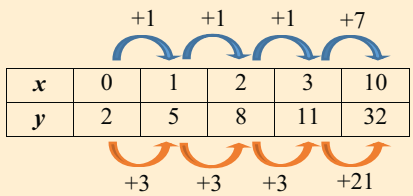
x	0	1	2	3	10
y	5	9	13	17	45

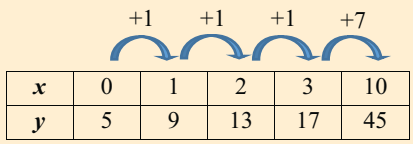
... continued

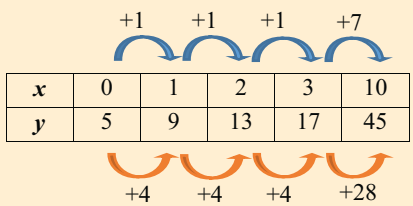
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 1 The slope of the graph is the amount that the y value increases for every increase of 1 in the x value. Check that the x values in the table are increasing by 1 each time. For the last entry in the table, the increase is 7 on the previous entry. This means we will need to divide the corresponding difference between the y values by 7 to get the slope.	**a** $y = 2 + 3x$
STEP 2 For every increase of 1 in the x values, find the corresponding increase in the y value.	The slope of the graph is 3.
STEP 3 Check that the x values in the table are increasing by 1 each time. For the last entry in the table, the increase is 7 on the previous entry. We would have to divide the corresponding difference between the y values by 7 to get the slope.	**b** $y = 4x + 5$
STEP 4 For every increase of 1 in the x values, find the corresponding increase in the y value.	The slope of the graph is 4.









ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 14 Identifying the slope of a graph from its linear equation

Identify the slope of the graph with the following equations.

a $y = 2 + 3x$ **b** $y = 4x + 5$

THINKING	WORKING
STEP 1	
The slope of the graph is the amount that the y value increases for every increase of 1 in the x value. Therefore, the slope of the graph is the **coefficient** of the x-term.	**a** $y = 2 + 3x$ The coefficient of x is 3, so the slope of the line is 3. **b** $y = 4x + 5$ The coefficient of x is 4, so the slope of the line is 4.

Example 15 Identifying the *y*-intercept of a graph from its linear equation

From the equation, identify the y-intercept, and write the point on the graph where this occurs as an ordered pair.

a $y = 2 + 3x$ **b** $y = 4x + 5$

THINKING	WORKING
STEP 1	
The y-intercept is where the graph crosses the y-axis and occurs when the value of x is 0. In the formula, $y = a + bx$, this is the a value. Locate this value for the given equation. Alternatively, we could substitute $x = 0$ into the equation to calculate the y-intercept.	**a** $y = 2 + 3x$ $y = a + bx$ $a = 2$ So, the y-intercept is 2. Alternatively, substituting $x = 0$, $y = 2 + 3 \times 0$ $y = 2$
STEP 2	
Write the point as an ordered pair (x, y). Remember that the x value is always 0, where the graph crosses the y-axis.	The y-intercept occurs at the point $(0, 2)$.

... continued

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

STEP 3

In the formula $y = mx + c$, the y-intercept is the c value. Locate this value for the given equation.

Alternatively, we could substitute $x = 0$ into the equation to calculate the y-intercept.

b $y = 4x + 5$
$y = mx + c$
$c = 5$
So, the y-intercept is 5.
Alternatively, substituting $x = 0$
$y = 4 \times 0 + 5$
$y = 5$

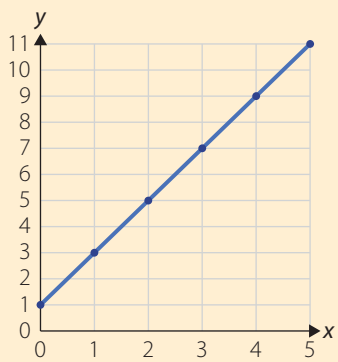
STEP 4

Write the point as an ordered pair (x, y).

The y-intercept occurs at the point $(0, 5)$.

Example 16 Developing a linear equation from its graph

Find the equation for the following linear graph.

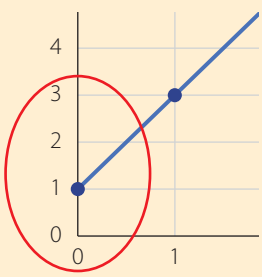


THINKING	WORKING

STEP 1

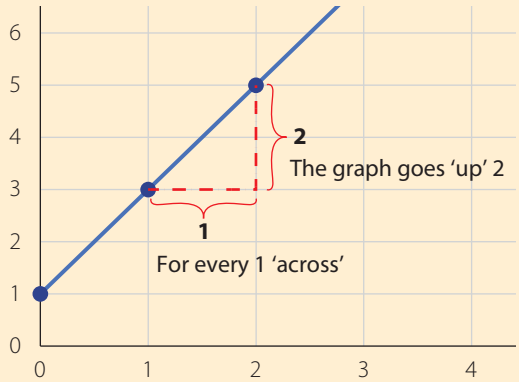
The equation is of the form $y = a + bx$. It is necessary to find the value for a and b. a is the y-intercept, or where the graph crosses the y-axis.

The equation is of the form $y = a + bx$.
The graph crosses the y-axis at $y = 1$ so $a = 1$.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 2	
b is the slope of the graph, so we are looking to see by how much the graph increases on the y-axis for every 1 it goes across on the x-axis.	For every 1 'across', the graph goes 'up' 2, so the slope is 2. This means the value of b is 2.



STEP 3	
Now that we have the values of a and b, we can put these values into the formula to write the equation.	$y = a + bx$ $a = 1, b = 2$ $y = 1 + 2x$

Example 17 Working out a suitable scale for the y-axis of a graph

Determine a suitable scale for the y-axis of the graph of $y = 95 + 120x$, for x values from 0 to 5.

THINKING	WORKING
STEP 1	
The graph for this equation will start at 95 (for $x = 0$), and for every 1 it goes across on the x-axis, it goes up 120 on the y-axis. We need to work out the value of y when x is 5.	$y = 95 + 120x$ When $x = 0$, $y = 95 + 120 \times 0$ $= 95$ When $x = 5$, $y = 95 + 120 \times 5$ $= 695$
STEP 2	
Write your answer.	The y-axis of the graph will need to go up to 700 in increments of 50 or 100.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4F Tasks and questions

Thinking task

1 What are the advantages of creating tables and graphs by hand? What are the advantages of creating tables and graphs using software like Excel? Share and compare your thoughts with your classmates.

Skills questions

2 Decide whether the following equations are linear, quadratic or exponential?

a $y = 7 + 4x$ **b** $y = x^2 + 3x + 2$ **c** $y = 5x + 20$

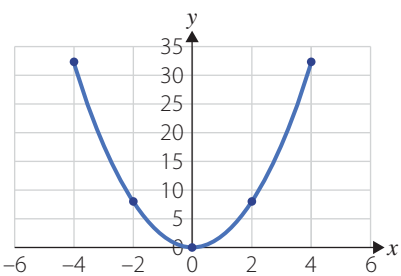
d $y = 20 - 5x$ **e** $y = 250 - 30x$ **f** $y = 100 + 45x$

g $y = 15^x$ **h** $y = x^2 + 5x - 6$ **i** $y = 16.3 - 2.75x$

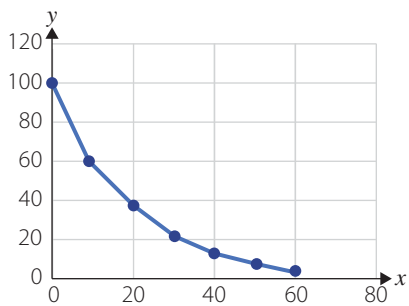
j $y = 15x$ **k** $y = \frac{2}{3}x + 7$ **l** $y = \frac{4}{3} + \frac{2}{5}x$

3 Identify which of the following graphs are linear, quadratic or exponential.

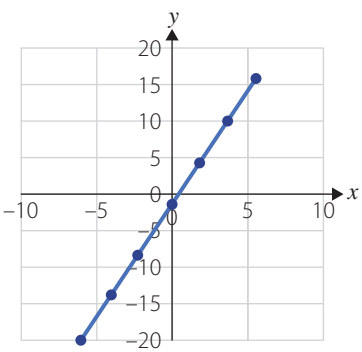
a



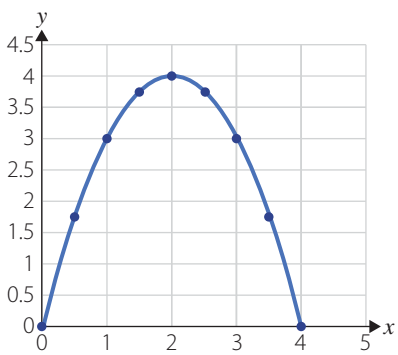
b



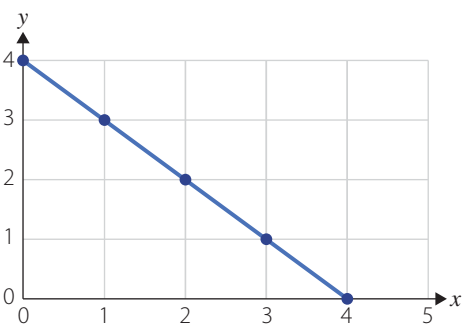
c



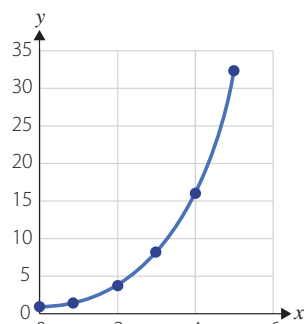
d



e



f



ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4 Complete this table of values by hand for each linear equation.

x	0	1	2	3	4	5
y						

a $y = 3 + 2x$ **b** $y = 4x + 2$ **c** $y = 8 - 2x$ **d** $y = -2x + 7$

5 Use technology to construct a table of values for each linear equation. Use the same table from question **4**.

a $y = -3x - 2$ **b** $y = 2 + \frac{x}{2}$ **c** $2y = 6 + 4x$ **d** $2y + 4x = 6$

6 Draw by hand the graph for each of the equations in question **4**.

7 Use technology to construct the graph for each of the equations in question **5**.

8 For each of the following equations, identify the y-intercept and the slope of its graph.

a $y = 30 + 4x$ **b** $y = 14 + 6x$ **c** $y = 15x + 4$

d $y = 18 - 3x$ **e** $y = -4x + 6$ **f** $y = x + 12$

9 For each of the following tables of values, identify the y-intercept and the slope of its graph.

a

x	0	1	2	3	4	5
y	7	11	15	19	23	27

b

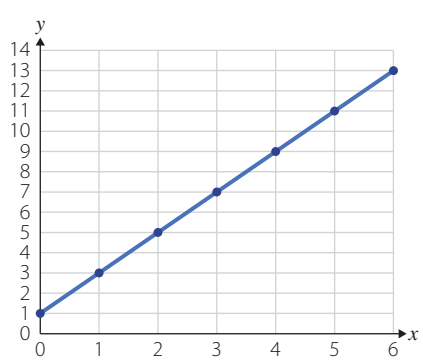
x	0	1	2	3	4	5
y	3	5	7	9	11	13

c

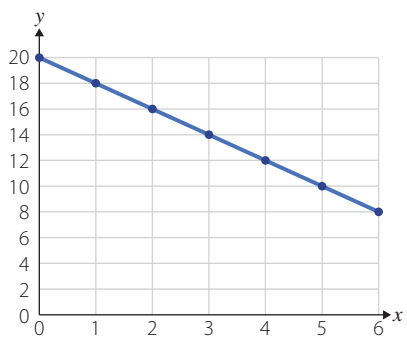
x	0	1	2	3	4	5
y	19	17	15	13	11	9

10 Determine the linear equation for each of the following graphs.

a

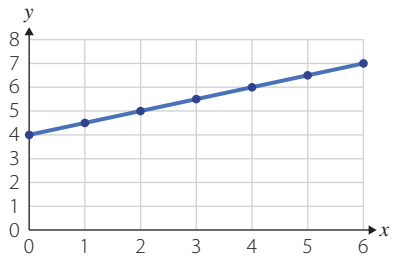


b

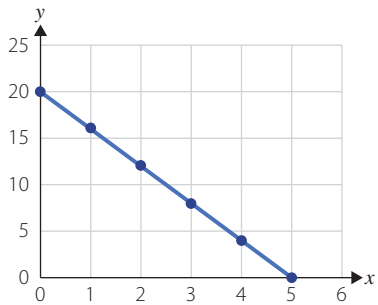


ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

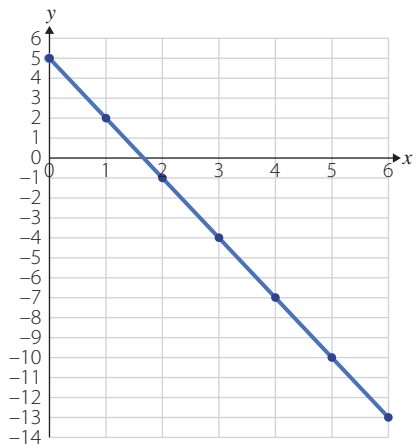
c



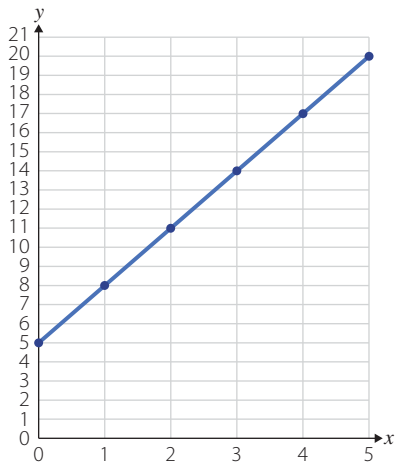
d



e



f



Mixed practice

11 Identify each of these equations as linear or not linear and explain how you know.

a $y = 3x^2 - 5x$

b $y = 7 - 2x$

c $x = y^2 + 2y + 1$

d $y = 4 + \frac{3}{4}x$

e $y - 2x = 5$

f $3y = 5 + 2x$

g $y = 4^x$

h $2x + 3y = 1$

12 For those equations in question **11** that are linear, transpose them so that they are in the form $y = mx + c$.

13 Select the equation that matches the table of values given.

a

x	0	1	2	3	4	5
y	4	16	28	40	52	64

A $4y = 1 + 12x$ **B** $y = 4 + 12x$ **C** $y = 12 + 4x$ **D** $y + 4 = 12x$

b

x	0	1	2	3	4	5
y	80	140	200	260	320	380

A $y = 60 + 80x$ **B** $y = 80 + 60x$ **C** $y = 80x + 60$ **D** $y = 80 - 60x$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

c

x	0	1	2	3	4	5
y	2	1.5	1	0.5	0	–0.5

A $y = 2 - 0.5x$ **B** $y + x = 2$ **C** $y = 0.5 + 2x$ **D** $y = 2x - 0.5$

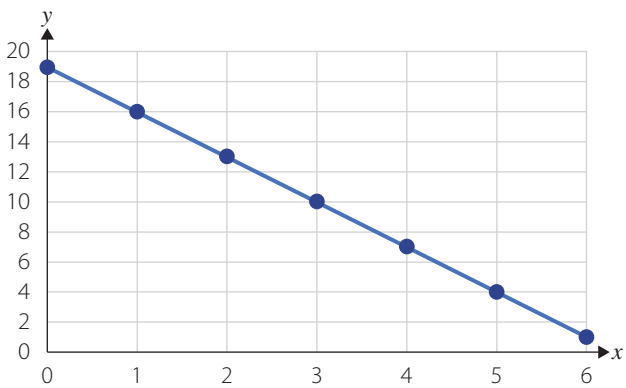
d

x	0	1	2	3	4	5
y	1	$1\frac{3}{4}$	$2\frac{1}{2}$	$3\frac{1}{4}$	4	$4\frac{3}{4}$

A $4y - 3x = 1$ **B** $4y - 3x = 4$ **C** $3y = 1 + 4x$ **D** $4y = 3 + 4x$

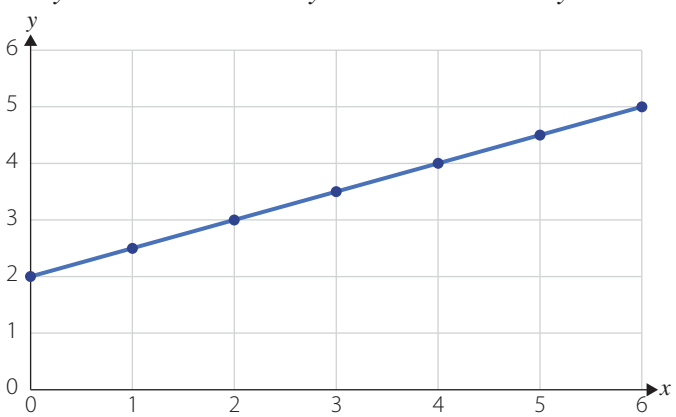
14 Select the equation that matches the graph given.

a



A $y = 19 + 3x$ **B** $y = 3x + 19$ **C** $y = 19 - 3x$ **D** $y = 19x - 3$

b



A $y = 2 + \frac{2}{x}$ **B** $2y = 4 + x$ **C** $2y = 2 + 0.5x$ **D** $2y = 4 + \frac{1}{2}x$

15 For each of the following equations, create a table of values and draw the graph.

a $y = 2x + 3$ **b** $y = 1 + x$ **c** $3y = 9 + 3x$

d $y + 2x = 10$ **e** $y - 2x = 5$ **f** $3y = 5 + 2x$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

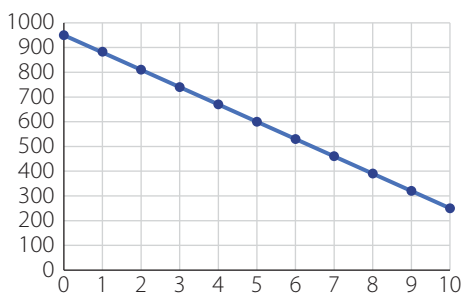
Mathematical literacy

16 Match each term on the left (a–f) with its explanation on the right (A–F).

a	Slope or gradient	**A**	Formulas for a linear equation
b	Linear	**B**	A family of graphs and tables which show a 'growing' pattern where the change between points starts small and quickly gets larger, or a 'decaying' pattern where the change between points gets progressively smaller.
c	y-intercept	**C**	The rate at which the graph is changing. Positive will show an upward trend, while negative will show a downward trend. A straight line indicates a constant rate of change.
d	Quadratic	**D**	A family of graphs and tables which show a classic parabolic or 'U' shape. In the formula the highest power of an x term is 2: $y = ax^2 + bx + c$.
e	Exponential	**E**	Where the graph meets or 'crosses' the y-axis. This can represent an initial starting position, for example an initial consultation fee, a callout charge or a flag fall.
f	$y = a + bx$ $y = mx + c$	**F**	A family of graphs and tables that represent a straight line. In the equation, both x and y are raised to the power of 1 (which means it 'looks' as though they are not raised to any powers, as we do not write the 1).

Application tasks

17 Describe a plausible scenario that would fit this graph.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

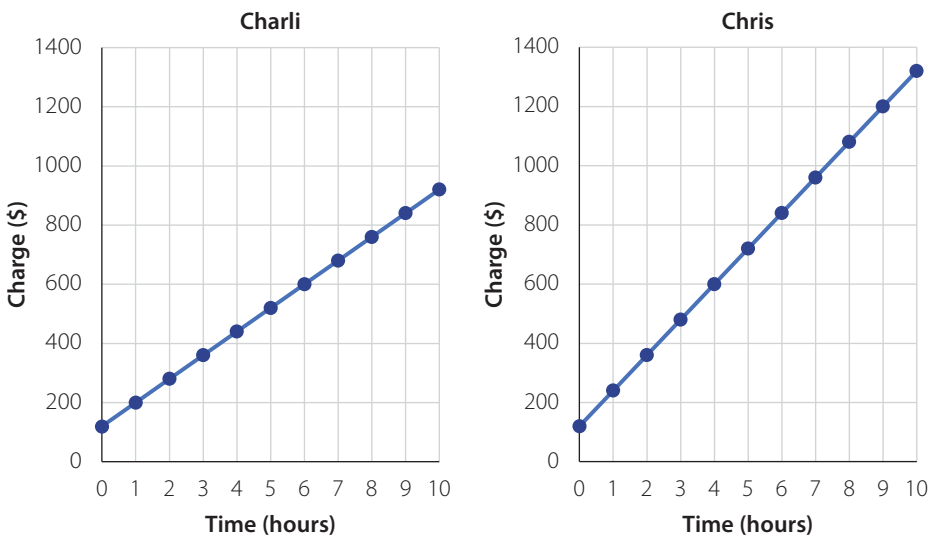
18 An electrician charges a callout fee of $75, then $120 per hour. Write the equation, create a table of values and draw the graph. Use this information to answer the questions.

a How much would the electrician charge for a job that took 3 hours?

b If the electrician charged $315 for the job, how many hours did they work?

c If the electrician charged $795 for the job, how many hours did they work?

19 Charli and Chris are two rival private detectives. They both charge an initial consultation fee of $120. The graphs below show you their charges.



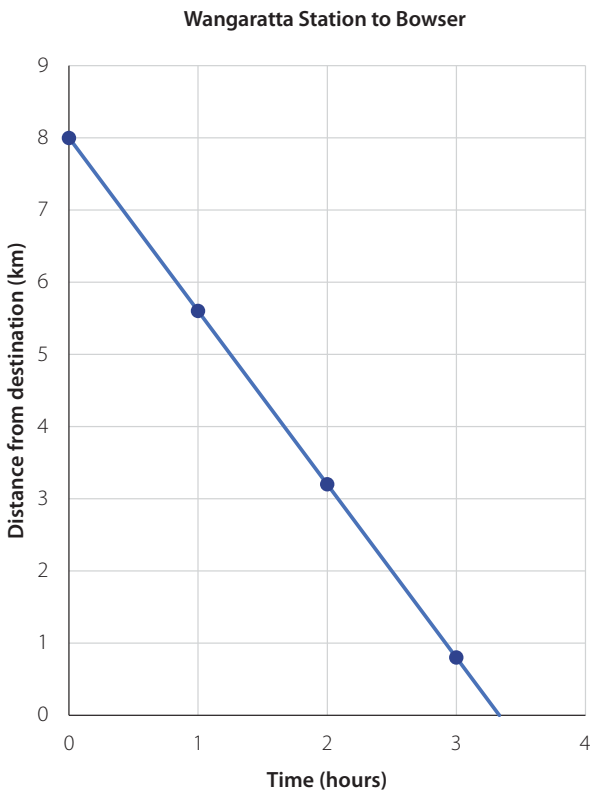
a Can you determine, just by looking at the graphs, who has the highest rate per hour? Is it Charli or Chris?

b Explain which features of the graph you used to help you answer part **a**.

c In the formula $y = mx + c$, which value is different for the two detectives?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

20 Paul and his friends are walking the Wangaratta Station to Bowser section of the Murray to the Mountains rail trail, a distance of 8 km. The graph below shows their journey time and assumes that they walk at a constant pace.



a How many kilometres per hour does the group walk? Be exact and make use of the tick marks on the axes to help you.

b If they started at 8:00 a.m., what time would the group reach their destination?

c How many more kilometres does the group have to walk when they have been walking for two hours?

d How far has the group walked in the first 100 minutes?

e Write the equation for the graph using the formula $y = a + bx$.

f Use the equation you developed in part **e** to calculate how far the group is from their destination after 3 hours.

21 The following table shows the taxi fare for different distances travelled.

Distance travelled (km)	0	1	5	10	20	50
Fare ($)	3.50	5.50	13.50	23.50	43.50	103.50

a How much is the flag fall (the fixed initial amount charged by the taxi driver)?

b What is the rate charged per kilometre travelled?

c The charge to travel 10 km is $23.50. Half this distance is 5 km, but the charge is not $11.75 (half of $23.50). Explain why this is so.

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4G Using and applying simultaneous equations

Simultaneous equations are very useful for solving real-world problems because they allow us to solve problems where multiple conditions must be met at the same time. Here are some reasons why simultaneous equations are valuable.

- How will you calculate how much to charge for handcraft items that you have made when you know the cost of hiring the stall and the costs of making the items, and don't want to make a loss?
- When tradespeople charge a call-out fee and an hourly rate, how can you compare them to work out which one you should hire for a job?
- When you know the cost of manufacturing an item, and your fixed overhead costs, how will you know how many items you must manufacture to make a profit?

We use simultaneous equations to solve these types of problems.

Simultaneous equations are a pair of equations with more than one variable.

Simultaneous equations can be solved graphically or using algebra – and both methods can be done by hand or by using software.

Solving simultaneous equations graphically

Example 1: Solving simultaneous equations by hand

Jo makes earrings and sells them at two different markets.

At Smallsville, the cost of the stall is $200 and she sells each set of earrings for $25.

At Bigtown, the cost of the stall is $500 and she sells each set of earrings for $30.

The equation for Smallsville is:

$$\text{Profit} = \$25 \times \text{number of earring sets} - \$200$$

Sets sold	0	10	20	30	40	50	60	70	80	90	100
Profit ($)	–200	50	300	550	800	1050	1300	1550	1800	2050	2300

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

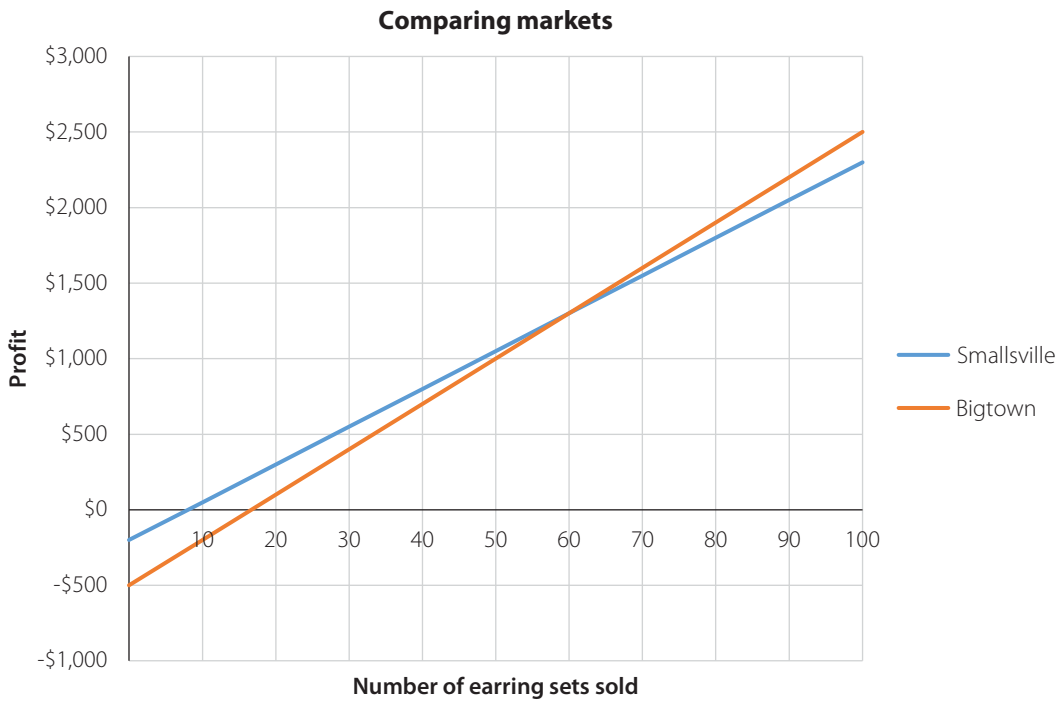
The equation for Bigtown is:

$$\text{Profit} = \$30 \times \text{number of earring sets} - \$500$$

Sets sold	0	10	20	30	40	50	60	70	80	90	100
Profit ($)	−500	−200	100	400	700	1000	1300	1600	1900	2200	2500

From the tables, we can see that if she sells 60 sets of earrings, she will make the same profit.

This is the graph of these simultaneous equations:



From this graph, we can see that if Jo doesn't sell any earring sets, she will make a loss.

We can also see that if she sells less than 60 sets, she will make more profit at Smallsville, but if she sells more than 60 sets, she will make more profit at Bigtown.

Example 2: Solving simultaneous equations using software

You are investigating the costs of two plumbing companies to work out which to hire.

Leaks Plumbers charges $120 per hour plus a call-out fee of $60.

Pipers Plumbing charges $90 per hour plus a call-out fee of $120.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

The equation for Leaks Plumbers is:

$$\text{Charge} = \$120 \times \text{number of hours} + \$60$$

The equation for Pipers Plumbing is:

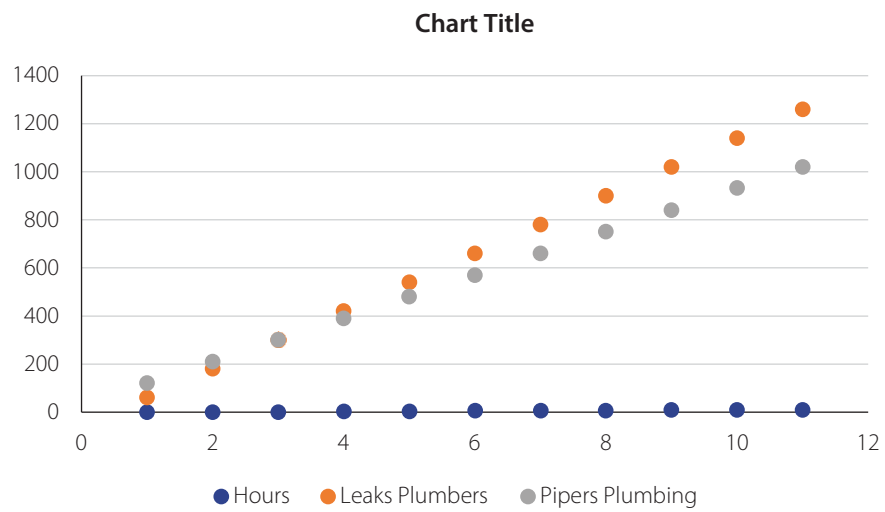
$$\text{Charge} = \$90 \times \text{number of hours} + \$120$$

Using Excel, the formula for Leaks Plumbers is 120*hours+60, and for Pipers Plumbing it is 90*hours+120.

This is how the Excel table should look:

	A	B	C	D
1		Plumbing costs comparison		
2		Hours	Leaks Plumbers	Pipers Plumbing
3		0	60	120
4		1	180	210
5		2	300	300
6		3	420	390
7		4	540	480
8		5	660	570
9		6	780	660
10		7	900	750
11		8	1020	840
12		9	1140	930
13		10	1260	1020
14				

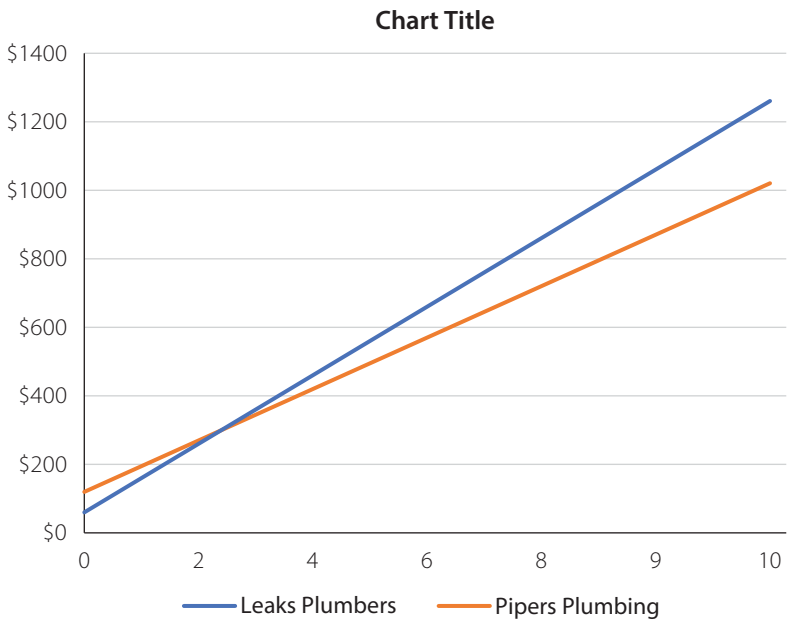
To create the graph of the two sets of charges, highlight the table of values, click on **Insert** and then **Recommended Charts**. In the pull-down menu showing, select a **Scatter plot**.



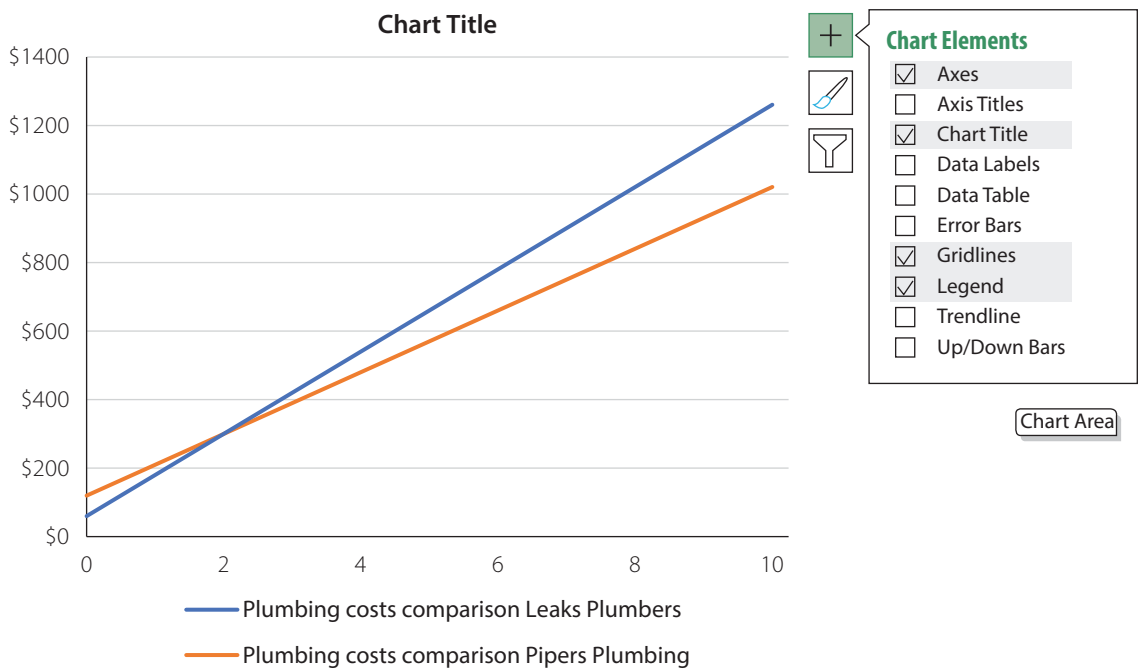
Go back to Recommended charts and click the 2D line graph icon.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

This is how your graph will look:

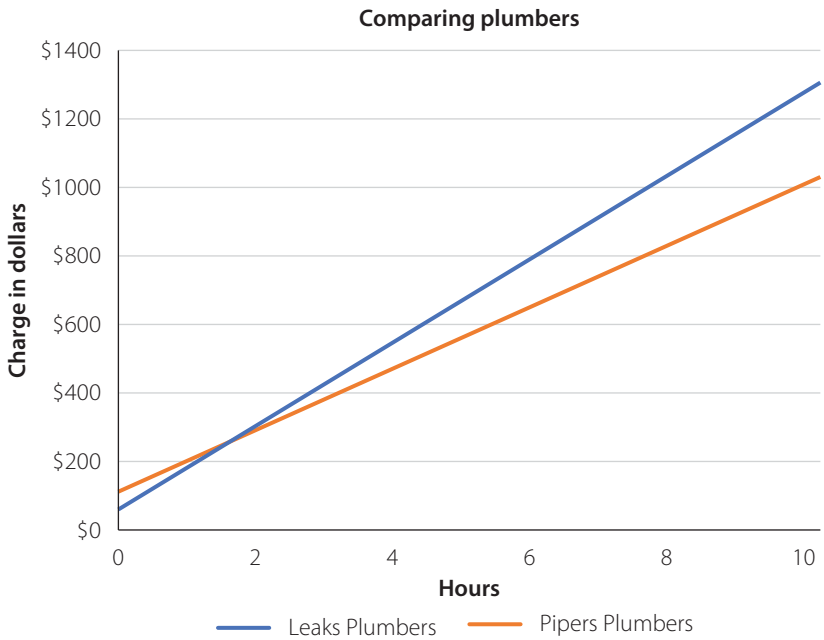


To format your graph, click on the graph to activate the **Chart Elements**, especially the Axes, Axis Titles, Chart Title and Legend.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

This is how your finished graph will look:



From this graph, we can see that the lines intersect at 2 hours – so it would not matter which company we hired.

If the job is less than 2 hours, Leaks Plumbers is cheaper.

If the job is more than 2 hours, Pipers Plumbing is cheaper.

Example 3: Using simultaneous equations to find the break-even point

The break-even point for a business is where costs and revenue are equal.

A business that manufactures bicycle frames needs to calculate their break-even point.

They know that the materials for each frame costs $250, and they will sell each of them for $750.

They also know that their overhead costs are $200,000 per month.

The equation for the revenue is:

$$R = \$750 \times \text{number of frames sold}$$

The equation for the costs is:

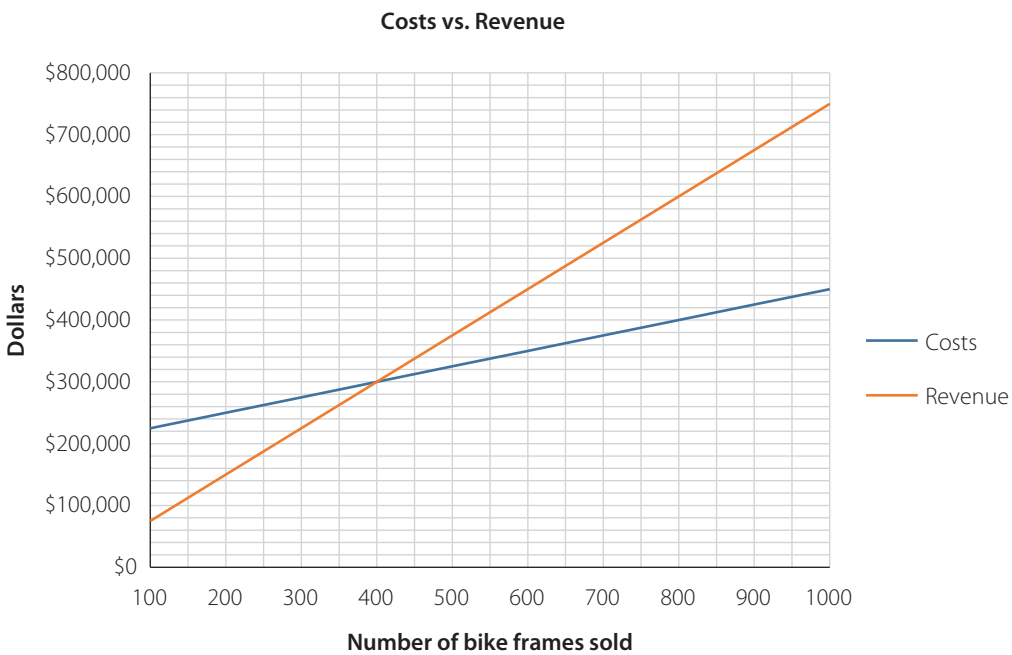
$$C = \$250 \times \text{number of frames made} + \$200{,}000$$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

If you use the formula function in Excel to enter the two equations for Revenue and Costs and fill down for 100 to 1000 frames, this is the table created:

	A	B	C	D
1		Bicycle frames		
2		Number of frames	Costs $	Revenue $
3		100	225,000	75,000
4		200	250,000	150,000
5		300	275,000	225,000
6		400	300,000	300,000
7		500	325,000	375,000
8		600	350,000	450,000
9		700	375,000	525,000
10		800	400,000	600,000
11		900	425,000	675,000
12		1000	450,000	750,000
13				

Here is the graph:



What can be seen in both the table and graph is that the break-even point is manufacturing and selling 400 bicycle frames per month.

If they sell fewer than 400 bike frames, the business is making a loss. If they sell more, the business is making a profit.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Solving simultaneous equations using algebra

The two algebra techniques we use to solve simultaneous equations are:

- substitution
- elimination.

The **substitution** method is better to use when at least one of the two equations is written in the form of $y = mx + c$ or $y = a + bx$. You can use one equation to solve for one variable and then substitute that expression for that variable into the other equation to solve for the second variable.

The **elimination** method is better to use when the two equations are written with the two variables on the same side of the equation such as $ax + by = c$. In this method, you make one of the variables cancel itself out by adding (or subtracting) the two equations. Sometimes you have to multiply one or both equations by constants in order to make the coefficients the same.

Example 18 Using substitution to solve simultaneous equations

The length of a rectangular soccer pitch is 40 metres longer than its width. The perimeter of the pitch is 320 m. Calculate the dimensions of the soccer pitch.

THINKING	WORKING
STEP 1	
Decide on the pronumerals to use for the variables.	l: length (in metres) w: width (in metres) P: perimeter (in metres)
STEP 2	
Write the two equations to represent the situation. The length is 40 m longer than its width. This becomes equation (1). The perimeter is 320 m. This becomes equation (2).	$l = w + 40$ (1) $P = 2(l + w)$ so $320 = 2(l + w)$ (2)
STEP 3	
Substitute equation (1) into equation (2). This replaces l in equation (2) with $w + 40$.	Substituting (1) into (2): $320 = 2(w + 40 + w)$
STEP 4	
Simplify by collecting like terms.	$320 = 2(2w + 40)$

... continued

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 5	
Rewrite the equation so the unknown is on the left-hand side.	$2(2w + 40) = 320$
STEP 6	
Undo the multiply by 2 by dividing both sides by 2.	$\frac{2(2w+40)}{2} = \frac{320}{2}$ $2w + 40 = 160$
STEP 7	
Undo the add 40 by subtracting 40 from both sides.	$2w + 40 - 40 = 160 - 40$ $2w = 120$
STEP 8	
Undo the multiply by 2 by dividing both sides by 2.	$\frac{2w}{2} = \frac{120}{2}$ $w = 60$
STEP 9	
Substitute the value of w into equation (1) to work out the length.	Substituting $w = 60$ into (1): $l = 60 + 40$ $l = 100$
STEP 10	
Write your answer.	The soccer pitch will have a length of 100 m and a width of 60 m.

You can check that your working is correct by substituting the values into the equations to see that they are true.

Length is 40 cm more than width: 100 is 40 more than 60 ✓

Perimeter is 320 cm: $2(100 + 60) = 320$ ✓

Example 19 Using elimination to solve simultaneous equations

The sum of two numbers is 34 and the difference of the two numbers is 16. Use the elimination method to determine the two numbers.

THINKING	WORKING
STEP 1	
Decide on the pronumerals to use.	x and y can be the two numbers.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

STEP 2

Write the equations. The sum of the two numbers gives equation (1) and the difference of the two numbers gives equation (2).

$x + y = 34 \quad (1)$

$x - y = 16 \quad (2)$

STEP 3

Decide on a pronumeral to eliminate. We can eliminate y by adding the two equations.

Eliminate y by adding (1) and (2):

STEP 4

Add equations (1) and (2).

$2x + 0 = 50$

$2x = 50$

STEP 5

Undo the multiply by 2 by dividing both sides by 2.

$$\frac{2x}{2} = \frac{50}{2}$$

$x = 25$

STEP 6

Substitute the value for x into equation (1).

Substituting $x = 25$ into equation (1):

$25 + y = 34$

$y + 25 = 34$

STEP 7

Undo the add 25 by subtracting 25 from both sides.

$y + 25 - 25 = 34 - 25$

$y = 9$

STEP 8

Write your answer.

The two numbers are 25 and 9.

You can check that your working is correct by substituting the values into the equations to see that they are true:

The sum of the two numbers is 34: 25 + 9 = 34 ✓

The difference of the two numbers is 16: 25 – 9 = 16 ✓

If the coefficients of the variables in the equations are not the same, we have to adjust either one or both of the equations before we can eliminate one of the variables.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 20 Using elimination to solve simultaneous equations (adjusting coefficients)

Solve the following pair of simultaneous equations:
$2x + 3y = 8$ and $3x + 2y = 2$

THINKING	WORKING
STEP 1	
Write the equations and number them as equation (1) and equation (2).	$2x + 3y = 8$ (1) $3x + 2y = 2$ (2)
STEP 2	
To make the coefficients of x the same, multiply the first equation by 3 and the second equation by 2.	Multiplying (1) by 3 and (2) by 2: $6x + 9y = 24$ (3) $6x + 4y = 4$ (4)
STEP 3	
To eliminate x, subtract equation (4) from equation (3).	Subtracting (4) from (3): $5y = 20$
STEP 4	
Solve for y: divide both sides by 5.	$y = 4$
STEP 5	
Substitute the value of y into one of the original equations.	Substituting $y = 4$ into (2): $3x + (2 \times 4) = 2$
STEP 6	
Simplify the equation.	$3x + 8 = 2$
STEP 7	
Solve for x: subtract 8 from both sides, and then divide both sides by 3.	$3x = -6$ $x = -2$
STEP 8	
Write the solution.	Solution is $x = -2$, $y = 4$.

You can check that your working is correct by substituting the values into the equations to see that they are true:

$(2 \times -2) + (3 \times 4) = 8$ ✓

$(3 \times -2) + (2 \times 4) = 2$ ✓

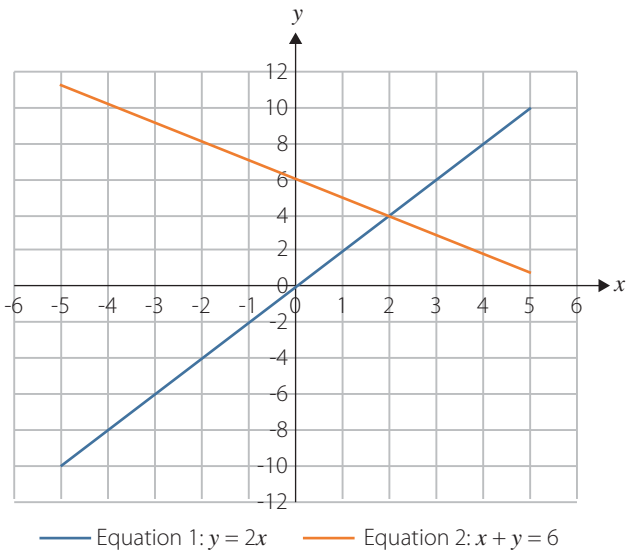
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

When we solve simultaneous equations, we are finding the only values that make both equations true.

If we plot these equations as graphs, the values of x and y for the solution are at the point of intersection of each line.

When we solve the simultaneous equations $y = 2x$ and $x + y = 6$, the point of intersection is $x = 2$ and $y = 4$. We show this point on the graph as (2, 4).

This can also be used to find the break-even point.



4G Tasks and questions

Thinking task

1 Research where simultaneous equations are used in sport or at work or in business and industry. Share and compare these with your classmates.

Skills questions

2 Use the tables of values to create a graph of each situation to represent the scenario and to determine:

- **i** the break-even point
- **ii** which option would be the best for which set of values of the independent variable and explain why.

a In this scenario, there are two possible pricing options for making and selling handmade pieces of artwork.

Number sold	1	2	3	4	5	6	7	8
Price option A	$350	$600	$850	$1,100	$1,350	$1,600	$1,850	$2,100
Price option B	$450	$650	$850	$1,050	$1,250	$1,450	$1,650	$1,850

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

b In this scenario, the different options are for hiring a piece of equipment from two different hire companies.

Number of hours	1	2	3	4	5	6	7	8
Company A cost	$90	$190	$290	$390	$490	$590	$690	$790
Company B cost	$140	$220	$300	$380	$460	$540	$620	$700

c In this scenario, the different options are two possible pricing options for catering for a party at two different venues.

Number of people	10	20	30	40	50	60
Venue A	$1,500	$2,000	$2,500	$3,000	$3,500	$4,000
Venue B	$ 900	$1,650	$2,400	$3,150	$3,900	$4,650

d In this scenario, the different options are two possible ways of being paid, based on a commission for the number of items sold.

Number of sales	5	10	15	20	25	30	35	40
Company A	$600	$900	$1,200	$1,500	$1,800	$2,100	$2,400	$2,700
Company B	$465	$840	$1,215	$1,590	$1,965	$2,340	$2,715	$3,090

3 Use the **substitution** method to solve each pair of simultaneous equations.

a $x + y = 15$ and $x - y = 3$

b $x + y = 0$ and $x - y = 2$

c $2x - y = 3$ and $4x + y = 3$

d $2x - 9y = 3$ and $y = x - 12$

4 Use the **elimination** method to solve each pair of simultaneous equations.

a $6a + b = 18$ and $4a + b = 14$

b $x + 2y = -4$ and $3x - 5y = -1$

c $3h + 2i = 8$ and $2h + 5i = -2$

d $4x + 9y = 5$ and $-5x + 3y = 8$

Mixed practice

5 Solve each pair of simultaneous equations.

a $y = -3x + 2$ and $y = 2x - 8$

b $3a + 4b = 43$ and $-2a + 3b = 11$

c $4x - 3y = 23$ and $3x + 4y = 11$

d $y = 2x + 2$ and $x + y = 5$

e $2y - x = 4$ and $2x - 3y = 2$

f $9m - 7n = 3$ and $3m - 2n = -1$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Application tasks

6 The cost of a ticket to the circus is $25.00 for children and $50.00 for adults. On a certain day, attendance at the circus is 2000 and the total gate revenue is $70,000. How many children and how many adults bought tickets?

7 Jamal is choosing between two truck-rental companies. The first, *Trucking Up*, charges an up-front fee of $200, then $2.00 per km. The second, *Moving It Your Way*, charges an up-front fee of $100, then $3 per km. When will *Trucking Up* be the better choice for Jamal?

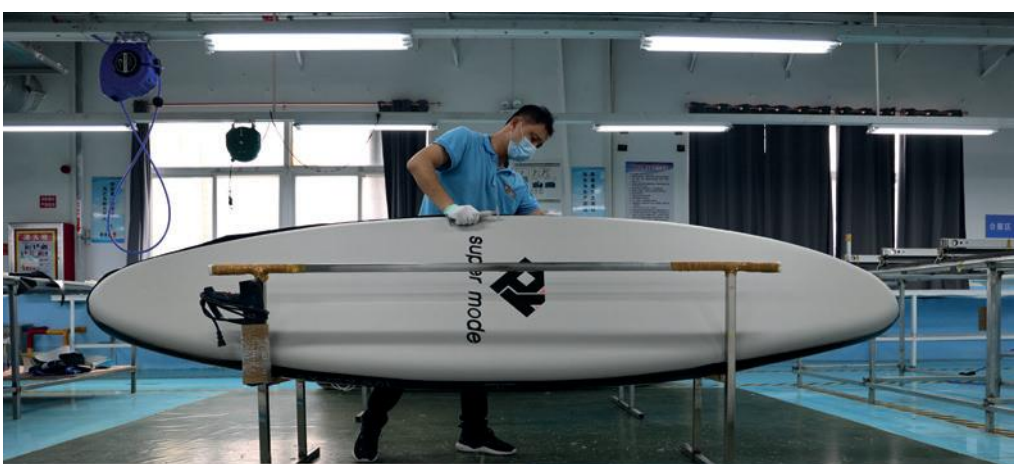
8 You need to hire a rotary hoe for a gardening job. *Hilda' s Hiring* has them available for a flat fee of $40 plus $60 per half day. *Rex's Rents* has them available for only a hiring fee of $140 per day's hire. When are the costs the same for both hiring firms? When would it be cheaper to hire from Hilda's and when would it be cheaper to hire from Rex's? Explain your answer using simultaneous equations and show this graphically.

9 A seaside business wants to manufacture some new paddle boards.

The company's accountant has created an equation for both the expected costs of manufacture and for the income per paddle board for a month's production.

The cost equation is $C = 150x + 50\,000$ where x is the number of units made (paddle boards) and the costs are a variable cost per board ($150 per board) and a fixed cost estimate of $50,000 per month. The accountant's income equation is $I = 350x$, where the estimated selling price for each board is $350 each.

Solve these two simultaneous equations graphically to illustrate the relationship between costs and income and determine the break-even point.

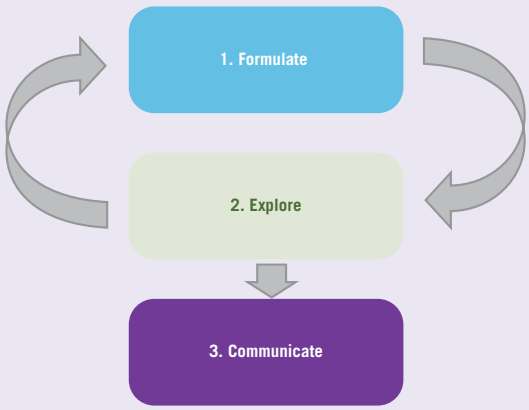


ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Investigations

When undertaking your investigations, remember the problem-solving cycle steps:

- **Formulate** – Sort out and plan what you need to know and need to do to solve the problem.
- **Explore** – Use and apply the mathematics required to solve the problem.
- **Communicate** – Record and write up your results.



1 Algebra at work

Algebraic equations and formulas are used extensively in many workplaces and industries, and not just the common ones about calculating perimeter, area and volume. In this investigation, we want you to research and find uses and applications of algebra and formulas in different areas of life.

The aim is to see how formal mathematical terminology and understanding is used outside of the maths classroom, and for you to document how it can be used and demonstrate your knowledge and skills in algebraic thinking.

As a starting point, the following table has some examples of formulas taken from different contexts. You will notice that in some cases, the formulas are not written using normal mathematical expressions. For example, in the first one about calculating number of standard drinks in different drinks, the variables are written out in words, not using pronumerals. The same is true of the last one about spraying chemicals on farms.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

The number of standard drinks in different alcoholic drinks	Number of standard drinks = Volume of drink in litres × the % of alcohol × 0.789 *Note*: Ethanol is the chemical name for pure alcohol, and 0.789 is its specific gravity (or density compared to water).
Braking distance of vehicles	The formula used to calculate braking distance is derived from physics: $$V_f^2 = V_0^2 - 2ad$$ where V_f is the final velocity, V_0 is the initial velocity, a is the rate of deceleration and d is the distance travelled during deceleration. Since we know that V_f will be zero when the car has stopped, this equation can be rewritten as: $$d = \frac{V_0^2}{2a}$$
Working out the lens settings on a camera	A camera has f-stop aperture values: $$\text{f-stop} = \frac{\text{lens focal length}}{\text{aperture circle diameter}}$$
Spraying chemicals in agriculture	**Boom sprayer calibration** To apply the correct amount of agricultural chemical (such as pesticides) to fields, the output of a device called a boom sprayer must be known. Follow these steps: **1** **Select pressure** (usually between 200 and 300 kPa) **2** **Measure output of boom nozzles** (litres per minute) and calculate: $$\text{Average output per nozzle} = \frac{\text{total output of nozzles}}{\text{number of nozzles}}$$ **3** **Determine speed of spraying** • Measure the time taken to travel over a measured distance (e.g. 100 m) • Calculate: $$\text{Speed (kilometres per hour)} = \frac{\text{distance travelled (metres)} \times 3.6}{\text{time taken (seconds)}}$$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

	4 Calculate spray output $\text{Spray output (litres / ha)} = \dfrac{600 \times \text{boom output (litres / minute)}}{\text{spraying width (metres)} \times \text{speed (km / hour)}}$ (spraying width = number of nozzles × distance between each nozzle) **5 Calculate the amount of chemical to add to spray tank** $\text{Amount of chemical} = \dfrac{\text{application rate (litres or kilograms / ha)} \times \text{volume of water in tank (litres)}}{\text{output (litres / ha)}}$

Formulate

The aim of the investigation is to find a number of applications of algebra and formulas in different workplaces or areas of life, such as those illustrated in the table above. You need to spell out how the mathematical aspects are being used, with a focus on algebraic thinking and the use of formal terminology and processes.

a In a small group or as a class, conduct a brainstorm to identify real life applications that you think or know use algebraic thinking and formulas.

b From your brainstorm, identify at least two different applications that you would like to focus on for your investigation.

c Develop a plan for your investigation that considers these questions:

- Where and how will you find the information you need?
- How will you record your investigation and the outcomes?
- What technologies and tools might you want or need to use?

Explore

d Conduct your research to find the required examples and undertake the mathematical aspects of the investigation. Criteria to meet in your investigation include:

- Explaining how the algebra is used, what the variables are, and all the terminology used

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- Explaining what sorts of mathematical relationships are behind the expressions and equations. You need to find examples of at least three of the following types of algebraic relationships (some may cover more than one type):
  - Linear
  - Quadratic
  - Direct
  - Inverse
  - Exponential.
- Providing examples of the use and applications of the processes of substitution and transposition across each of your relationships.
- Providing a graphical representation of each algebraic relationship or formula.

Communicate

e Write up and present the findings of your research. You can choose the form of your presentation.

Include the following in your presentation:

- Document what maths you used and how – include a summary to highlight what sorts of mathematics and what algebraic expressions and processes you encountered and undertook in order to do your investigations.
- Reflect on your research and your findings – what did you discover? How much algebra was used in each of your contexts?
- Explain why you think that, in some cases, the formulas may not be written using normal mathematical expressions. Were the ones you found written using words or were they written as a formal algebraic expression?
- What technological tools might be used to calculate the formulas that you found?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

2 Sales commissions – the best job for the money

Algebraic thinking is highly useful for understanding how different commission structures work. By taking multiple variables into account, including salary, benefits and commission rates, you can make informed decisions about which commission-based jobs might be more attractive and why. Understanding and using mathematics, including algebra and formulas, are important to understand and compare how different commission structures work.

Below are some suggestions about how you might like to research and undertake an analysis of how the use of algebraic thinking is important in relation to working out and comparing different sales commissions.

Formulate

a Develop a plan for your investigation that considers these questions:

- Where and how will you find the information you need?
- How will you record your investigation and the outcomes?
- What technologies and tools might you want or need to use?

Potential issues to consider for the investigation include:

- What are some common, but different, methods used for calculating how a person gets paid on commission? These could include:
  - Base salary plus commission
  - Gross margin commission
  - Residual commission
  - Revenue or straight commission
  - Tiered commission.
- What are the advantages and disadvantages of the different types? For the business? For the employee?

Criteria to meet in your investigation include:

- Researching and investigating at least two different commission structures for sales and provide examples of each.
- Documenting how each one can be represented algebraically and graphically for calculating and comparing different sales commissions.
- For at least one case include an example of the use of **simultaneous** equations to compare different rates of commission. This needs to be both solved algebraically and shown graphically.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Explore

b Conduct research to find all the required information and examples and undertake the mathematical aspects of the investigation. For example, some more specific issues and questions to research and investigate could be:

- Find examples and cases for calculating and comparing different sales commissions.
- Describe your different formulas in terms of the language of mathematics – that is, in terms of constants, coefficients and variables.
- Use simultaneous equations to compare two different ways of paying commissions. What are the differences in terms of your variables and the constants and coefficients?
- Use technology or applications (e.g. a spreadsheet) for calculating income based on different commission formulas.
- If you were to be paid on commission, which approach and formulas would you prefer, and why?

Communicate

c Write up and present the findings of your investigation into comparing the two (or more) commission structures and their formulas. You could choose to write up a report or create a presentation that explains what you found out and your results.

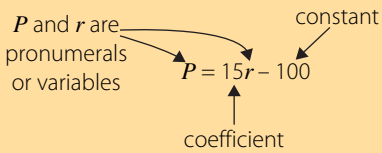
Include the following in your presentation:

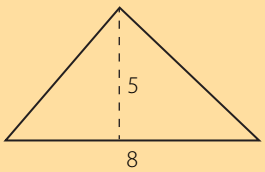
- Document what maths you used and how – include a summary to highlight what areas of mathematics and what algebraic processes you encountered and undertook in order to do your comparisons and analysis.
- Reflect on your research and your findings and comparisons – do you think one of the commission-based pay structures is better than the other(s)? Justify your response.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key concepts

- **Algebraic** equations are made of different parts.
- Algebraic equations can be solved by **substituting** numbers for the variables.
  e.g. the area of the triangle can be found by substituting values for the base (b) and height (h) into the area formula.





$$A = \frac{1}{2}b \times h$$
$$A = \frac{1}{2} \times 8 \times 5$$
$$A = 20$$

- **Transposing** a formula uses algebraic rules 'in reverse.'
  The key to transposing formulas is to
  - recognise the sequence of operations that have been carried out on the variable you are making the subject of the formula
  - work backwards through those operations to apply the opposite operation
  - remember that addition and subtraction are opposites, and
  - multiplication and division are opposites.
- **Linear equations** appear as a straight line when they are graphed.
  - The general formula for a linear equation is $y = mx + c$ or $y = a + bx$.
  - You may need to transpose an equation to work with it in a linear format.
  - The slope of a linear equation is the b or m value.
  - The line will have an upward, positive slope if m or b is a positive number, or a downward, negative slope if m or b is a negative number.
  - When drawn as a graph, the c or a value indicates the y-intercept, where the line will cross the y-axis.
  - When values are given in a table, the c or a value will occur when $x = 0$.
- **Simultaneous equations** are used to compare scenarios involving two variables in two equations.
  - They can be solved graphically, such as by drawing two linear graphs on the same axes by hand or using technology such as Excel.
    - The point of intersection of the graphs represents the *break-even* point where the two scenarios are equivalent.
  - They can be solved algebraically using either:
    - **substitution** of variables between the two equations, or
    - **elimination** of one variable by suitable algebraic steps.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Success criteria and review questions

☐ I can make algebraic sentences.

1 Make algebraic sentences from the following problems.

a A forklift can carry a maximum of 500 kg. Each box weighs 80 kg. How many boxes can the forklift carry?

b A shelf in a pet shop can carry a maximum load of 200 kg. Bags of pet food come in 5 kg, 15 kg and 20 kg amounts. What mix of bags can you have on the shelf?

c The area of a car lot is 1000 m^2. If each car to be stored needs a space 1.8 m wide and 4.85 m in length, what is the maximum number of cars that can be stored here?

2 Make algebraic sentences from the following pictures. Use the wording in question **1** above as a model.

a

b

c

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

☐ I can identify the parts of an algebraic equation.

3 Identify the variables, coefficients and constants in the following equations.

a Perimeter of a rectangle: $P = 2l + 2w$ or $P = 2(l + w)$, where l is the length and w is the width

b Circumference of a semicircle: $C = \pi r + 2r$, where r is the radius

c An equation for a linear relationship: $y = 7x + 5$

d Newton's law of gravity: $F = G\frac{m_1 m_2}{d^2}$, where force F is in newtons, G is 6.67×10^{-11}, mass m is in kilograms and distance d is in metres

e Euler's formula for polyhedrons: $F + V - E = 2$, where F is the number of faces, E is the number of edges and V is the number of vertices on the 3D object.

☐ I can solve algebraic equations by substituting variables.

4 Substitute numbers for variables to solve the following equations.

a Find the area of a car parking space using $A = l \times w$, given its length is 5.4 m and width is 2.4 m.

b Find the volume of a wading pool using $V = l \times w \times h$, given the length and width are both 2.2 m and the height is 300 mm.

c Find the cost, $\$C$, of a taxi ride from the airport using C = flag fall + airport fee + \$1.895 per km, given the flag fall is \$7.20, the airport fee is \$5.95 and the trip is 36 km.

☐ I can transpose common equations.

5 Transpose the following equations.

a Make y the subject: $x + 21 = 8 - y$

b Make t the subject: $C = 120 + 5t$

c Make r the subject: $A = 2\pi rh$

d Make q the subject: $y = \frac{7+q}{x}$

☐ I can identify linear equations.

6 Which of the following equations are linear?

a $y = 4 + 7x$ **b** $y = x^2 + 5x + 6$ **c** $y = 3x + 4$

d $y = 15 - 2x$ **e** $x^2 + y^2 = 16$ **f** $\frac{y}{2} - 4 = x$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

☐ I can construct a table of values for a linear equation.

7 Construct a table of values as shown for each linear equation.

x	0	1	2	3	4	5
y						

a $y = 2 + 3x$ **b** $y - 3x = 1$ **c** $y = 2x + 3$

☐ I can graph a linear equation from a table of values.

8 Draw the graphs for each of the equations in the previous question, either by hand or with technology.

☐ I can identify the slope (or gradient) of a line and its y-intercept from an equation or a table of values.

9 For each of the following, identify:

i the y-intercept **ii** the slope (or gradient) of the graph.

a $y = 12 + 3x$ **b** $y = 3x + 4$ **c** $y = 18 - 3x$

d

x	0	1	2	3	4	5
y	5	9	13	17	21	25

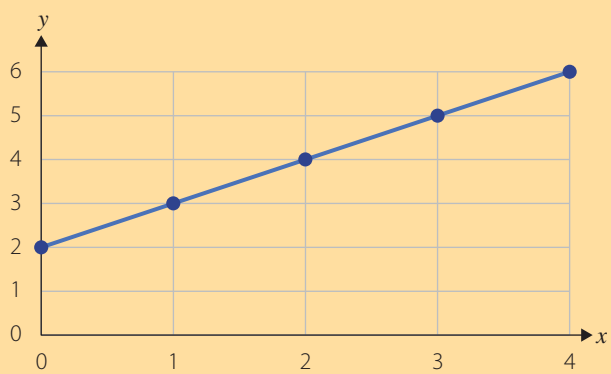
e

x	0	1	2	3	4	5
y	17	14	11	8	5	2

☐ I can develop a linear equation from a graph.

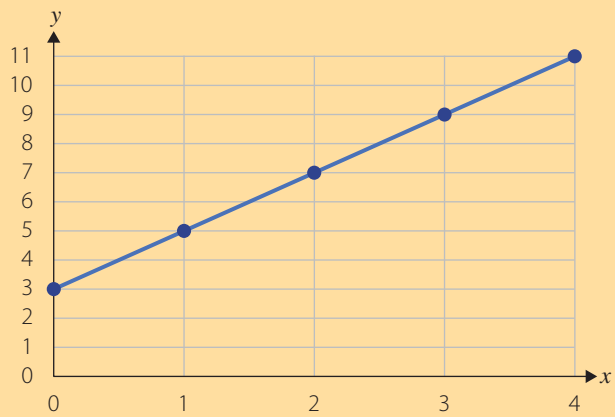
10 Develop the linear equation that matches the following graphs.

a

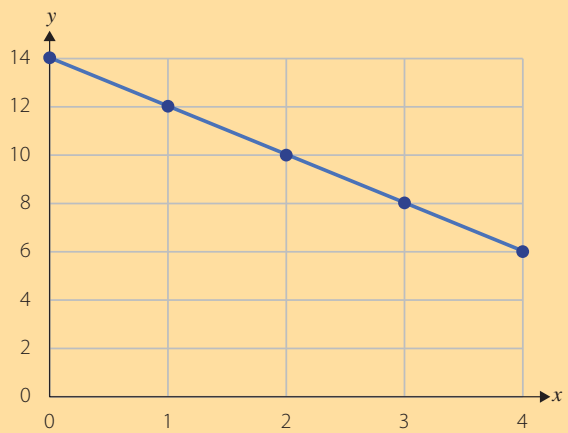


ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

b



c



☐ I can solve simultaneous equations graphically.

11 Use Excel to find the break-even point for these two costs equations, where C is the cost in dollars and h is the number of hours worked by a tradie:
$C = 50 + 30h$ and $C = 30 + 40h$

☐ I can solve simultaneous equations algebraically by substitution.

12 Solve this pair of simultaneous equations:
$y = 3x + 1$ and $y = 4x - 2$

☐ I can solve simultaneous equations algebraically by elimination.

13 Solve this pair of simultaneous equations:
$9x - 6y = 12$ and $4x + 6y = 14$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mathematical toolkit

1 Reflect on the range of different technologies and tools you used throughout this chapter, and how often you used them for undertaking your work and making calculations. Indicate how often you used and worked out results and outcomes for each of these methods and tools.

Method and tools/ applications used	**How often did you use this?**
• Calculating and working in your head	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using pen-and-paper	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using a calculator	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using a spreadsheet	Not at all: ☐ A little: ☐ Quite a bit: ☐
• Using measuring tools – name the tool, technology or application: _____ _____	Not at all: ☐ A little: ☐ Quite a bit: ☐ Not at all: ☐ A little: ☐ Quite a bit: ☐
• Using other technology or apps – name the technology or application: _____ _____	Not at all: ☐ A little: ☐ Quite a bit: ☐ Not at all: ☐ A little: ☐ Quite a bit: ☐

2 Did this chapter and the activities help you to better understand how you use different tools and technologies in using and applying mathematics in our lives and at work? In what areas and ways? Write down some examples.

3 In one sentence, explain something relating to tools and technologies that you learned in the unit. Write an example of what you learned.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key vocabulary

Here is a list of this chapter's key maths terms and their meanings.

Term	Meaning
Axes	The number lines that run along the side and bottom of a graph. In mathematics, the horizontal number line is usually called the x-axis, and the vertical number line the y-axis.
Break-even	The point where costs equals profits.
Cartesian coordinates	The formal system for drawing up mathematical graphs showing the relationship between two variables, usually x and y. The ordered pairs of numbers that give the position of any point on a graph, (x, y).
Coefficient	A number multiplied to a variable in an equation or formula.
Constant	A fixed value in an equation or formula.
Equation	A mathematical sentence that has an equals sign (=). It is a statement that says two expressions are equal, e.g. $y = 2x + 3$, $2x + 5 = 32$.
Formula	A way of finding and using a general expression that represents problems where you have a number of factors that vary and change. A formula is a shorthand way of writing a mathematical sentence.
Intersection	Where lines cross over (where they have a common point).
Linear equation	The general equation for a linear graph of the form $y = a + bx$, where a is the constant and b is the coefficient of x.
Linear graph	When all the points on a graph are in a straight line.
Ordered pair	Used to describe a position on a graph drawn on a Cartesian plane. The x value is always first, so (x, y).
Pronumerals	The letters that we use for the parts that can vary and change in a formula.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Term	Meaning
Simultaneous equations	When you have two (or more) equations that are true at the same time, and you are trying to find which values satisfy both at the same time. On a graph, this is where the two lines intersect.
Slope (or gradient)	The slope (or gradient) of a line is a measure of its steepness or the rate that it rises (positive gradient) or falls (negative gradient). If a linear equation is of the form $y = a + bx$, then the value of the gradient is b. If a linear equation is of the form $y = mx + c$, then the value of the gradient is m.
Subject	The single variable, usually on the left-hand side of the equals sign (=), is called the subject of the equation or formula.
Term	In algebra, a term is either a single number or variable, or numbers and variables multiplied together. Terms are usually separated by + or − signs, or sometimes by division, e.g. $5x + 12$ has two terms.
Transpose	When you change a formula around to make a different letter (pronumeral) the subject of the formula (that is, by itself on the left-hand side of the equals sign).
Variable	A value in a formula that can vary or change.
x-intercept	The point where a graph cuts the horizontal axis (where $y = 0$).
y-intercept	The point where a graph cuts the vertical axis (where $x = 0$). If a linear equation is of the form $y = a + bx$, then the y-intercept is a. If a linear equation is of the form $y = mx + c$, then the y-intercept is c.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

5 Collecting data

Brainstorming activity: Where's the maths?

Using this photo as a stimulus, brainstorm the type of maths we need to know to undertake this task or activity. Think especially about any maths skills related to the content of this chapter – about data and statistics and how they are collected and collated. Prompt questions might be:

- What activity might be happening in this photo?
- What sorts of numbers might be encountered or needed?
- What data and information could be collected and represented?
- What different ways might the data be collated and represented?
- What research or investigation questions could be undertaken, based on this photo?
- What different tools, technologies or software might be used?

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter contents

Chapter overview and Spotlight

5A Starting activities
5B Tuning in
5C The statistical cycle
5D Types of data
5E The purpose of data collection
5F Data collection specifications
5G Developing and producing surveys
5H Can we believe the data?
Investigations
Chapter review

From the Study Design

In this chapter, you will learn how to:

- collect, organise, collate and represent categorical and numerical data, including continuous data
- use technology effectively and appropriately for accurate, reliable and efficient collation and representation of data sets
- draw inferences and conclusions, and explain any limitations and implications of a statistical study

(Units 3 and 4, Area of Study 2)

© Victorian Curriculum and Assessment Authority 2022

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter overview

Introduction

Each time you consent to cookies on your browser or sign up for discounts at your favourite shop, you are consenting to others collecting your data.

Data collection has enormous value to businesses who use it to tailor their products and target their advertising. Data collection may be used for machine learning, which, in turn, drives new software for businesses. Data collection may be used for developing new products or making new discoveries.

A self-driving car has the input of many data sets which are used to develop processes called **algorithms**. These algorithms allow the car to make decisions such as what a stop sign looks like, or when a human may be on the road in front of a car requiring emergency braking. The car also collects data to feed further into refining the algorithms.

Data collection must be relevant to the purpose to be useful. Before collecting data, it is important to decide what you want to know and how you are going to collect it.

Learning intentions

By the end of this chapter, you will be able to:

- understand and use the statistical cycle
- recognise different types of data
- differentiate between different types of data collection
- understand the purposes of data collection
- develop, deliver and analyse surveys
- collect, collate and organise data
- use technology for data collection, collation and organisation
- recognise errors in data collection.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Spotlight: Billy Ryan

An interview with a distribution officer

Tell us about your job and some of the work that you do.

As a distributions officer, I oversee and coordinate the supply and export of our goods, particularly margarine, fats and oils, to buyers both domestically and internationally.

What maths do you use regularly in your work?

I work with a lot of data in my role, and I perform a lot of data analysis to see how our warehouse is performing. The main calculations I use are finding the sum or the average of large data sets, such as finding the average amount of products we have shipped per day, week or month. By analysing data on previous sales and performance, I provide forecasts for future sales which help us determine our production plan moving forward and helps our purchasing team prepare for upcoming orders. From these forecasts, we can determine how many labour hours will be needed for production, packing and distribution of our goods in certain periods. I also use graphs and a lot of tables to represent the forecast data so we can analyse performance. Bar graphs and pie graphs are the most useful, as they are the easiest way to describe data and explain it to groups in a presentation. The visual nature of these graphs is easy to understand as opposed to simply presenting a list of data which may be hard to decode. Pie graphs are also great for showing the allocation of our resources and our wastage of goods.

What is the most useful tool or piece of technology in your work?

I use Excel spreadsheets for all my calculations and data analysis. You can do everything in Excel and there's no need for me to use a calculator. I especially use the basic average tool embedded in Excel for finding the average of large data sets. We also have a mathematical tool in our work system which can provide some forecasts from previous averages that have been calculated.

What was your attitude towards learning maths in school? Has this attitude changed over time?

I wasn't very good at maths, but I did like how there was an actual answer at the end compared to other subjects where a lot of interpretation was required. I would say that my attitude towards maths changed the most from early years in school to my later years. It took me a little while to get better at finding the correct answer, but I did get there in the end and I continued with maths in Year 12. In using maths every day in my professional career, I now feel more confident in my maths abilities when doing it on a day-to-day basis. The maths I do at work is also applied in a more practical manner than it was in school, and as such is more likeable.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

5A Starting activities

Activity 1: Public transport

Design a survey about public transport with the target audience to be your class.

Use the following steps.

1. Brainstorm what the issues could be for your age group in relation to using public transport.
2. Think of five 'good' and five 'bad' questions that you could ask.
3. Give reasons why some questions are good and some are bad in this context.
4. Write at least five questions that you will use in your survey.
5. Phrase your questions so that you can mathematise the responses, e.g. choose one of yes/no, scale of 1–5 etc.
6. Decide on how you are going to collect the data, e.g. Google Forms.
7. Give your survey to at least three classmates to check it.
8. After this check, what would you change and why?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Activity 2: Big data

Everybody collects data! When you look out the window to see if it is raining, you are gathering data that can help you decide whether to take an umbrella or not. But you might make a better decision if you use the weather forecast that predicts the whole day.

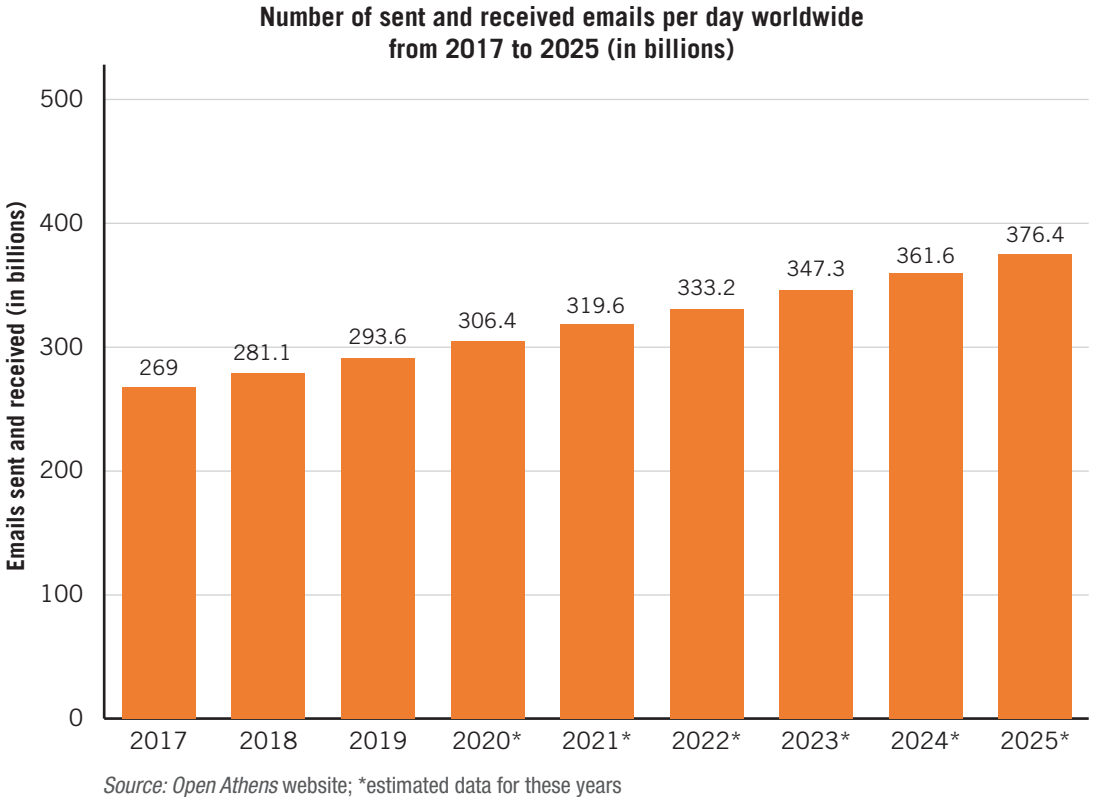
Data is collected for a purpose: to answer a question, make a decision, or make a prediction.

As the weather example shows, some data can be more useful than other data.

Here are some specific examples of large-scale data collection.

- Sports statisticians collect data to be able to compare teams and players.
- State governments collect data to know where infrastructure like hospitals, roads and rail lines are needed.
- The federal government collects data about Australia's population.
- Social media providers collect data to maximise the effect of advertising.
- Retail businesses collect data about the items they sell to know what products are trending.
- The UN collects data about climate change to see if policies are having an impact.
- Public transport companies collect data about running on time and delays so that they can meet their contractual obligations with the state government.
- Political pollsters collect data to predict which party is going to win the next election.
- Scientists collect data to support or disprove their hypotheses.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.



Source: Open Athens website; *estimated data for these years

Big data is the idea of collecting and analysing vast data sets. Big data is data that you cannot collect or analyse by hand, but with technology it is possible to interrogate the data. It is estimated that in 2025 we will be sending about 376 billion emails EACH DAY! Each email that you send or receive provides data for the company that owns the email platform.

But how do you handle 376 billion pieces of data?

Use the internet to visit data.gov, the US government repository of free data, and navigate through the site to find a topic of interest.

1. Choose the data tab and select a subject that you find interesting.
2. Choose a subject that has a free download to **.CSV**, **.XLS** or **.XLSX**.
3. Download the file as a spreadsheet and open it in a software package such as Excel.
4. How large is the data file that you have selected?
5. How many variables are in this data set?
6. List five things that you notice about this data set, e.g. by year.
7. If you were to analyse and explain this data set, how would you go about this?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

5B Tuning in

Epic Success: Statistical analysis of baseball

Sabermetrics is a statistical analysis of baseball. The term was created in 1980 by a baseball fanatic and statistician Bill James. He made the term by combining the acronym for the Society for American Baseball Research (**SABR**) with **metrics**, a word that describes tracking performance. You may like to visit the website of SABR for more information on sabermetrics.

Clubs use sabermetrics to analyse player performance, and in player selection.

You may have seen the movie *Moneyball* (2011) which is based on real events. It depicts the Oakland Athletics Baseball Team, which is near the bottom of the ladder. Using data collection and analysis of players (sabermetrics), the team's general manager Billy Beane and the assistant general manager use statistics to plan their game play and to choose players. The result was a record 20 wins in a row, and success at winning the 2002 American League West title. Unfortunately, they lost in the next round and did not make the World Series.

The story tells how the Red Sox tried to poach Billy Beane as they were so impressed by his system, but he was deflated by the team's loss and declined. The Red Sox went on to use sabermetrics and with this approach they won the 2004 World Series breaking the team's 86-year drought.

Discussion questions

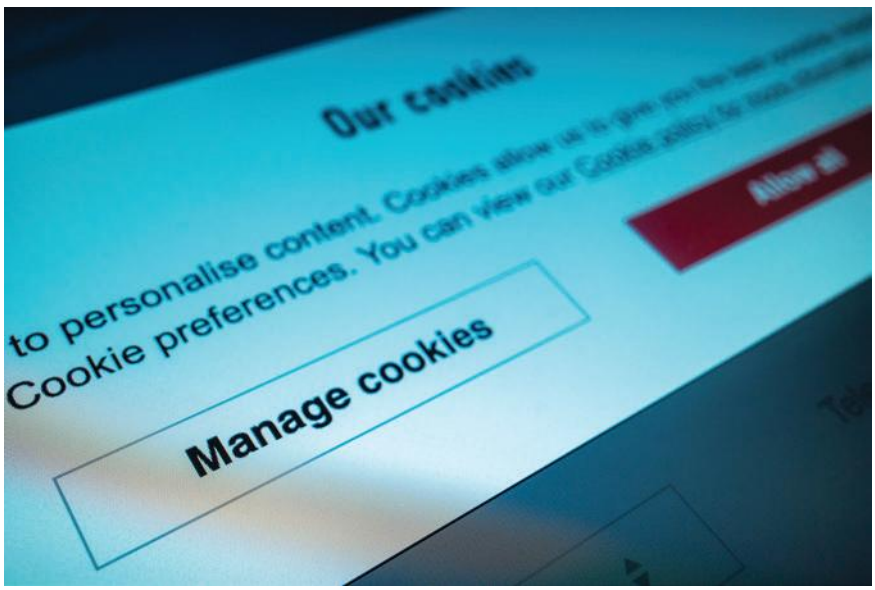
1. Do you know of other sports that could benefit from a data science approach or that you know use data science already?
2. Choose three from your list and briefly explain how data science could help individuals and teams improve their performance.
3. Share your thoughts with your classmates.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Data sampling on the internet

Each and every time you are on the internet, data is collected about you. The main method of data collection is through the use of cookies. Cookies are small data files that give information about your web browser and trends. Many pieces of small data from many people can provide useful aggregate information for websites and companies. For example, if you browse the site of a large retail store, they can then see if you visit competitor sites and how long you spend browsing there.

Cookies also have a positive side for the user. They can remember your preferences, passwords or favourite pages. This can make for a better and faster browsing experience next time you visit their site.



Data and privacy

Many websites and browsers now require you to sign in to access their full services. Often they will provide (extremely long and usually unreadable) privacy statements. These statements ask you to agree to their terms and conditions before signing you up. Do you read these? Do you wonder what data is being collected about you? Have you checked your privacy settings?

There is an old saying ‘there is no such thing as a free lunch’. This applies in the case of the internet. It appears that many services are free, but you are really paying by giving away your data.

Experts recommend undertaking a privacy check-up every couple of months to make sure that you are happy with the settings you have chosen and to see if any options have changed.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Practice questions

1 Explain the difference between a population and a sample in relation to statistics and data collection.

2 Explain the concept of random selection and give one example where it might be useful.

3 Using the internet, search for several different free software or websites that:

- **a** provide publicly available data for your next project. Give one advantage for each.
- **b** can be used for creating a survey. Give one advantage for each.
- **c** you have used for creating and running a survey – if you have, what did you use it to survey?

4 As a class, or individually, answer the following questions.

- **a** What is the difference between a structured and an unstructured question?
- **b** Provide a table of advantages and disadvantages for both structured and unstructured questions.
- **c** List some different ways a question response can be structured, e.g. multiple choice.
- **d** Write four different types of structured questions on any topic. Give the question (stem) and possible solutions/response options.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

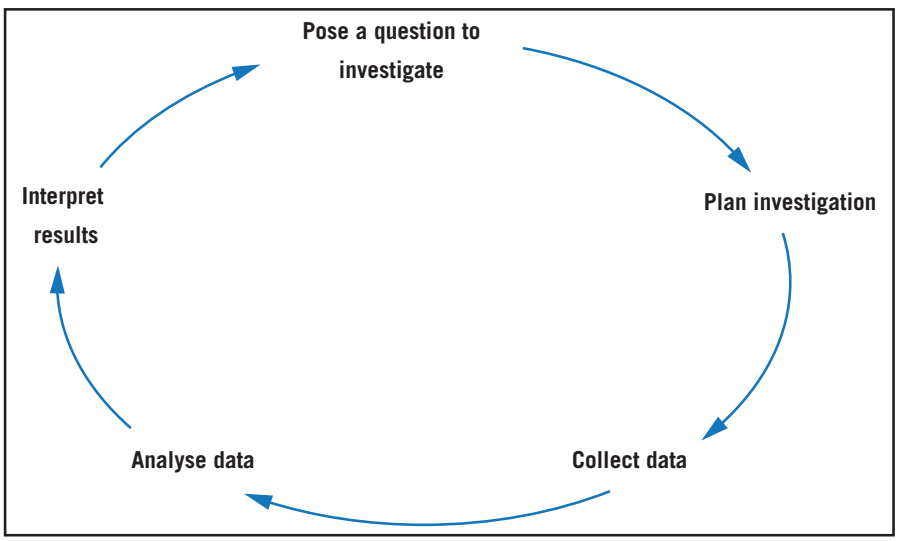
5C The statistical cycle

Buying your first car is a big deal. You wouldn't make this decision without thinking long and hard. Some of the questions you would ask yourself could be:

- What type of car do I want?
- How can I find out if this is the best car for me?
- What is the typical purchase price of this car?
- What is my budget?
- How will I get any extra money I need once I've chosen a specific car?
- Should I buy from a private seller or from a car yard?
- What sort of insurance will I need?

When we are trying to make these big decisions in our real lives, we are using the statistical cycle. If you studied Foundation Mathematics in Year 11 you will have already seen this cycle.

The statistical cycle



The goal of the statistical cycle is to use evidence-based information to answer a question, to make a decision, or to make a prediction.

After we have determined just exactly what it is we want to answer/decide/predict (and this is not as easy as it sounds), collecting useful and accurate data is the first step. Each of the stages is explained on the next page.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Pose a question to investigate

Starting with a broader topic of interest, we come up with a specific investigation question to answer. We can ask multiple questions about one topic.

For example, a small business might be researching how to operate more sustainably. They may focus on finding out if their customers would like to receive their products in more eco-friendly packaging.

Plan investigation

Next, we plan how we will answer the question. We decide what kind of information we need, like words, numbers or pictures. We also identify where we can find the information, such as data that has already been collected or from sources we need to gather data from directly. It is also wise to think about practical things like time and money.

Collect data

Data collection might involve surveys, questionnaires, forms, interviews, experiments, and focus groups, just to name a few. Data might be collected in-person, on social media, by email, through texts, and may even be collected just by browsing on the internet. There is no limit to the ways in which data may be collected. In retail, data is sometimes collected by asking customers to select a smiley face from a scale to indicate their feelings of an experience.

Analyse data

Analysing data is a critical step in the cycle, as it helps us to make sense of the information we have collected and draw meaningful conclusions from it. There are several techniques we can use to find patterns and relationships in the data, depending on the type of data we have collected. This might include graphing it and calculating summary statistics.

Interpret results

Interpreting the data involves answering the original research question using the data collected and considering what this means in the real world.

Once the data has been analysed, the business owner can use the insights gained to make decisions about their product or their business strategy. For example, they might decide to investigate lowering the price of the product to make it more affordable, or they might decide to focus on marketing the product to customers who are more concerned about the product's environmental impact.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

The cycle does not happen over a fixed time. Each of the different stages may take a longer or shorter time depending on what the question is and how difficult each stage is to carry out. A small cycle can be over in a matter of days, but some projects can be very involved and have multiple cycles.

An example of a long running cycle is the Longitudinal Survey of Australian Youth (LSAY), commissioned by the Australian government. Starting in 1995, this project collects data from more than 10 000 15 to 25-year-old Australians every year for 10 years. The purpose of this data is to study their transitions from school to further education and work.

You may like to view the website for LSAY to find more information.

5C Tasks and questions

Thinking task

1 In pairs or small groups, brainstorm all the different ways (e.g. surveys, interviews etc.) that you think you may have had data collected about you or from you in your lifetime. What was the purpose of the survey and what question was being investigated? For each, decide whether the data was collected with your knowledge and consent or not.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Skills questions

2 Give three examples where you have to make a big decision in your life and write up a statistical cycle for each of these situations.

3 Consider the set of possible questions from earlier about buying your first car.

- What type of car do I want?
- How can I find out if this is the best car for me?
- What is the typical purchase price of this car?
- What is my budget?
- How will I get any extra money I need once I've chosen a specific car?
- Should I buy from a private seller or from a car yard?
- What sort of insurance will I need?

In pairs, map out what each stage of the statistical cycle would involve for working through this investigation of buying a car.

4 Identify which stage of the statistical cycle that each of the following tasks might belong.

a Constructing a graph of the food categories purchased in the school canteen

b Counting the number of cars that travel on a road at different times during the day

c Presenting the results of a survey of students to the school leadership team

d Meeting with company leaders to determine what information about your customers is needed to grow the company

e Determining the time, place and questions you will ask in a survey of public transport users

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mathematical literacy

5 There are organisations whose business it is to undertake the statistical cycle for their clients. Market research companies focus on helping other organisations to understand how their products perform in the market, whether their customers' experience is positive, what consumers think about a new product and how they compare to their competitors, among other things. For each of the following jobs in a market research company, identify which stage of the statistical cycle they are most likely to work on (it is possible for them to work on more than one).

a Survey designer

b Data analyst

c Face-to-face interviewer

d Statistician

Application task

6 A statistical inquiry is conducted into the effect of high school students' part-time work on their study habits, with the goal of using this information to review the policies about school students and part-time work. The following activities would be carried out as part of the statistical cycle. Put these activities in order and then match each of them with the stage of the statistical cycle to which they belong.

Activity	Order	Stage of the statistical cycle
a Use the report to modify policies about school students and part-time work.		
b Prepare a report that details the findings of the inquiry.		
c Sort and categorise the data using a statistical computer package.		
d Prepare simple charts from the data to see if there are any patterns.		
e Design the questions that will be asked.		
f Make sense of what the data is saying. Turn the data into information.		
g Calculate statistics for numerical data. Look for trends in the data.		
h Plan the method of collection.		

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

5D Types of data

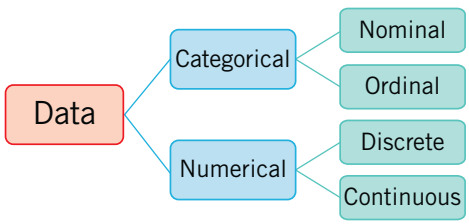
If you are trying to find out the most popular shows that are being watched by your classmates, the data you collect will be in the form of words.

If you are investigating family sizes in Australia compared with those in another country, the data you collect will be in the form of numbers.

Or if you are investigating students' satisfaction with the school's canteen menu and prices, the data you collect will be using a scale like: terrible, fair, OK, great.

To work in the Plan investigation, Collect data and Analyse data stages of the statistical cycle, we need to understand the different types of data.

The types of data we can collect can be separated into different categories or types, shown in this diagram.



Note that **categorical** data may also be referred to as **qualitative**, and **numerical** data is also referred to as **quantitative**.

Categorical data can be broken up into two subcategories called **nominal** and **ordinal**.

- **Nominal** data is information used for naming categories, e.g. hair colour, type of pet.
- **Ordinal** data is information that can be put in order, often by classifying variables into descriptive or separate categories such as a satisfaction rating ('highly dislike', 'dislike', 'neutral', 'like', 'highly like') or in order from 1 to 10 such as in the rankings of sports players.

Numerical data can be broken up into two subcategories called **discrete** and **continuous**.

- **Discrete** data is information (data) that can only take certain values – often we say that the values can be counted, e.g. the number of students in a class, the number of different coloured cars in a carpark.
- **Continuous** data can, in principle, assume all possible values in a given interval – often we say it can be measured, e.g. time, height, weight.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

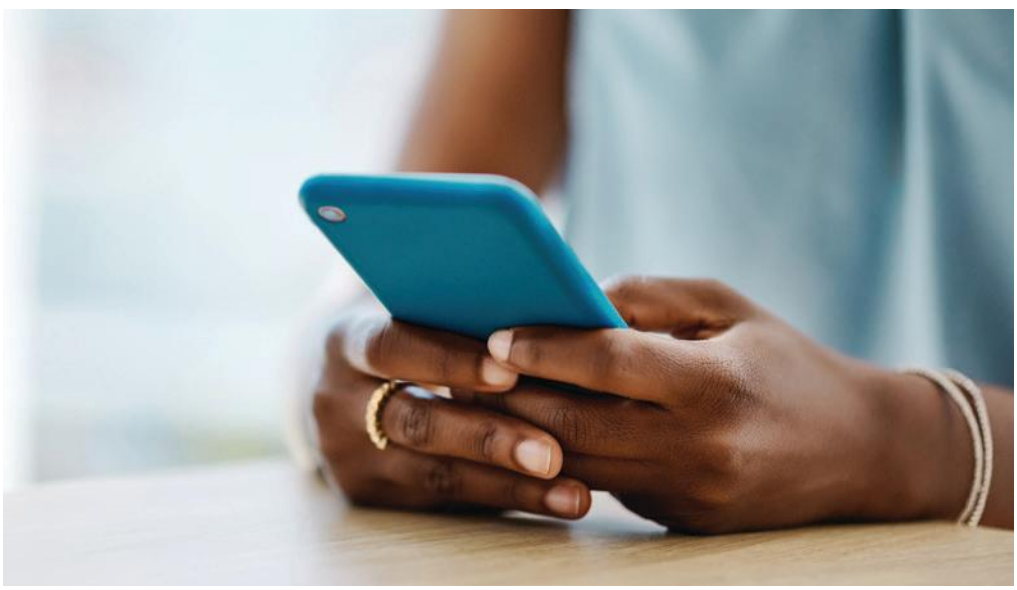
Knowing the type of data you are working with is important because different types of data require different collection techniques and enable different types of statistical analysis to be performed.

The type of data also influences the types of graphs you can draw to illustrate the data. These decisions are all part of the Planning investigation stage of the statistical cycle.

5D Tasks and questions

Thinking task

1 Brainstorm all the data you could collect about a mobile phone, such as the brand, how old it is, the amount of memory it has, and the operating system it uses.



a See if you can find at least one piece of data that matches each of the four different data types.

b Classify each item on the list into one of the four types of data: nominal, ordinal, discrete, continuous.

c Did you include the phone number? How did you classify it?

Skills questions

2 Match the data sets listed with the type of data they belong to, and who might use this data.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

a Brown, blue, green, grey	Discrete	Traffic engineer
b The weight of babies as they grow	Continuous	Artist
c The ranking of tennis players in the world	Ordinal	Fashion magazine editor
d The number of cars travelling through an intersection	Continuous	Ecologist
e List of trains that are on time or are late	Nominal	Company asking opinions about their products
f The rate of water flowing in streams	Nominal	Sports journalist
g Brown, chestnut, burnt umber, bronze	Ordinal	Consumer group monitoring public transport
h Highly agree, agree, neutral, disagree, highly disagree	Continuous	Doctor concerned about healthy growth

3 Your school wants to know which of its computer facilities need to be improved.

a Who should be asked this question?

b How could this data be collected?

c What types of data would be collected to answer this question?

Application task

4 Plan and design a survey to find out what your fellow students want to do as a group excursion.

a What questions will you ask?

b What type of data will you be collecting?

c How will you record responses?

d How will you distribute this survey?

e How will you ensure that each student responds only once?

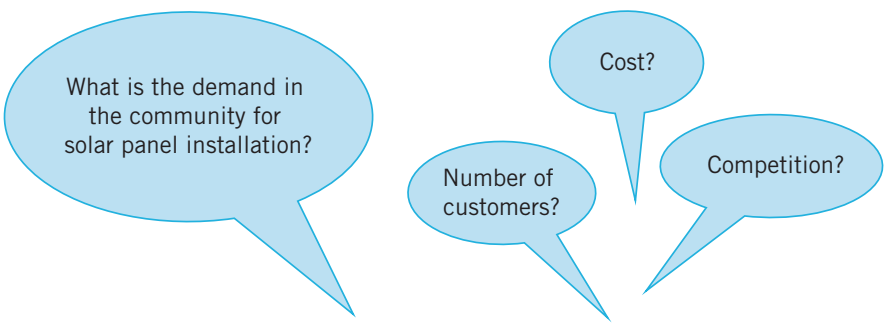
f What timeframe will you plan for this survey?

g How will you publish the results of your survey?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

5E The purpose of data collection

Amir has been asked by his boss to investigate whether it is a good idea to diversify into installing solar panels on residential houses. Amir proposes to answer the following key question and that he needs to consider these issues:



The answers to Amir's questions could change the direction and purpose of the company. The decisions that are made based on the data collected will have financial ramifications.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

It is important that the data collected is true and accurately reflects the market that Amir is investigating.

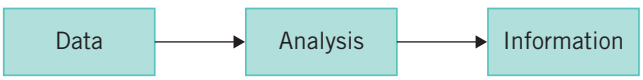
In general, the **purpose of collecting data** is to answer a question, make decisions or make predictions. It is important that the data that is collected is relevant to this purpose. These decisions are important to address as part of the first two stages, Plan investigation and Collect data, of the statistical cycle.

It is equally important that the purpose for collecting the data is clearly defined and not ambiguous.

There are two important things to remember about collecting the 'right' data.

- Make sure the purpose for collecting the data is clear.
- Make sure that the data you plan to collect is relevant to the purpose.

Data collection must have **purpose for a certain context**.



Consider the data below.

Blue 45 675 8 34 29
15 green 78 .02 yes 24
4500 $56 yes yes yellow

Without context, the data presented here is meaningless and has no purpose.

When considering the purpose of data collection there are six key questions that the statistician should address.

1. WHO is providing the data?
2. WHAT is the information that you are seeking from the respondents?
3. WHEN is/was the data collected?
4. WHERE is/was the data collected?
5. WHY is/was the data collected?
6. HOW is/was the data collected?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

5E Tasks and questions

Thinking task

1 Why wouldn't you accept a statement like '9 out of 10 dentists recommend brand X'? Explain another situation where the claim being made is questionable.

Discuss these with your classmates.

Skills questions

2 For each of the following scenarios, indicate whether the purpose of collecting data is to answer a question, make a decision or make a prediction.

Scenario	Answer a question	Make a decision	Make a prediction
a There has been a suggestion to hold a 'bring your pet to school' day.			
b The school council wants to know if students are bringing healthy lunches to school.			
c The local council wants to know if households would support fortnightly rubbish collection.			
d The local council wants to plan where to locate childcare centres.			
e There has been a suggestion that the senior school ball be taken 'up market.'			

3 The Transport Accident Commission (TAC) in Victoria collects data about road crashes and fatalities across Victoria. This data is available for research purposes and can be viewed on their website.

The following graph is based on data for road fatalities in Victoria from 2013 through to the end of 2023. Use the graph to answer the questions below.

a Who collected this data?

b When was this data collected?

c What are the variables in this data?

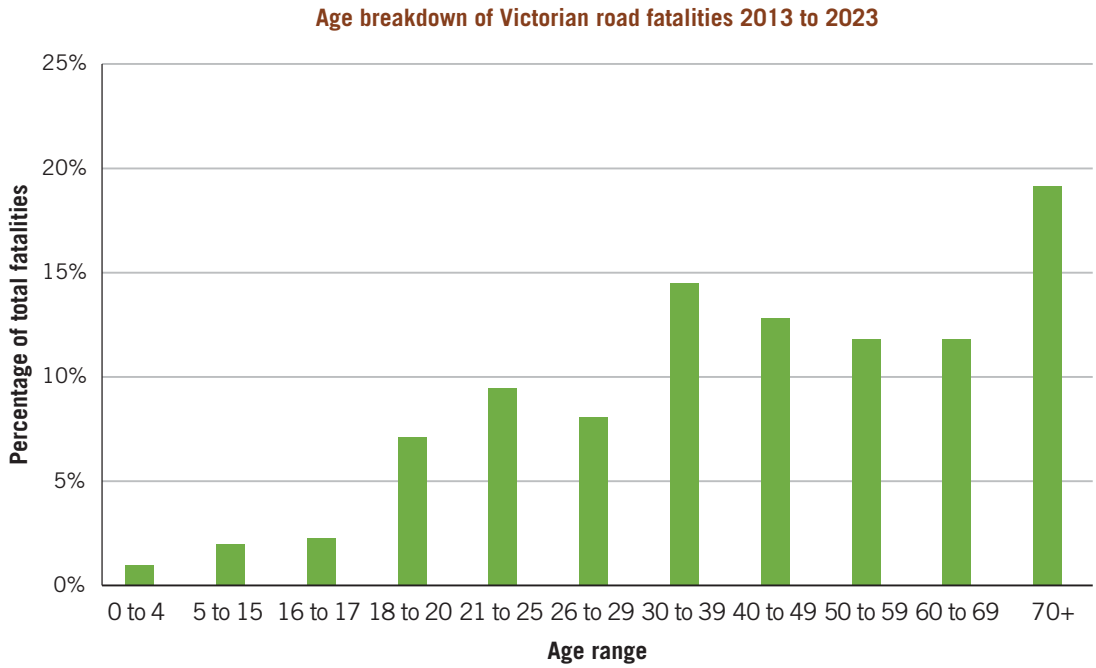
d Where was the data collected? Does this impact the applicability of the data?

e How do you think this data was collected?

f What is the message that this data conveys?

g Explain two potential uses of this data.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.



Mathematical literacy

4 In small groups, discuss the meaning of these different types of survey or interview questions that are normally not recommended to use. Discuss why they are named the way they are.

- **a** Absolute question
- **b** Ambiguous question
- **c** Double-negative question
- **d** Double-barrelled question
- **e** Leading question
- **f** Loaded question

Application task

5 **a** Use the internet to find examples of these different types of problematic survey questions.

Type of poor survey question	Example	Hyperlink
Leading question		
Loaded question		
Double-barrelled question		
Absolute question		
Ambiguous question		
Double-negative question		
Another one you found interesting		

- **b** Rewrite each so that it is a good survey question.
- **c** Share these with your classmates.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

5F Data collection specifications

Your family is thinking about getting a dog. After discussing it together, you have narrowed the choice between two different dog breeds. One is known for its protective nature, while the other is known for being very good with children.

How will you make this decision?

You could talk directly with people who own each breed. Though this is only a small data set, you would be getting first-hand information.

You could then use the internet to research both breeds. This would be based on a large data set and give you a deeper understanding of the nature and needs of each breed.

There are two main types of data collection.

- **Primary data** collection refers to data that the researcher has planned and collected.
- **Secondary data** collection refers to data that has been planned and collected by someone else.

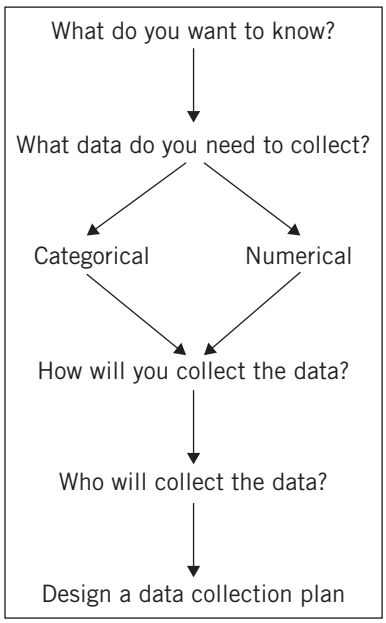
In section 5H, we will look more thoroughly at the issue of whether we can believe the data and the information and opinions we all read these days. It is important to be able to reflect on and evaluate the **validity** and **reliability** of the sources of information and data we are exposed to and use, and this is critical when we look at secondary data. We need to be aware of whether the secondary data we access is current and unbiased and has been validly collected by a reputable organisation.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

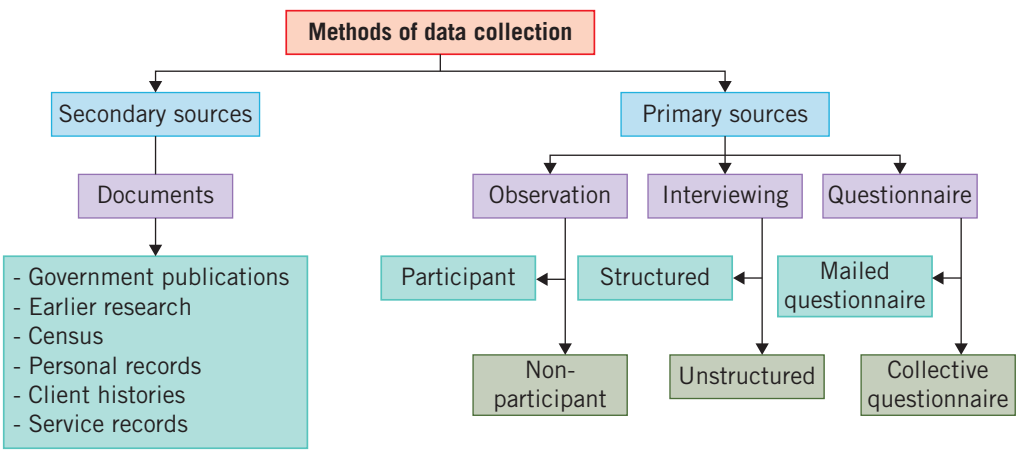
Methods of data collection

Before collecting data, the method of collection should be planned, based on the following steps.

1. Consider the purpose of the data collection.
2. Consider whether the data is categorical or numerical. Does it need to be primary data or can you use existing, secondary data?
3. Decide how you will collect or find the data.
4. Decide who will collect and record the data and what resources will be required. This depends on how much data is needed, and how difficult it is to collect.
5. Finally, develop your data collection plan.



The diagram below highlights the possible methods of data collection that can be used for secondary and primary sources.



Types of data collection

There are many ways of collecting data, including:

- Chat
- Face-to-face groups
- In-depth interviews
- Mail
- Online forums
- Online groups
- Online one-on-one interview
- Phone
- Web survey

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Surveys

One of the most common forms of data collection is a survey. This involves participants answering the questions contained in the survey.

Scientific data is collected by people making observations or by instruments that record the data automatically. This includes such things as weather data, air quality readings or UV index.

Surveys can be carried out in person, face to face or by telephone, or electronically through an app. They can be very quick to administer, with just one or two questions, or take much longer for participants to complete, requiring in-depth responses.

Surveys can contain different types of questions that can be open-ended or closed.

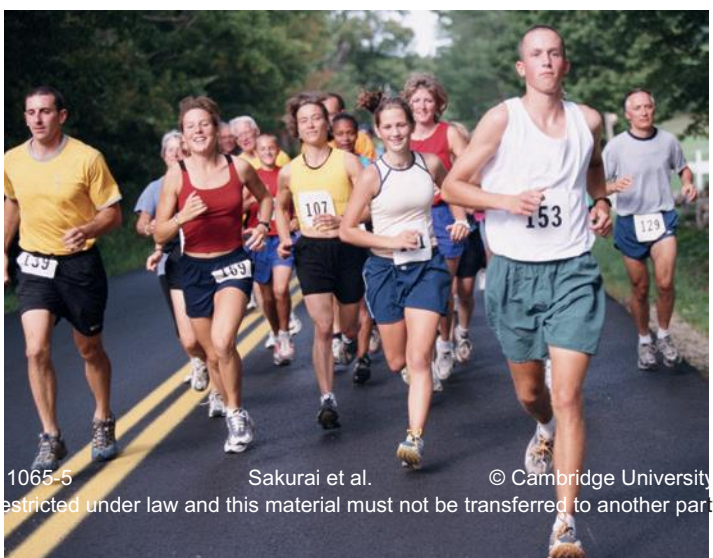
Open-ended questions allow participants to use their own words to answer the question. Closed survey questions present the participant with a set of choices that you have pre-chosen.

5F Tasks and questions

Thinking task

1 For each scenario, what data would you collect?

- **a** Go on a holiday in July
- **b** Narrow down a career you might want to pursue
- **c** Run a marathon
- **d** Live in a share-house
- **e** Write an article about the pets kept by the students in this class
- **f** Learn a musical instrument
- **g** Join a new club



ISBN 978-1-009-1065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Skills questions

2 Use the data from the Australian Bureau of Statistics (ABS) to answer the questions that follow.

Characteristics of Employment, Australia, August 2021

Released at 11:30 a.m. (Canberra time) Tue 14 Dec 2021

Employees by demographic characteristics and full-time or part-time

	Males		Females	
	Full-time in main job (in thousands)	**Part-time in main job (in thousands)**	**Full-time in main job (in thousands)**	**Part-time in main job (in thousands)**
Age group (years)				
15–19	91.1	205.6	41.8	293.5
20–24	346.5	226.8	247.9	288.3
25–34	1170.2	198.3	864.7	457.1
35–44	1153.2	105.6	664.9	507.4
45–54	920.4	95.7	653.6	424.8
55–59	379.5	38.8	258.9	177.1
60–64	242.4	64.8	131.7	167.8
65 and over	101.9	71.7	57.6	98.9
Born in Australia	2943.2	677.0	1923.0	1679.5
Born overseas	1459.1	330.3	994.8	735.4

© ABS, Commonwealth of Australia, 2021

a Who collected this data? Do you consider this to be a reliable source? Why or why not?

b List the four variables that this data has addressed.

c When was this data published? Is this data current or out of date?

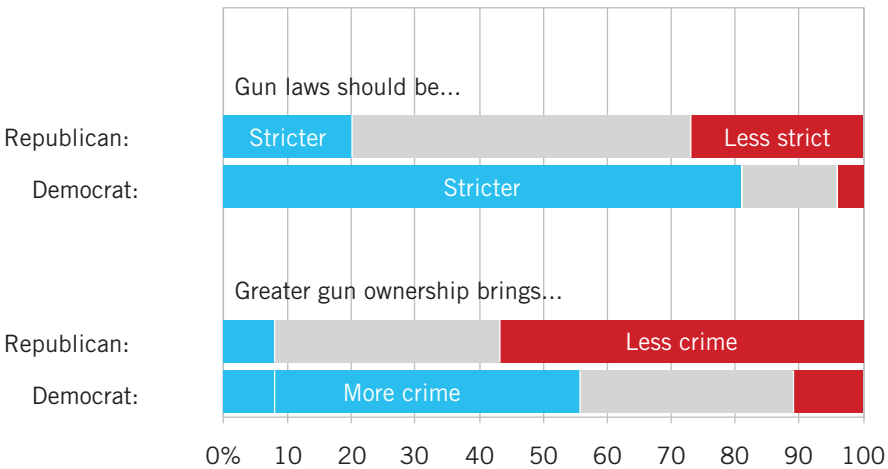
d Where was this data collected?

e Why was this data collected? Give at least two potential applications of this data.

f How do you think this data was collected?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3 A survey of gun control issues was conducted in April 2021 after a series of mass shootings in the United States. The results are organised by political party in this bar chart. The data was sourced by the Pew Research Center who organised a panel of randomly selected U.S. adults to participate in a web survey. Of the 5109 respondents, about a third supported the Republican Party and two-thirds supported the Democrats.



Source: Pew Research Center

a How was this survey conducted?

b Use the internet to look up the source. Is it a reliable source? Why or why not?

c Is the data current?

d Is the number of respondents sufficient to support the statement 'Gun laws should be stricter'?

e Do you think that this data supports the statement 'Gun laws should be stricter'? Why or why not?

Mathematical literacy

4 Consider each of the following important terms in relation to data collection and data types. Research what the terms mean and their relationship to other meanings of the words in more general, everyday usage.

a Categorical data

b Numerical data

c Primary data

d Secondary data

Application task

5 Explain how you would find out which social media platform is the most popular with your age group. Research the internet to see if the same is true in other countries. Present your findings to these questions in a format of your choice.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

5G Developing and producing surveys

Your local council is considering building a skate park in the town's recreational area. You and your mates are keen to have this happen because the closest skate park is in the next suburb. However, in the local social media, you've seen that the owners of businesses adjacent to the proposed site are against this idea, as are the people who live in the immediate neighbourhood.

You don't believe those opinions are representative of all the people in the council area. How could the council get a fair representation of the whole community's attitude towards this proposed development?

The response to this issue would be to conduct some form of a survey. This is when you, or the council in this case, would need to decide on the best way to develop, produce and administer the survey.

The Australian Bureau of Statistics (ABS) has information about conducting surveys. Look for information on basic survey design on their website.

Survey types

There are two main types of survey:

1. Census
2. Sample survey.

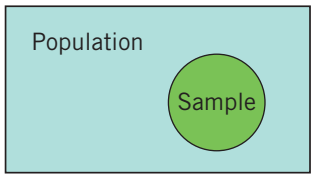
A **census** investigates the total population. Census is used when you need accurate information for an entire population. An example of census is the Australian Bureau of Statistics Census, which every Australian must complete on a certain night every five years. The information gathered in the census helps governments plan resources and services for the population of Australia.

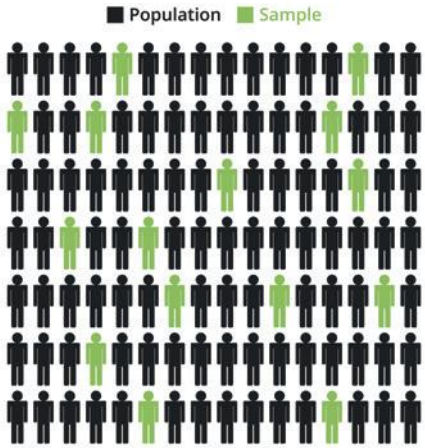
The census is a massive undertaking requiring thousands of hours of work to design, distribute, collect and analyse. Though it is very expensive, the information gathered in the census is highly accurate and has little error.

In our skate park example above, the council would have to use a census model to make sure that ALL children and young people have their opinions included, but this would be costly and take time, and possibly not all people (e.g. very young children or the elderly) would be able to participate or have an opinion. In this case, a sample survey makes more sense.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

A **sample survey** investigates a subset of the population.





In our skate park example, the council would most likely ask the question of some of the people; that is, undertake a sample survey. The critical issue with surveys is about deciding how you select the sample in order to make it representative of the group of people you are wanting to get an opinion or information from.

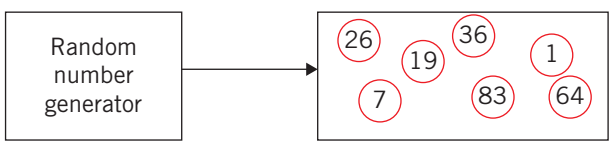
Sampling strategies

If the sample does not accurately reflect the target population, then the sample is **statistically biased.**

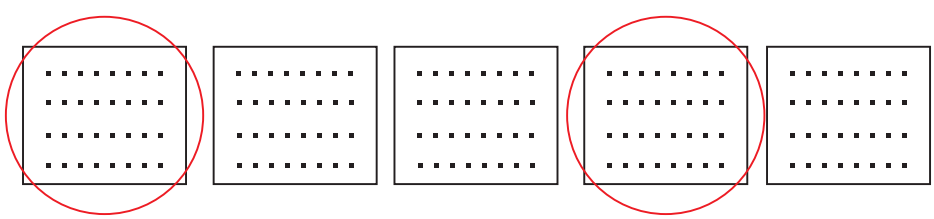
In order to minimise bias from samples, sampling strategies can be used such as:

- random sampling
- cluster sampling
- stratified sampling
- systematic sampling.

Random sampling is where every individual has an equal chance of being selected.

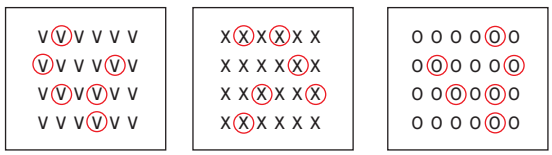


Cluster sampling divides the population into clusters which are then randomly sampled.

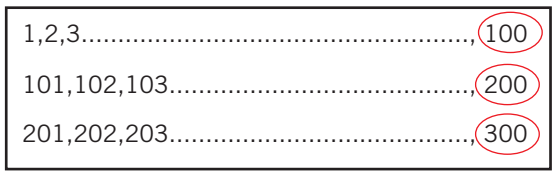


ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Stratified sampling takes groups from the population with similar attributes. The groups are then randomly sampled.



Systematic sampling samples every *n*th individual, such as every 100th individual.



An organisation such as ABS would use statisticians to decide on which sampling method was most sensible and reliable for collecting the required representative data.

Survey questions

Different formats of survey questions

The examples given here are all independent questions. They are not from the same survey. But they all refer to the same theme of a survey about school uniforms.

Multiple choice/Multiple choices

Multiple choice (single answer) or Multiple choices (can select more than one answer). Let your participants know that they can select more than one answer by including this in the instructions.

Which part of the school uniform do you think needs to be changed? (Select as many as you like.)

- ☐ Sun protection hat
- ☐ Shirt
- ☐ Jumper
- ☐ Blazer
- ☐ Skirt/trousers/shorts
- ☐ Socks
- ☐ Shoes

... *continued*

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Short answer

A short answer question gives participants the opportunity to let you know their opinion in their own words. This might include answers that you have not previously considered.

> For each of your selections in the previous question, state what you think the change should be.
>
> _____
>
> _____

Yes/No questions

Yes/No questions are often qualified with Yes/No/Don't know. These questions enable you to quickly build a snapshot of participants. They are quick to collect and simple to analyse.

> Do you think the school uniform should be compulsory?
>
> ☐ Yes ☐ No

Likert scale

A Likert scale is sometimes referred to as a satisfaction scale and ranges from a negative extreme to a positive extreme. It enables you to collect data on participants' opinions and perceptions, and gives you more subtle information than a straight Yes/No question.

> A uniform gives students pride in their school.
>
○	○	○	○	○
Fully Disagree	Disagree Somewhat	Neutral	Agree Somewhat	Fully Agree

Continuum/Slider

A continuum or slider question allows participants to give a rating of how they feel about a particular issue.

> How committed are you to wanting to change the school uniform?
>
>
>
> Not at all Fully

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

5G Tasks and questions

Thinking task

1 The four main types of sampling are:

- random sampling
- cluster sampling
- stratified sampling
- systematic sampling.

a Discuss and make a list of the positives of each method.

b Discuss and make a list of the negatives of each method.

Skills questions

2 For each of the survey topics below, state which type of sampling you think would be the most effective in avoiding bias.

a Twitter users

b Smoking

c Personal income

d Bike paths

e Education levels

f Private health insurance

g Pet ownership

h Religion

3 What type of questions would you ask in the following surveys?

a Should schools ban homework?

b How do we get more Australians to use public transport?

c Which drugs should be decriminalised?

d How well were you treated when you were at the Emergency Department?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mathematical literacy

4 Use the words in the box to complete the sentences below.

open	someone	categorical	current	unbiased	numerical	closed	data

a Primary _____ is information that you have collected yourself.

b Secondary data is information that _____ else has collected. For secondary data to be reliable, it must be _____ and _____.

c _____ data can be represented by a word or symbol, whereas _____ data is in the form of numbers.

d True or false and multiple-choice questions are both examples of _____ survey questions. A variety of responses is possible when _____ survey questions are used.

Application task

5 Design a survey to discover what your class wants to do for its end-of-year school-based celebration. You need to have at least five questions in your survey.

- Your survey needs to ask questions that can be quantified and summarised.
- Decide on how you will deliver your survey, so that it fairly represents the views of all the students.
- Decide how you will collect the responses.
- Collate and represent the responses in a table.
- Keep your data for further analysis in the following chapters.
- At this stage, from your table of data, what are your initial thoughts about what the students in your school think about your topic?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

5H Can we believe the data?

Can we believe the data and the information and opinions we all read these days? It is important to be able to reflect on and evaluate the validity and reliability of the sources of information and data we use, no matter whether it's about:

- our health and wellbeing, such as information about pandemics
- the environment and climate change
- our culture and peoples
- sport
- finances such as inflation, wages, car and house prices
- politics and how to vote in elections.

If the data and its information source is not credible, then our thoughts and opinions based on that data or information will not be valid or credible. So, we need to take the time to find out more about the basis and source of the information and data we are reading and relying on for making decisions. It needs to be as valid and accurate as possible in order to get the facts right.

Thinking about data

There are a few relevant expressions relating to this issue that you may have heard before:

- Garbage in, garbage out
- Lies, damned lies and statistics
- Fake news.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Garbage in, garbage out

The adage 'Garbage in, garbage out' **(GIGO)** is well known in computer science, where it refers to the fact that if the data that is input into a program is of poor quality, then the result of the computer program will be of poor quality, no matter how good the program is.

This is also true in relation to what we read and interpret that is based on data. It doesn't matter if the tables or charts of data we are reading and trying to interpret look impressive and the arguments or conclusions being made from them are sound and look justified, if the original set of data it is based on is invalid, biased or unreliable in any way it is *garbage* and hence, the analysis and results will also be *garbage*.

Lies, damned lies and statistics

'Lies, damned lies and statistics' is another phrase we often hear about. It is claiming that there are three kinds of data. It describes how it is possible to find, use and manipulate data and statistics to back up any argument – to support incorrect or weak arguments.

Fake news

Fake news actually isn't new but has exploded due to our reliance on social platforms as our source of information. We need to develop the ability to distinguish *fake news* from reliable, accurate news sources. One of the critical aspects of fake news is that it is often based on deliberate bias or selective use of data and information.

Summary

It is important when finding and using data and statistics, to be fully aware of the dangers of assuming the data being selected and used is in fact accurate, valid and reliable.

Errors in data collection – primary data

There are a few issues to address and think about in the collection of any primary data.

Outputs can appear correct and sound as they may be based on correct representations and data analysis techniques, but if they got there by being based on garbage input data, they aren't of much use.

Common sources of garbage input include:

- cherry-picked data
- small or biased samples
- allowing the same person (or device) to submit more than one response to the survey.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Cherry-picked data

Cherry-picking data is the deliberate practice of only collecting and analysing the results of a survey or data collection that best support the data collector's own perspectives or arguments, instead of using and reporting on all the data. This can be done by intentionally using limited categories of selection for the participants in the survey or of the information to be reviewed and analysed. So, it is not an independent or representative sample of the population being considered. Cherry-picking is dishonest and misleading, and reduces the credibility of any findings.

Small or biased samples

If you use a small sample size, then you run a risk of the small sample being unusual just by chance. For example, choosing five people to represent the entire state of Victoria, even if they are chosen completely at random, will result in a sample that is very unrepresentative of the Victorian population.

To conduct a survey properly, you need to determine the scope and size of your sample group. Your sample group should include individuals who are relevant to the survey's topic.

In most cases it's better to see a bigger study than a small one. But the meaningfulness of the data set and the analysis comes down to how well the population is represented by the sample. Some large studies may be garbage and some small studies may be extremely reliable and valid.

Allowing the same person (or device) to submit more than one response

A different issue to be aware of is the ability of the same person to vote or respond multiple times. Although this can happen more easily in online surveys and questions, it can also happen in face-to-face interviews.

There are a number of outcomes if this happens.

- If a survey respondent can submit the same set of responses repeatedly, this gives their opinion too much weight to the results.
- If they submit a different set of results a number of times, they can skew the data, again making it invalid and unreliable.

Errors in data collection – secondary data

When accessing and using external, secondary data for any investigation and analysis, you need to check the reliability and validity of the data. If it is invalid data, it could lead to inaccurate analyses and poor interpretations. With today's ready access to data via the internet, anyone can publish anything from anywhere, but not everything posted online can be trusted. To ensure the accuracy and validity of any external secondary data, you should review the source of the data.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Before you accept information, you should ask the following questions.

- Who collected the data?
- What is the data provider's purpose or goal?
- Is the data current?
- What type of data was collected and how?
- Is the data consistent with data from other sources?

Who collected the data?

Reliability of data can be affected by who collected it. Data from a government agency is more likely to be reliable than data found on a personal website or blog, or even some commercial organisations or businesses. With commercial organisations, make sure you find out who they are to ensure you are working with a widely recognised, independent and trustworthy organisation.

What is the data provider's purpose or goal?

Based on the purpose, the agency or organisation could still have a biased reason to collect and post the information. Commercial organisations and political parties will post information that might favour them in some way or explicitly support and promote their own interests. You need to find out why the data was collected.

Is the data current?

You also need to be able to check how up-to-date and current the data is. Data from three or more years ago may not help you. Check the dates on all of the data so you know you have the newest and most relevant information available – including how far back the data goes if you are wanting to research trends over time.

What type of data was collected and how?

This is especially important when using data directly related to people's opinions and needs. You need to know how the information was collected, what the survey questions were, what the response options were and who was asked the questions. Were they a representative and fair sample? This knowledge can help you decide if the data is related to the population you are investigating.

Is the data consistent with data from other sources?

When using external data, it is worth finding out if it is consistent with what other similar data sources are saying, so that you can trust the data you are using.

Asking these five questions is going to help you in making sure you use the most accurate data for your investigation. We all can search for and find data online, but getting valid and reliable data is the difference between making a successful or unsuccessful analysis of the questions you are researching and trying to answer.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

5H Tasks and questions

Thinking task

1 'Fake news', 'Garbage in, garbage out' and 'Lies, damned lies and statistics' are all emotive statements related to the collection and use of data, and in the resulting representations, analysis and interpretation of that data. Work with one or two fellow students to find at least one example of each. Discuss these with your classmates.

Skills questions

2 Answer each of the questions below about believing or trusting data.

Survey and data information	Would you classify the data as valid and reliable, or potentially fake or biased?
a A daily news show on TV claiming that the poll of their viewers shows they are the best news show available	☐ valid and reliable ☐ fake or biased
b A survey of 10 boys at a school about whether girls should be allowed to play in the same Australian rules football team	☐ valid and reliable ☐ fake or biased
c A political party surveys its members and asks them about who would make the best prime minister	☐ valid and reliable ☐ fake or biased
d A national survey conducted by the Australian Bureau of Statistics (ABS) about the participation rate of adults in education and training in the last 12 months	☐ valid and reliable ☐ fake or biased
e An Education Department survey of 2000 students, randomly chosen from across Victoria, about whether girls should be allowed to play in Australian rules football teams in schools. Data set included a balance of genders	☐ valid and reliable ☐ fake or biased
f A set of data collected by a commercial polling company about the buying habits of teenagers. The sample was of 10000 teenagers, collected in 2023.	☐ valid and reliable ☐ fake or biased
g An online poll voting for the most popular performer in a TV show, where there is no limit on the number of times you can vote or who you vote for	☐ valid and reliable ☐ fake or biased

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mathematical literacy

3 Previously we have talked about how there can be different usages of terms and words in the maths world versus how we use them in everyday life. Here are some of the words related to how data can be misused. Write down some of the ways these same words are used in everyday life and how they might be related to how we use them in the maths and statistical world.

Word	Meaning(s) in everyday life and how they might relate to the world of maths and statistics
bias	
cherry-picked	
fake	
garbage	
invalid	
manipulate	
skewed	

Application task

4 Review the data and the responses for each of the following scenarios. Answer the questions under each scenario.

Scenario 1: Spending more money on sports facilities and equipment

The Year 9 and Year 10 students at Edendale Heights Secondary College decided to conduct a survey to see if students thought it would be a good idea to spend more money on sports facilities and equipment. This is the survey question they used.

Your name: _____

If the school wanted to spend more money on sports facilities and equipment, do you think this would be a good idea?

☐ Yes

☐ No

If no, what other areas should the school consider spending more money on?

_____

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Here is their summary of the results of the survey.

Year	Yes	No
7	14	14
8	35	14
9	54	14
10	50	13
11	6	22
12	4	22
Total:	**163**	**99**

The data was based on the following information.

- There are 760 students who attend the school.
- There are about equal numbers of students in years 7 and 8 (about 140 in each), then about 370 in years 9 and 10, and around 110 students in years 11 and 12.
- Students voluntarily responded and could only submit one response each.

a Review the data and the responses. Do you believe there were any issues with the data collected and its validity and reliability, and hence, any interpretations that could be made? Explain your answer with reasons. If there were issues, how could they have been addressed so that the data was more reliable and valid?

Scenario 2: The Mad Mix Comedy show poll

A group of Year 10 students at Edendale Heights Secondary College put on the Mad Mix Comedy show at school, selling 275 tickets. They developed an online poll of three questions to survey the 760 students at the school. The week following the show they sent the survey login to all the students, allowing only one response each, with the option to respond anonymously. They received 265 responses. Here is one of the questions they asked.

How much did you enjoy attending our Mad Mix Comedy show?

❍ Not at all ❍ A little bit ❍ Very much

❍ Not very much ❍ Pretty much

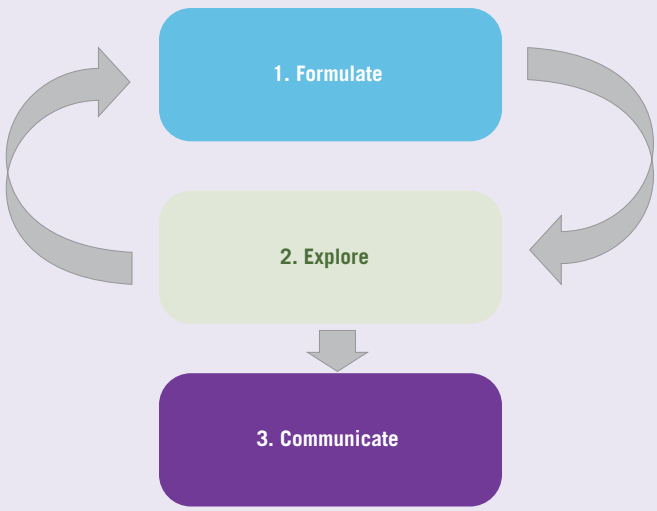
b Do you believe there were any issues with the data collection and the validity and reliability of the data? Do you think the results of their survey will have been fair and accurate? Explain your answer, with reasons. If there were issues, how could have they been addressed so that the data was made more reliable and valid?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Investigations

When undertaking your investigations, remember the problem-solving cycle steps:

- **Formulate** – Sort out and plan what you need to know and need to do to solve the problem.
- **Explore** – Use and apply the mathematics required to solve the problem.
- **Communicate** – Record and write up your results.



1 Primary data collection: 21st century opinions

What are people's opinions about 21st century topics? How can we find out? In this investigation, you will be developing your own survey questions and then collecting and collating some primary data based around people's views on a particular issue.

The main tasks in this investigation are to:

- create a survey (not too many questions)
- administer the survey and collect the data
- collate the data and input into a spreadsheet or other suitable format
- represent the data in tables and graphs
- discuss what the table of data is telling you about your topic and questions.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

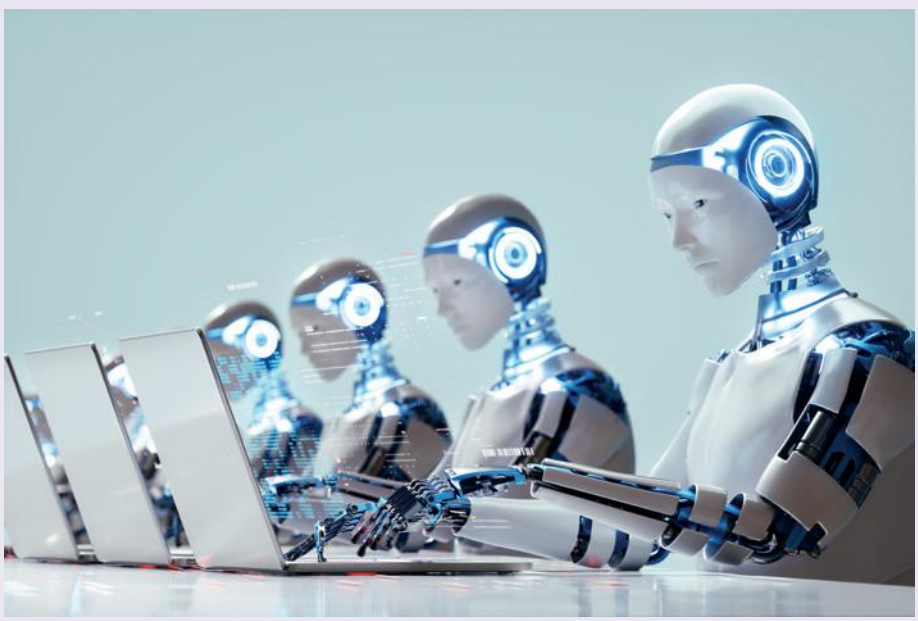
Formulate

In groups of two or three:

a Brainstorm areas or topics that people might have opinions about. Think of subjects that are topical in the 21st century and are of broad interest.

Some ideas you could ask people's views and opinions on could be chosen from the following subjects:

- Epidemics and disease
- Climate change
- The environment – including impacts on flora and fauna
- First Nations and Indigenous Australian issues
- Population and migration issues
- Artificial intelligence
- Changing work practices and the gig economy
- Gambling
- Sport and recreational issues
- Wages, including gender pay rates.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

b Share your group's ideas with the other students in the class to note the wide variety of the many possible issues that are related to your general topic.

c Create a mind map. You can do this using pen-and-paper or a digital application. As we have seen previously, your mind map is likely to have a large number of different areas that are related to the overarching topic or area of interest.

Based on your mind map, decide the following:

- The main focus of your investigation and survey
- The key questions or issues that you want to have answered
- The sub-questions you might ask to help answer these key issues.

d Start formulating the questions that you will ask in your survey. Make sure it is manageable and that you believe your data will be valid and reliable. Consider the following when you are designing your survey.

- How will you construct the survey – pen-and-paper or on a tablet or laptop and/or online?
- How will you conduct the survey? How many people will you ask? Are they representative of the target group you are surveying?
- How will you collate the survey results and represent them in tabular form?
- How will you proceed to organise, sort and use your data to answer the question(s) you asked?

Explore

This is the part of the investigation where you need to implement and conduct your survey.

e Develop the survey questions. Decide on the best way to deliver the questions. Create the survey to be delivered.

f Conduct the survey with the sample of people you decided on in the formulate stage.

g Collate the data and sort it into tables. Analyse the data set and check that it all fits with your main lines of enquiry.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

h Review the methods that you used to collect the data, including your sampling and recording of the responses.

i Were there any issues with the data collection and the validity and reliability of the results of your survey? If there were issues, how could have they been addressed so that the data was reliable and the results valid?

Communicate

j Write up and present the findings of your survey-based investigation. You could choose to write a report or to create a presentation that explains what you investigated, and your results.

In writing your report, the following should be considered.

- Demonstrate the use of statistical language in your communication of the data and the results.
- Highlight the mathematics and statistics that were used in order to undertake your investigation.
- Reflect on the technologies that were used to conduct the survey and collate and analyse the results.
- Reflect on your investigation and what you found. Were you surprised? In what ways? Why?

2 Secondary data collection: 21st century issues

In Investigation 1, you collected your own data to analyse. This investigation is about analysing existing valid data.

Formulate

In groups of two or three:

a Brainstorm topics or subjects that the group may be interested in researching. It should be something topical in the 21st century and be of broad interest. Decide on a single issue that you would like to investigate.

b Formulate the questions that you will ask as part of your research, and what data will be suitable to answer your questions. Make sure that it is manageable and that you believe the data you use will be valid and reliable.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Explore

c Conduct the research to collect data about your topic that will help you answer your key question(s).

You should make sure you access and use data from reliable sources such as:

- ABS (Australian Bureau of Statistics)
- Statista (if your school has an account to access the data).

d Collate the data and input into a spreadsheet or other suitable format. Represent the data in tables.

e Analyse the data. Discuss what the table of data is telling you about your topic and questions.

f Reflect on the data you have collected. Can your data source answer your key questions? If not, do you need to review and adjust your questions?

g Were there any issues with the data you accessed in relation to its validity and reliability? If there were issues, how could have they been addressed so that the data was reliable and valid?

Communicate

h Write up and present the findings of your investigation. You could choose to write a report or to create a presentation that explains what you investigated, and your results.

In writing your report, the following should be considered.

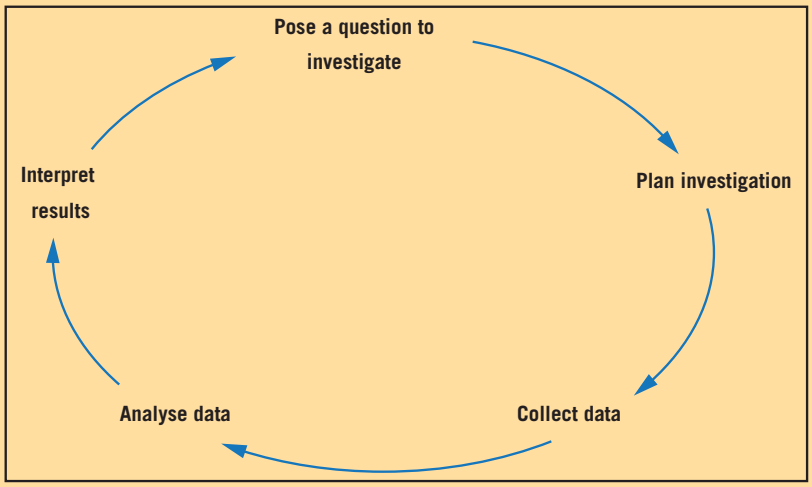
- Demonstrate the use of statistical language in your communication of the data and the results.
- Highlight the mathematics and statistics that were used in order to undertake your research.
- Reflect on the technologies that may have been used to collect the data initially and what technology was used to collate and analyse the data.
- How did you know whether the data was reliable and valid?
- Reflect on your research and what you found. Were you surprised? In what ways? Why?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

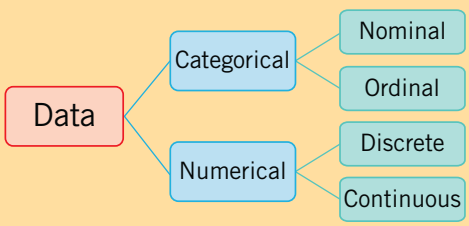
Key concepts

- The goal of the **statistical cycle** is to use evidence-based information to answer a question, to make a decision, or to make a prediction.

The statistical cycle

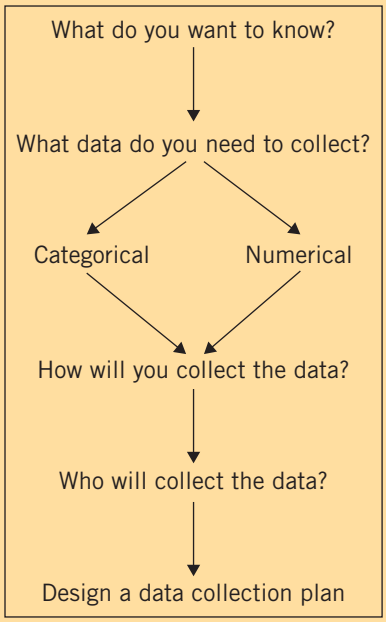


- The **type of data** you collect influences how you can present the data and the interpretations you can make from the data.

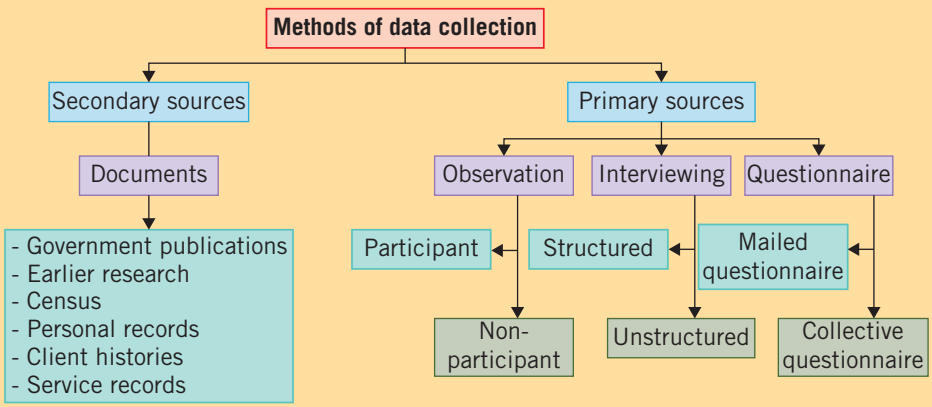


- The **purpose of collecting data** is to answer a question, make decisions, or make a prediction.
  - There are six key questions to make sure your data collection is relevant.
    1. **WHO** is providing the data?
    2. **WHAT** information are you seeking?
    3. **WHEN** is/was the data collected?
    4. **WHERE** is/was the data collected?
    5. **WHY** is/was the data collected?
    6. **HOW** is/was the data collected?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.



- **Methods of data collection**
  - **Primary** data is data that you have planned and collected yourself.
  - **Secondary** data is data that has been collected by someone else.



- **Surveys** or questionnaires are the most frequently used method of data collection.
  - The most common types of survey questions are:
    1. Multiple choice
    2. Short answer

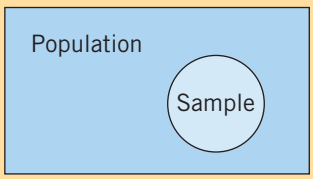
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3 Yes/No or True/False

4 Likert scale

5 Continuum/Slider

- A **census** investigates the whole population.
- A **sample** investigates a subset of the population. A sample should accurately reflect the population to avoid **bias.**



  - **Sampling strategies** include:
    1 Random sampling
    2 Cluster sampling
    3 Stratified sampling
    4 Systematic sampling
- **Possible errors in primary data collection**

  Common sources of garbage input include the following:
  - Cherry-picked data
  - Small or biased samples
  - Multiple responses from the same person (or device)
- **Possible errors in secondary data collection**

  Before you accept information, you should ask the following questions.
  - Who collected the data?
  - What is the data provider's purpose or goal?
  - Is the data current?
  - Where was the data collected?
  - How was the data was collected?
  - Is the data consistent with data from other sources?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Success criteria and review questions

☐ I can identify types of data and know how the different types of data can be used.

1 Give an example of each type of data (nominal, ordinal, discrete, continuous).

2 Answer the following questions for the given data.

i Classify the data as categorical or numerical.

ii Classify the data as nominal, ordinal, continuous or discrete.

iii State whether you could calculate a meaningful average from this type of data.

a Brown, green, green, blue, blue, brown, hazel

b The lengths of jump at the long jump in the school sports competition

c The minimum temperatures recorded in Harrietville for August 2022

d The number of students in each class who buy their lunch at the canteen

e

Strongly agree	15
Agree	25
Disagree	17
Strongly disagree	11

☐ I can identify data collection tools suitable for collecting categorical and numerical data.

3 For the following data collection tools, tick whether they are more likely to be used for collecting categorical or numerical data (or both).

Data collection tool	Categorical	Numerical
a Online survey		
b Focus group		
c Face-to-face groups		
d Observation		
e In-depth interviews		
f Online forums		

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Data collection tool	Categorical	Numerical
g Phone survey		
h Mail survey		
i Web survey chat		
j Online groups		

☐ I can identify when using primary or secondary data is appropriate.

4 For the following topics, suggest at least three pieces of data you would want to gather. For each piece, identify:

- **i** the type of data it is
- **ii** whether you would use primary or secondary sources to collect that data.

a How can we encourage people to use their car less?
b How do we want to celebrate our end-of-year graduation?
c How widespread is rental stress in this neighbourhood?
d Is global warming real?
e Do people spend more time indoors in winter?

☐ I can identify the type of sampling that would be most effective in avoiding bias.

5 For the following survey topics, state the type of sampling that would be most effective in avoiding bias. Explain how this would avoid bias.

a The genres of music people prefer
b Whether people aged over 60 undertake regular exercise
c Vaping
d Regional public transport use
e Crop yields in the Wimmera

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

☐ I can identify the format of survey questions, identify the best source of information and gather the right type of data.

6 Answer the following for the survey questions below.

- **i** List the question format(s) that would be suitable to collect data to answer each question.
- **ii** Name the type of data collected with this format: nominal, ordinal, discrete or continuous. There could be more than one format for some of the survey questions.

a What sport do you play on the weekend?
b How do you rate the service you received at the restaurant?
c Why do you think 16-year-olds should be able to get their P plates?
d How many times did you wake up last night?
e Do you think Australia should become a republic?
f What is your opinion of the Australian national anthem?
g What time did you go to bed last night?

7 Write two different types of survey questions that would collect information about the time students spend in part-time work. What type of question is each of the questions you have written?

☐ I can review data sources and how data is collected to help identify if the data is likely to be valid and reliable.

8 For each of the scenarios below, would you classify the data as potentially fake or biased or is it more likely to be valid and reliable?

a A Year 12 student surveys 60% of their fellow Year 12 students about where the Year 12 students should go for their end-of-year celebration.
b A set of data is released by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) about food wastage across Australia.
c A survey of all 10 members of a rowing club's committee of management about whether to increase the annual membership fees. The club has a total membership in excess of 100 people.
d A popular radio show host holds an anonymous online poll of their listeners about whether their morning show is the best radio show.
e The Australian Bureau of Statistics (ABS) publishes annual data about the average weekly earnings of workers.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mathematical toolkit

1 Reflect on the range of different calculations, technologies and tools you used throughout this chapter, and how often you used them for undertaking your work and making calculations. Indicate how often you used and worked out results and outcomes for each of these methods and tools.

Method and tools/ applications used	**How often did you use this?**
• Calculating and working in your head, and using algorithms	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using pen-and-paper	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using a calculator	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using a spreadsheet	Not at all: ☐ A little: ☐ Quite a bit: ☐
• Using measuring tools – name the tool, technology or application: _____ _____	Not at all: ☐ A little: ☐ Quite a bit: ☐ Not at all: ☐ A little: ☐ Quite a bit: ☐
• Using other technology or apps – name the technology or application: _____ _____	Not at all: ☐ A little: ☐ Quite a bit: ☐ Not at all: ☐ A little: ☐ Quite a bit: ☐

2 Did this chapter and the activities help you to better understand how you use different tools and technologies in using and applying mathematics in our lives and at work? In what areas and ways? Write down some examples.

3 In one sentence, explain something relating to tools and technologies that you learned in the unit. Write an example of what you learned.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key vocabulary

Here is a list of this chapter's key maths terms and their meanings.

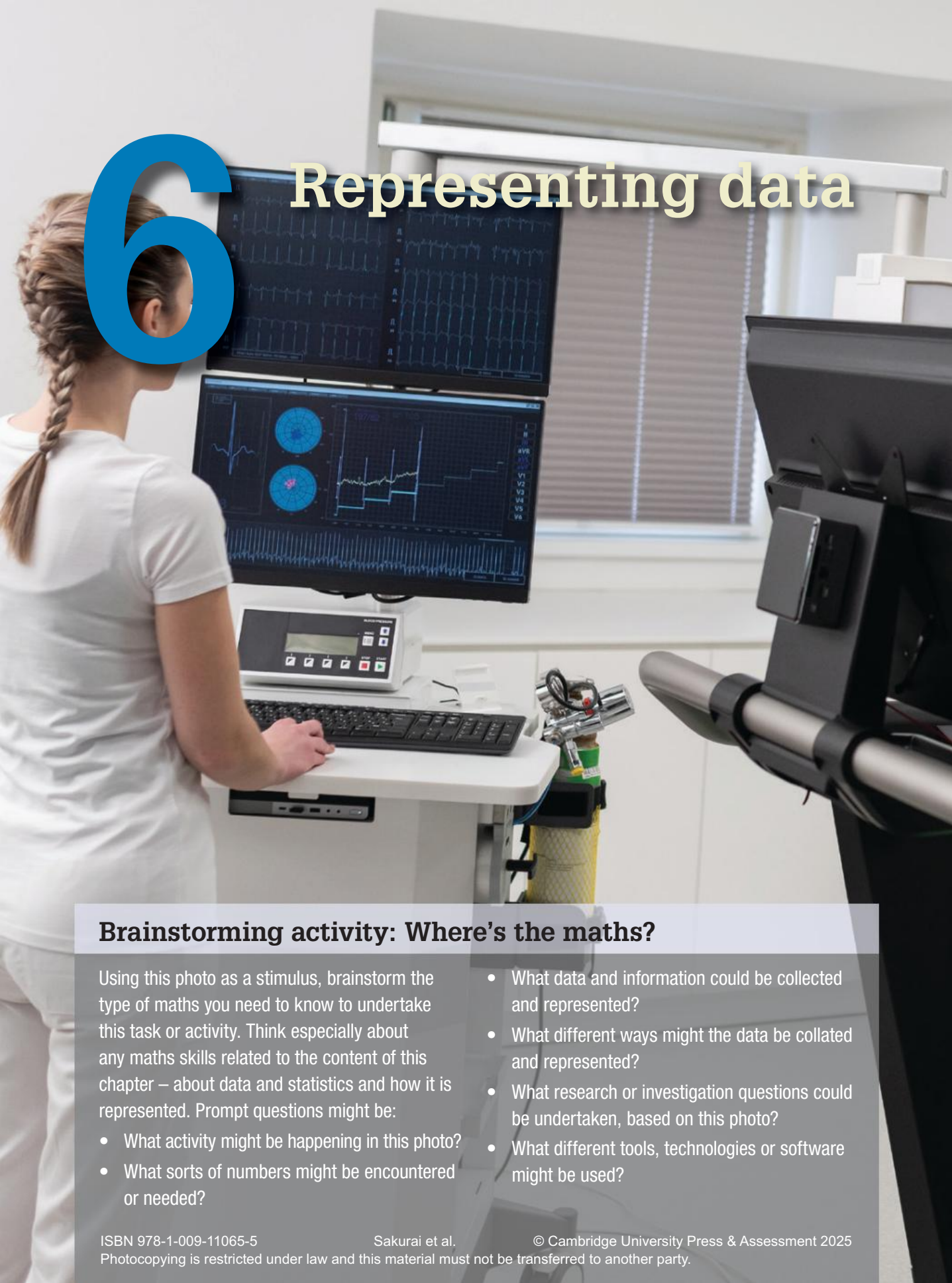
Term	Meaning
Algorithm	A process that can be carried out systematically using a well-defined set of instructions to perform a particular task or solve a type of problem.
Big data	Collecting and analysing vast data sets that you cannot collect or analyse by hand; however, with technology it is possible to interrogate the data.
Categorical	Data that describes categories, e.g. favourite colours: red, blue etc., where the idea of 'average' does not make sense. Also referred to as *qualitative*.
Census	A census investigates the total population. This method is used when you need accurate information for an entire population.
Cherry-picking	Cherry-picking data is the deliberate practice of only collecting and analysing the results of a survey or data collection that best support the data collector's own perspectives or arguments, instead of using and reporting on all the data.
Cluster sampling	The population is grouped into clusters which are then randomly sampled.
Continuous	Continuous data can, in principle, assume all possible values in a given interval – often we say it can be measured. For example, time, height and weight are continuous data.
.CSV	A comma-separated value file format allows data in a table to be saved as a text file.
Discrete	Discrete data is information (data) that can only take certain values – often we say that the values can be counted. For example, the number of students in a class, or the number of different coloured cars in a carpark are discrete data.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Term	Meaning
GIGO	'Garbage in, garbage out' means that if the data collection or analysis is flawed, the resulting analysis is also flawed.
Nominal	Categorical data that cannot be ordered.
Numerical	Data that describes quantities or amounts in numbers, e.g. number of pets 0, 1, 2 etc. Also referred to as *quantitative*.
Ordinal	Categorical data that can be put in order, such as a happiness scale, e.g. 1 Unhappy, 2 Neutral, 3 Happy.
Primary data	Data that the researcher has planned and collected.
Qualitative	See *Categorical*.
Quantitative	See *Numerical*.
Random sampling	Where every individual has an equal chance of being selected.
Reliability	Used to judge the source of secondary data.
Sample survey	Investigates a subset of the population. A sample should accurately reflect the population to avoid bias.
Secondary data	Data that has been planned and collected by someone else.
Statistical bias	Any type of error or distortion that is found with the use of statistical analyses.
Stratified sampling	Groups with similar attributes are selected from the population, e.g. students from particular year groups.
Systematic sampling	Every *n*th individual on a list is included, such as every 5th individual in the alphabetical list of Year 12 students.
Validity	Survey methods and data analysis are suitably designed to test what the researcher intends to test.
.XLS or .XLSX	Formats for Excel spreadsheet files.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6 Representing data

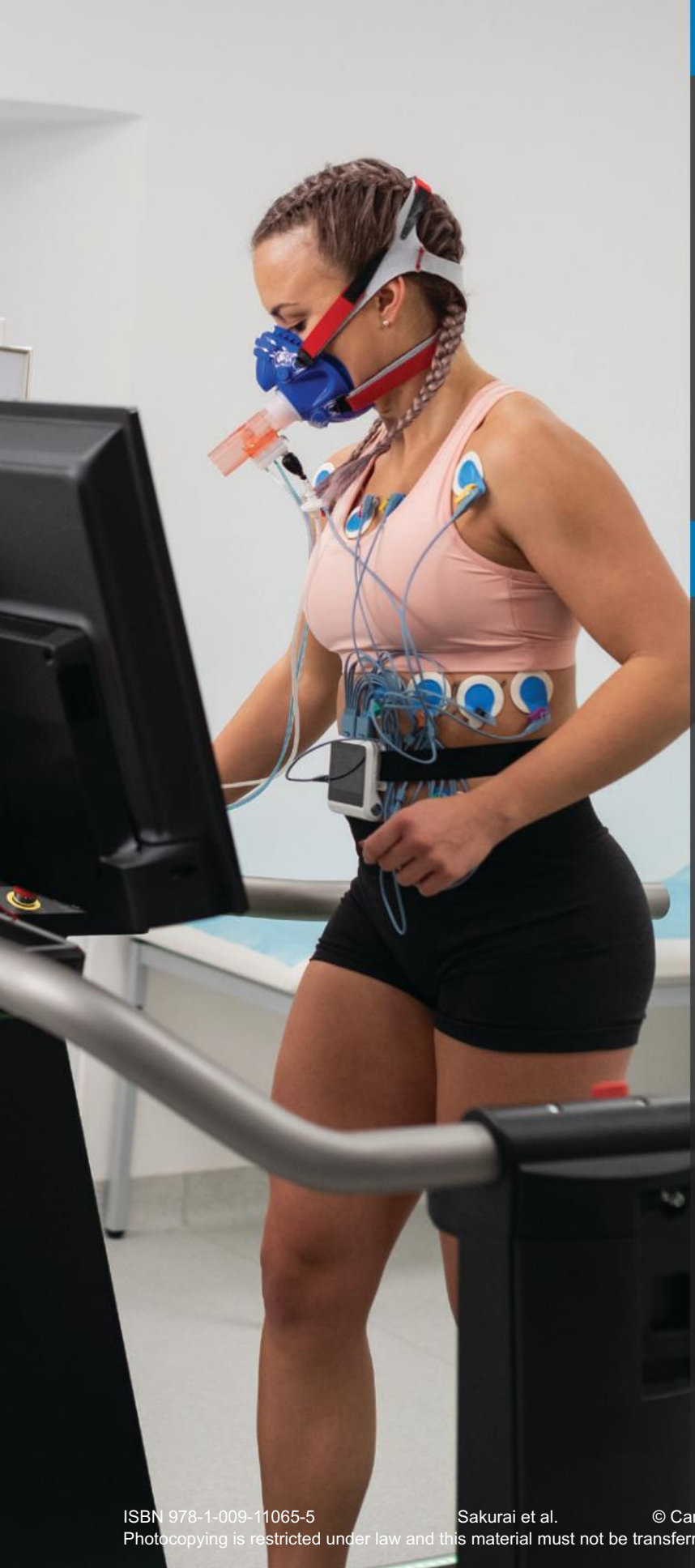


Brainstorming activity: Where's the maths?

Using this photo as a stimulus, brainstorm the type of maths you need to know to undertake this task or activity. Think especially about any maths skills related to the content of this chapter – about data and statistics and how it is represented. Prompt questions might be:

- What activity might be happening in this photo?
- What sorts of numbers might be encountered or needed?
- What data and information could be collected and represented?
- What different ways might the data be collated and represented?
- What research or investigation questions could be undertaken, based on this photo?
- What different tools, technologies or software might be used?

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.



Chapter contents

Chapter overview and Spotlight

6A Starting activities

6B Tuning in

6C Collating data in tables

6D Refresher on common graphical representations

6E Creating graphs and charts using Excel and Word

6F Contemporary graphs

Investigations

Chapter review

From the Study Design

In this chapter, you will learn how to:

- collect, organise, collate and represent categorical and numerical data, including continuous data
- use technology effectively and appropriately for accurate, reliable and efficient collation and representation of data sets
- draw inferences and conclusions, and explain any limitations and implications of a statistical study

(Units 3 and 4, Area of Study 2)

© Victorian Curriculum and Assessment Authority 2022

ISBN 978-1-009-11065-5 Sakurai et al.

© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter overview

Introduction

In the previous chapter, we looked at aspects of collecting data in a systematic and valid way, and then collating and organising it. This chapter moves on to looking at the different ways of representing data in visual or graphic formats, including using contemporary graphs.

In recent years, the use of graphs and charts has become increasingly prevalent across various domains – in the media, by marketers and businesses, in social media and by governments, alongside the fact that their generation has become automated by everyday apps and software.

Charts, graphs or forms of maps, help identify patterns, trends and insights that might not be immediately apparent from a set of numerical data alone. Graphs and charts tell a story with the data – making complex information digestible at a glance. Graphs reveal patterns and trends that numbers and words alone cannot capture – they provide context and allow for comparisons. Our brains can process visual information more efficiently than raw data.

In the next chapter, we will proceed with the calculation of summary data about typical or central values such as the mean or median, and measures of the spread of the data in values such as the range or standard deviation.

The intention is to develop a solid foundation in 'statistical literacy' in readiness for applications that we will inevitably meet in our personal and community lives, in the workplace and in the context of ideas across a range of everyday media.

Learning intentions

By the end of this chapter, you will be able to:

- understand and apply the conventions of representing data graphically
- read and interpret tables, charts and graphs, including contemporary representations
- create familiar graphs using built-in tools in software such as Microsoft Excel and Word
- use statistical language.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Spotlight: Regine Abos

An interview with a data visualisation designer

Tell us about your job and some of the work that you do.

I am a data visualisation designer, which means I take research data given to me by highly technical people, like engineers and industrial designers, and I translate the data into a more digestible form like a graph, chart or other visualisations. The goal of data visualisation is to speak to different intended audiences and stakeholders, like the general public, people in government, or people who work in a similar field like architects or communications designers. I also lecture at the RMIT University, where I teach students the principles and guidelines for translating data ethically and also effectively in an engaging way. In the past, I've worked on a number of different projects, but one particularly interesting one involved research into how scientists and researchers trying to preserve Antarctica are ironically destroying Antarctica in the process. I was involved in visualising some shocking data that demonstrated the disruptive impact these researchers were having on the delicate ecosystems of Antarctica.

What maths do you use regularly in your work?

I deal with reams and reams of Excel spreadsheets full of raw data. My role is to then identify numerical patterns in the data and make a decision as to what data to include and what to exclude. This puts me in a position of power and I need to be careful about what data I am selecting. When looking at patterns, I try to see what pattern shapes the particular story that the collectors of the data want me to tell. So, essentially, I work as a translator. When representing the data, the maths involved includes arranging data from highest to lowest as well as grouping the data into categories.

What is the most useful tool or piece of technology in your work?

Excel gets a real workout from me and is how I access the technical data that I receive in the form of a spreadsheet. I sometimes also use SPSS (a statistical software) if the data is more statistics based. Both these programs automatically do the calculations for me and spurt out some charts and graphs. However, I find that these generic graphs and charts are not engaging at all and often tell the wrong story by emphasising data that is not essential to the story. So, I then use Adobe Illustrator and InDesign alongside my training as a graphic designer to rejig the graphs and charts to tell the 'correct' story in a more visually appealing and engaging way.

What was your attitude towards learning maths in school?

I liked learning at school, but I wasn't particularly good or bad at maths. Even at school I always was intrigued by the translation of the numerical into the visual and liked the graphing side of maths.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6A Starting activities

Activity 1: Growing up

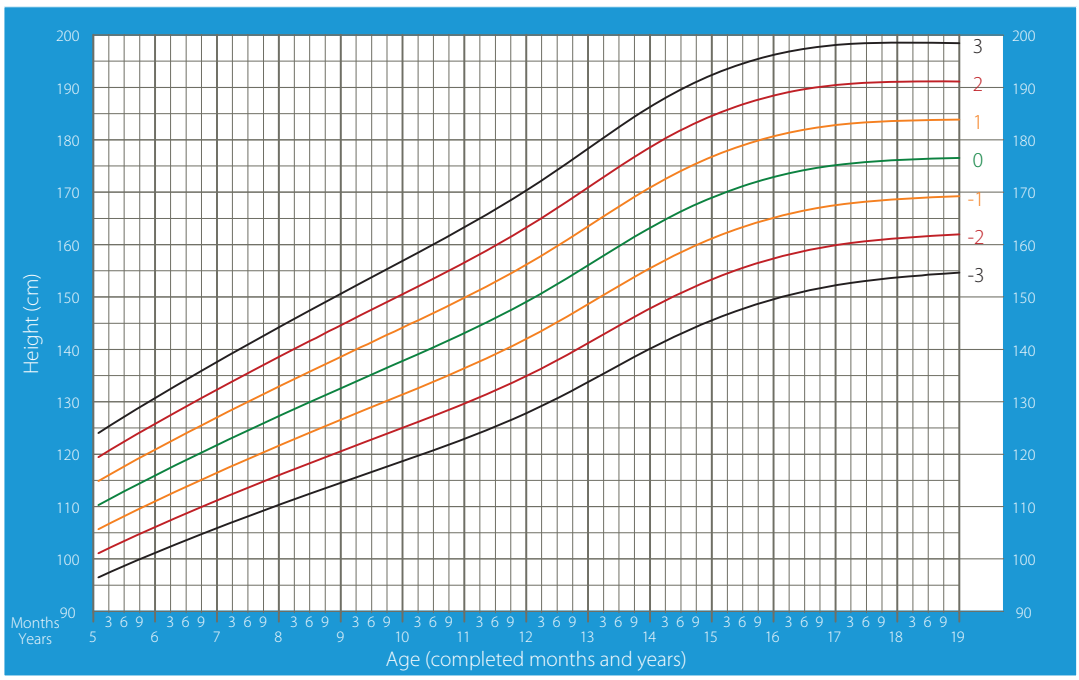
When you were growing up did you measure and mark your height on the wall or a door jamb? Do you remember the excitement when you had grown and could put a new mark on the wall? Or when your mark was higher than that of your siblings?

The World Health Organization (WHO) has developed charts for measuring expected height for age of children (and teenagers) aged 5–19 years. The following chart is for boys aged 5–19 years.

Height-for-age BOYS

5 to 19 years (z-scores)

World Health Organization



2007 WHO Reference

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Here is a table of Brin's growth.

Brin's growth	
Age (in years)	**Height (in cm)**
5	105
6	108
7	115
8	121
9	132
10	136
11	140
12	148
13	154
14	159
15	165
16	167
17	169
18	170

1 Use technology to graph Brin's age and height.

2 On the same graph, plot the average line from the WHO growth chart above.
Hint: The average line is given the code '0'.

3 Brin grew at different rates during different years. Determine in which years Brin grew the fastest and explain how the data shows this.

4 In comparison with the WHO growth chart, was Brin above or below average? For which ages?

Activity 2: Weather bomb

During March of 2022 there were serious floods in Queensland and NSW with loss of life, animals, homes and infrastructure. The rain during these times of flood was so heavy it was described in the media as a 'rain bomb'.

Communities in the flood-affected areas united as they rescued each other and clothed, fed and housed displaced people.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

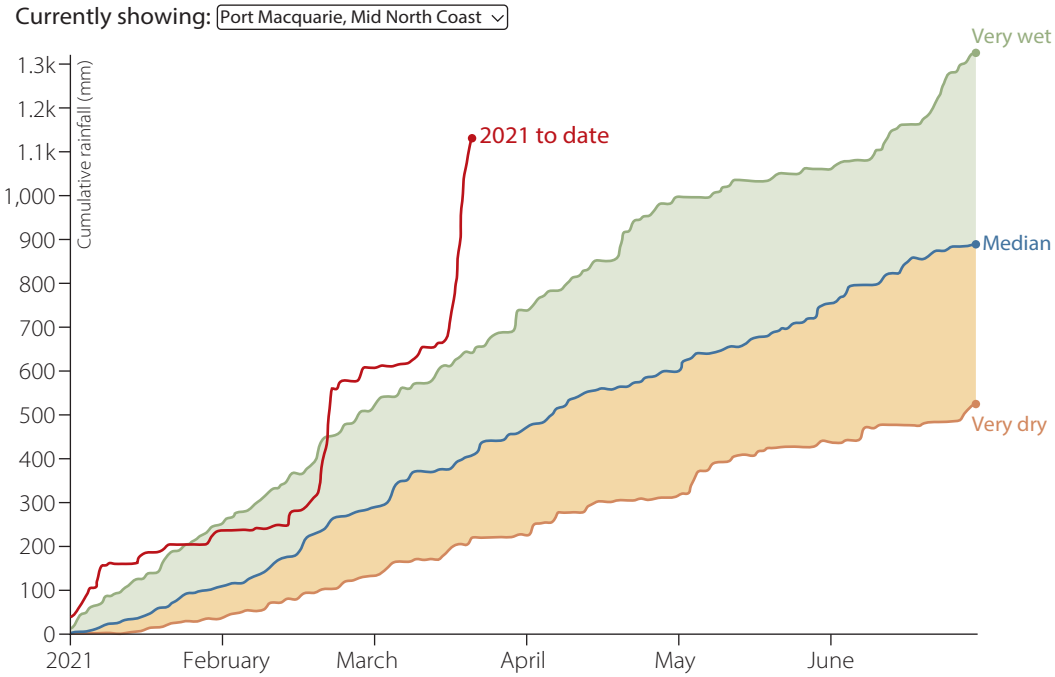
The following four graphs tell different aspects of the flood story.

Graph A

2021 floods: cumulative rainfall vs. long-term averages

Showing daily cumulative rainfall for 2021 versus the median, 10th percentile (very dry) and 90th percentile (very wet) of historical daily cumulative rainfall values. Historical data is from 1900 to 2020

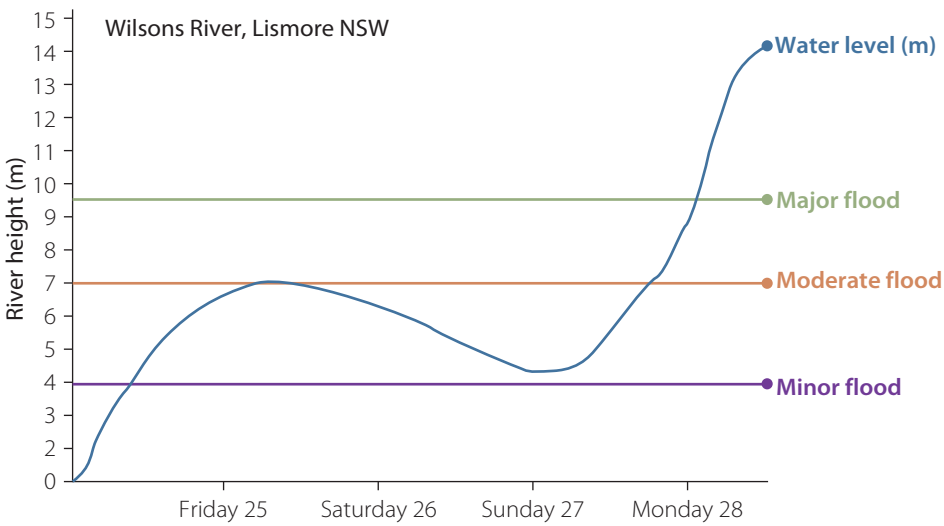
Currently showing: Port Macquarie, Mid North Coast



Source: Bureau of Meteorology

Graph B

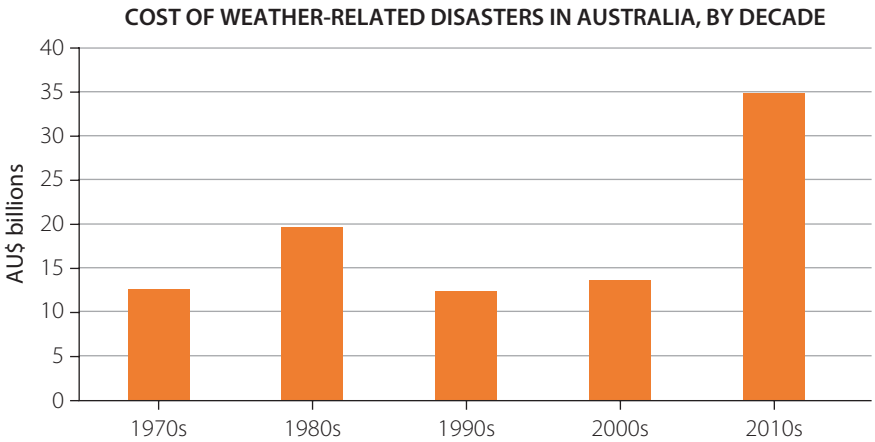
HEIGHT OF THE WILSONS RIVER AT LISMORE COMPARED WITH FLOOD THRESHOLDS



Source: Bureau of Meteorology

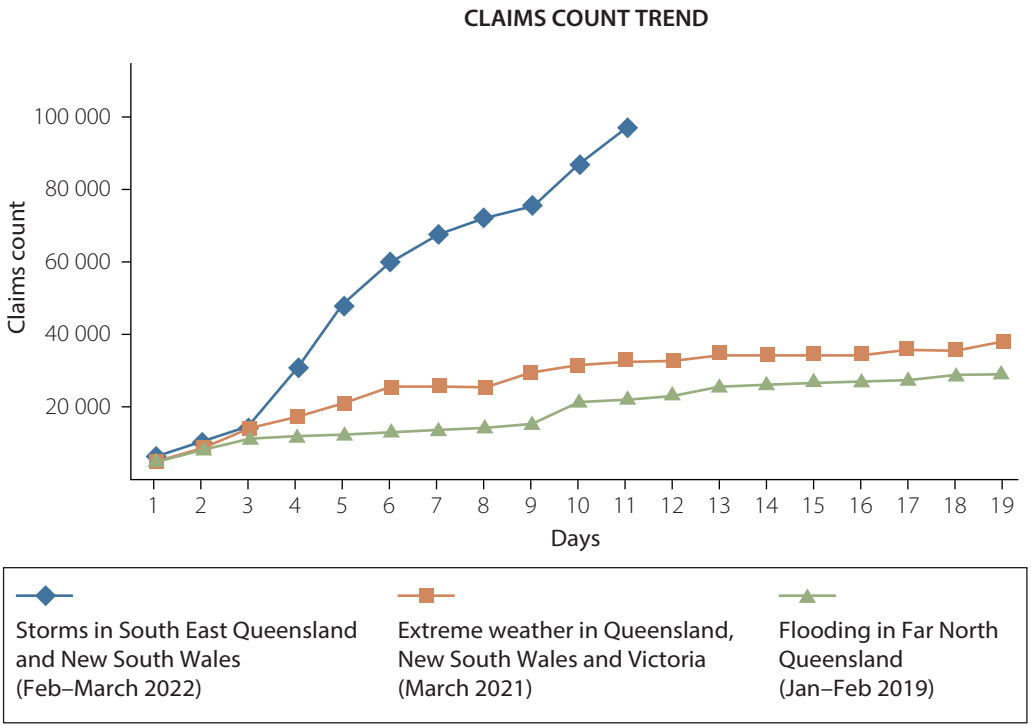
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Graph C



Source: EM-DAT, Climate Council

Graph D



Source: Insurance Council of Australia

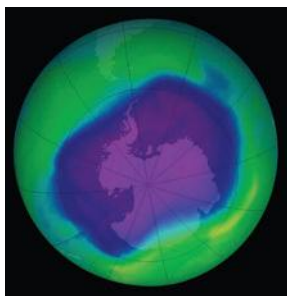
Answer the following questions for each graph A, B, C and D.

1. Explain the heading.
2. State what type of graph you are looking at.
3. Give a key message from the graph.
4. Make a future prediction from the graph.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6B Tuning in

Epic Success: NASA saved the world!



In 1988, the USA's National Aeronautics and Space Administration (NASA) made a discovery through their collection of data that literally saved the world!

As well as studying space, NASA also studies Earth and its atmosphere. From about 1915, scientists started collecting data from high atmosphere clouds. By 1985, scientists at NASA began sounding the alarm on a growing class of chemicals known as chlorofluorocarbons or CFCs for short. They found that the amount of ozone in the atmosphere had dropped in 1985 by 67%. Without ozone, there is no filtering of harmful ultraviolet (UV) rays preventing them entering Earth's atmosphere.

NASA sent high altitude aircraft to carry out scientific measurements to determine the cause of the drop. By 1988, Mario and Luisa Molina had discovered the chemical reaction that was occurring high up in the atmosphere and destroying the ozone layer. This reaction was directly attributed to the CFC chemicals that were being produced and used on Earth for refrigeration, air conditioning and aerosol sprays.

The world listened to the scientists, and governments acted fast, banning or curtailing the use of CFCs in many countries. Without this intervention it is a widely held belief that life on Earth would become intolerable by 2065!

The data that NASA collected, displayed, interpreted and communicated to the world, literally saved the world.

Today, the ozone hole sits roughly over the Pacific Ocean encompassing parts of eastern Australia, New Zealand and Antarctica. The hole shifts with the high-altitude winds and weather.

That is why we have a UV watch on our weather apps in Australia, and why we should wear sunscreen when outside.

Discussion questions

1. How do scientists know other scientists are telling the truth about their data?
2. What is a reliable source of data?
3. What might be some unreliable sources of data?

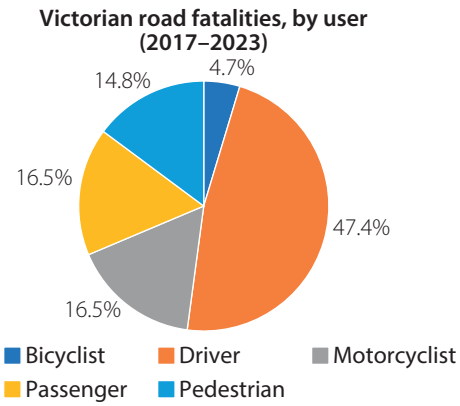
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Practice questions

1 For each of the following data displays, state:

- **i** what the graphs or charts are about
- **ii** what kind of display they use
- **iii** a key message from the data.

a



Source: Transport Accident Commission

b

Source: Transport Accident Commission

c

Sources: State Revenue Office, Victorian Gambling and Casino Control Commission

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6C Collating data in tables

How do you know that the chocolate bar you buy is actually the weight that it is supposed to be? Or that the size of the tee-shirt that you are thinking of buying online will fit?

In Australia we have strong consumer laws that protect us when we are buying things. So, companies need to monitor the quality and stated sizes of goods and materials they produce or sell.

It is common when undertaking any form of data collection for a statistical investigation that the data collected will be organised and represented in tables, often the first step in the data analysis process.

For example, a food packaging company needs to keep track of the accuracy of their pack sizes. Peanuts might be sold as '50 gram' size but the actual weight will vary slightly from one packet to the next.

This checking is done by randomly sampling packets from the production line and weighing them accurately. The raw data is collected in a table or spreadsheet that might look like this.

Weight Check Sheet

Item: Peanuts Date: 11/3

Size: 50 Gram

51.2	52.7	58.4	50.4	57.1
52.4	48.6	52.5	51.4	50.2
50.5	50.0	51.2	54.0	54.5
55.7	59.1	49.3	49.7	54.9
51.1	52.5	60.7	55.7	52.0
58.2	51.4	56.6	52.5	53.4
59.5	56.0	51.3	56.1	56.0
51.6	52.9	52.5	51.5	53.6
57.8	57.7	50.7	59.9	49.3
54.1	51.4	56.9	58.4	61.0

We can fairly easily spot the **minimum 48.6** and the **maximum 61.0** but this table is too difficult to analyse because the data is entered randomly.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

A summary table is constructed to show the weights as grouped data in a **frequency table**.

Weight of packets, g	Tally	Frequency
48 –	||||	4
50 –	𝍸 𝍸 ||||	14
52 –	𝍸 𝍸	10
54 –	𝍸 ||	7
56 –	𝍸 ||	7
58 –	𝍸 |	6
60 – 62	||	2
	total	50

Note:

- The data in this table has a large number of different values so the weights are grouped into **class intervals** of size 2 grams: 48– , etc. up to 60–62.
- These values are decided by scanning the raw data.
- Typically, the class interval size is chosen so that there are about 5 to 8 rows in the summary table.
- The total of 50 in the frequency column matches the 50 scores in the raw data check sheet.

We will look further into class intervals in the next chapter. The class intervals in this example can be written in different ways. Each class interval is 2 grams and the first one (48–) means it is all the packets that weigh from 48.0 grams up to but not including 50 grams, the next class interval (50–) means all the packets weighing from 50.0 grams up to but not including 52 grams. Sometimes we can write these intervals as 48–49.9, 50–51.9 etc.

We can further analyse the data by including the relative frequency of each interval, and the percentage frequency of each interval.

The **relative frequency** of each class interval gives the proportion of values that occur in the class interval and is calculated using the formula:

$$\text{Relative frequency} = \frac{\text{frequency}}{\text{total frequency}}$$

The **percentage frequency** is the relative frequency expressed as a percentage:

$$\text{Percentage frequency} = \frac{\text{frequency}}{\text{total frequency}} \times 100$$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Weight of packets, g	Frequency	Relative frequency	Percentage frequency
48 –	4	0.08	8%
50 –	14	0.28	28%
52 –	10	0.20	20%
54 –	7	0.14	14%
56 –	7	0.14	14%
58 –	6	0.12	12%
60 – 62	2	0.04	4%
total:	50	1.00	100%

From this table, we can see that nearly half of the packets sampled are in the 50–53.9 g intervals, and that only 8% of the packets are underweight. The company would need to decide whether this performance is satisfactory, both for a consumer's perspective, but also from the company's perspective in terms of wastage and making packets weigh more than necessary.

This sort of statistical analysis is standard procedure for a company's operations, so that they can monitor their performance and quality of their packaging and production processes. They can use the data to recalibrate their machinery if needed.

Example 1 Choosing class intervals for a frequency table

In the history of Australian basketball (NBL), there have been 55 times when a player has scored 50 points or more in a game. The highest ever score by one player is 71 points. What would be suitable class intervals to use in a frequency table of this data?

THINKING	WORKING
STEP 1	
Work out the range by subtracting the lowest value from the highest value.	Range = 71 – 50 = 21 points
STEP 2	
To have a suitably sized table, we usually prefer to have between 5 and 8 class intervals.	So, we could have: 5 class intervals with 5 points in each (5 × 5 = 25) or 6 class intervals with 4 points in each (6 × 4 = 24)
STEP 3	
Write some possible class intervals that would be suitable.	Suitable groupings might be: By 5 points: 50–54, 55–59, 60–64, 65–69, 70–74 or By 4 points: 50–53, 54–57, 58-61, 62–65, 66–69, 70–73

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

When there are only a small number of different data values (usually less than about 10) they may not need to be grouped into class intervals to be displayed in a frequency table.

For example, the table below shows the number of computers borrowed from the resource centre each weekday in the month of February.

8	6	4	7	5
8	6	5	7	8
6	7	8	4	3
8	5	8	6	5

A frequency table for this data might look like this.

Number of computers borrowed	Tally	Frequency
3	|	1
4	||	2
5	||||	4
6	||||	4
7	|||	3
8	𝍸 |	6
	Total	**20**

Categorical data can be displayed in a frequency table in the same way.

Favourite dog breed	Tally	Frequency
Beagle	|||	3
Pug	|	1
German Shepherd	|||	3
Poodle	𝍸	5
Jack Russell Terrier	||	2
Labrador	𝍸 |	6
	Total	**20**

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6C Tasks and questions

Thinking task

1 If you were collecting data about the height of your classmates, what class intervals would you use? Explain why.

Skills questions

2 You need to analyse data for scores in AFL football.

a What class intervals would be suitable for creating a summary table showing the total game scores of teams?

b What class intervals would be suitable for creating a summary table showing the number of goals per game for all teams?

c What class intervals would be suitable for creating a summary table showing the winning margin per game for all games?

d Would you use different class intervals if you were analysing the Under 8's league results?

3 What would be appropriate class intervals for data collected about these scenarios?

a Weights of the fish caught in a fishing competition

b Character limits of a TikTok post

c Ages of residents in an aged care home

d Times taken by competitors in a community fun run over 10 kilometres

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4 The number of parents that come to the school office to drop off lunch boxes for students over a 3-week period are:

0	2	5	4	0
1	2	1	0	3
0	0	2	3	4

a When constructing a frequency table of the data, would it be appropriate to use class intervals? Why or why not?

b Construct a frequency table for the data.

5 Analyse the table below to answer the questions that follow about gambling in Victoria.

Player loss and taxes ($ million) paid by category activity, 2021–22

Source	Player loss ($million)	Taxes and levies paid into the consolidated fund ($million)
Gaming machines – hotels and clubs	2,237.2	846.2
Melbourne casino – gaming machines and table games	644.6	114.4
Wagering – racing (totalisator), football, trackside and sports betting	775.7	77.6
Lotteries (Victoria only)	788.3	626.3
Keno	16.5	4.0
Total	**4,462.3**	**1,668.4**

Source: Victorian Gambling and Casino Control Commission

a What is the largest source of player loss?

b Is this loss reflected in the taxes and levies paid to the government?

c Calculate the percentage of taxes and levies paid against the player loss for gaming machines. Round your answer to 1 decimal place.

d Calculate the percentage of taxes and levies paid against the player loss for lotteries. Round your answer to 1 decimal place.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mixed practice

6 The school canteen needed to plan its menu for winter, so the manager recorded how many hot meals were sold daily for a month. Here are the results:

16, 22, 14, 8, 37, 19, 12, 30, 19, 5, 24, 27, 13, 15, 23, 6,
20, 17, 9, 15, 18, 24, 19, 14, 16, 17, 18, 27, 13, 19, 13

a Decide on an appropriate class interval for this data.

b Construct a table to record the data using the class interval that you have selected.

7 Use the table below to answer these questions.

a List the top four industries, in descending order, which pay the highest average weekly earnings.

b List the bottom two industries for average weekly earnings.

c Calculate the percentage of average weekly earnings for 'Accommodation & food services' against that of 'Mining'. Round your answer to 1 decimal place.

d Explain how the 'All industries' figure would have been calculated.

Average weekly ordinary time earnings, full-time adults by industry, original

Industry	Persons ($)	Males ($)	Females ($)
Mining	2,854.00	2,941.80	2,484.50
Manufacturing	1,631.10	1,673.40	1,486.20
Electricity, gas, water & waste services	2,155.40	2,199.50	1,992.80
Construction	1,802.80	1,833.40	1,601.10
Wholesale trade	1,685.00	1,762.40	1,508.90
Retail trade	1,383.70	1,468.30	1,283.10
Accommodation & food services	1,346.80	1,402.70	1,267.40
Transport, postal & warehousing	1,799.70	1,844.70	1,634.20
Information media & telecommunications	2,317.90	2,445.20	2,055.50
Financial & insurance services	2,159.70	2,376.80	1,919.40
Rental, hiring & real estate services	1,719.70	1,851.40	1,572.10
Professional, scientific & technical services	2,170.90	2,404.20	1,857.40

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Average weekly ordinary time earnings, full-time adults by industry, original			
Industry	**Persons ($)**	**Males ($)**	**Females ($)**
Administrative & support services	1,616.40	1,741.10	1,428.30
Public administration & safety	1,964.50	2,011.70	1,906.50
Education & training	1,949.70	2,072.20	1,886.20
Health care & social assistance	1,807.70	2,124.20	1,678.50
Arts & recreation services	1,653.30	1,757.20	1,510.30
Other services	1,382.70	1,437.20	1,309.50
Total all industries	**1,838.10**	**1,938.30**	**1,686.00**

Source: Australian Bureau of Statistics

Mathematical literacy

8 Think about the terminology and the words we use related to collating, creating and interpreting data that is organised into tables, including when we have the data in a spreadsheet. Work in pairs to think about the words we use, including when looking at features, trends and differences in or between different sets of data. Share your words and terms with other students in the class.

Application tasks

9 Use the table to answer the following questions about the monthly **change** in the percentage that households spent on different goods and services.

Household spending through the year by category, current price, calendar adjusted			
	Mar-23 (%)	**Apr-23 (%)**	**May-23 (%)**
Food	8.9	7.1	5.8
Alcoholic beverages & tobacco	–0.4	–0.9	0.5
Clothing & footwear	2.4	–1.7	–3.4
Furnishings & household equipment	–5.6	–2.7	–4.8
Health	11.0	9.3	6.1
Transport	14.9	14.3	7.7
Recreation & culture	1.3	–2.9	–3.2
Hotels, cafes & restaurants	17.3	8.3	7.8
Miscellaneous goods & services	3.7	4.1	7.6

Source: Australian Bureau of Statistics

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

a What is the overall household spending trend in this data?

b Which categories do not follow this trend?

c What do you think could be covered in the Miscellaneous goods & services category?

d Find the total percentage for each month.

e Explain why these percentages do not add to 100.

f Explain whether you think that this data is sufficient to make long-term predictions.

g What other questions would you ask of this data?

10 Use the table below to answer the questions that follow.

Grams of protein per person per day					
Africa	1961	53.4	India	2020	66.5
Africa	2020	64.7	Indonesia	1961	35.2
Asia	1961	47.5	Indonesia	2020	69.3
Asia	2020	83.0	North America	1961	89.0
Australia	1961	104.8	North America	2020	104.3
Australia	2020	114.1	Oceania	1961	99.6
China	1961	39.3	Oceania	2020	95.6
China	2020	107.7	Pakistan	1961	54.0
Europe	1961	90.6	Pakistan	2020	66.6
Europe	2020	106.0	Rwanda	1961	46.1
India	1961	52.3	Rwanda	2020	55.5

Source: Food and Agriculture Organization of the United Nations

a Which four regions or countries had the highest consumption of protein per person in 1961? Are these the same in 2020?

b What is the overall trend in consumption of protein per person in this time frame?

c Are there any regions that do not follow this trend? If so, list these regions.

d Some of this data is not easy to read in the format provided in the table. What could you do to make it easier to read and interpret this data? Explain what you would do and why.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6D Refresher on common graphical representations

Graphs are an easy and quick way to look at information; to see what is going on, rather than having to read and understand lots and lots of numbers. You will see graphs in social media, in newspapers and magazines, and on leaflets and brochures, and often on bills.

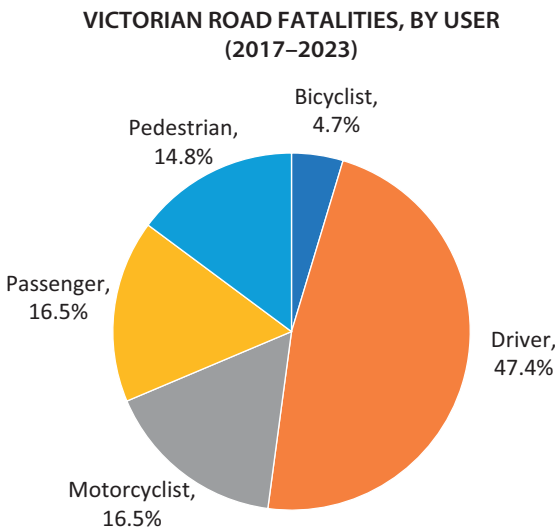
Types of graphs

The most common graphs you see are pie charts, bar graphs (also called column graphs), histograms and line graphs. There are related versions of a number of these that we will look at too. Another graph that you need to know is the stem-and-leaf plot.

Pie charts

A **pie chart** is a circular chart where values are indicated by the size of the piece or 'slice' of the circle. A pie chart is very useful for visually comparing different and alternative factors or categories of the one, whole issue.

Here, the example shows the data for Victoria regarding the type of fatalities in road crashes by user from 2017 to 2023.



Source: Transport Accident Commission

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

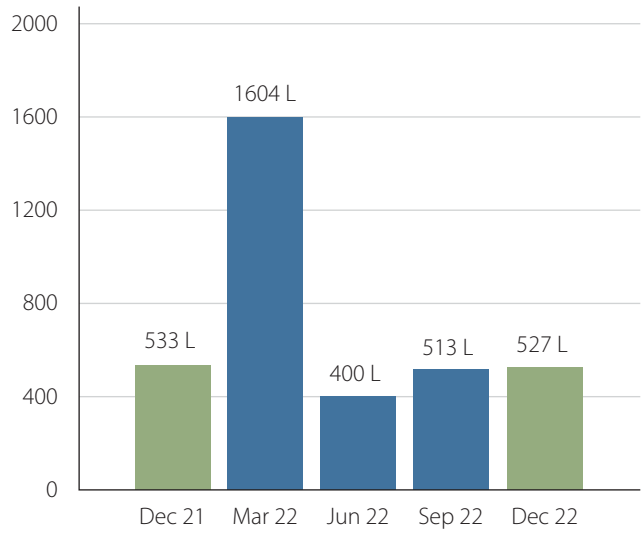
Bar or column graphs

A **bar graph** or **column graph** is a chart with tower-like bars or columns representing the value or frequency of whatever is being measured or graphed. The bars can sometimes go horizontally – this is when it is often more appropriate to call it a bar graph, compared to a column graph.

This example shows a graph taken from a water bill – it displays the water usage for a household over the past year.

Your household's daily water use

Target 155 L of water use per person, per day.



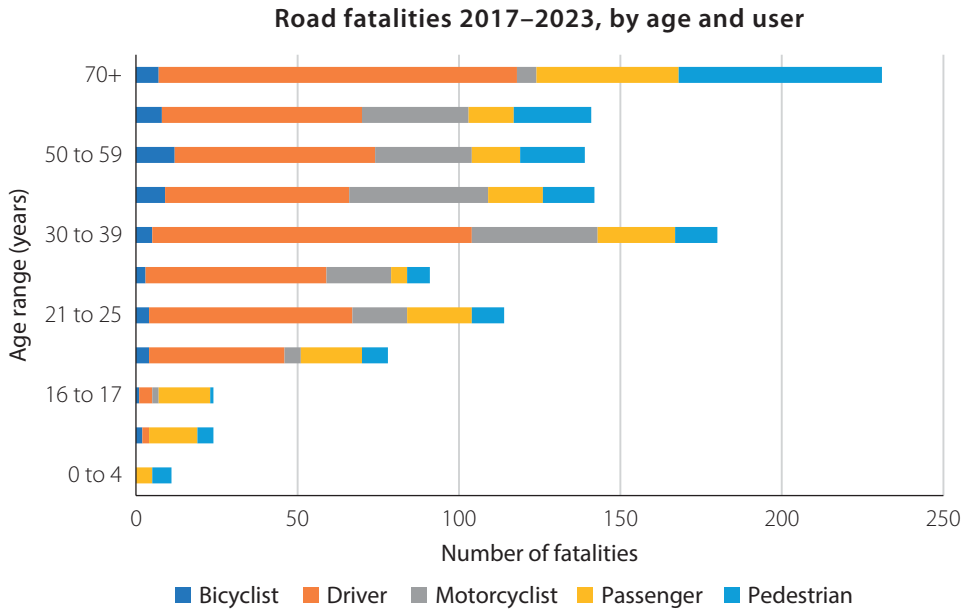
There are other related graphs based on bar graphs. One is a **stacked bar graph** (or stacked column graph), and the other is a **histogram.**

Stacked bar or column graphs

Stacked graphs depict items stacked one on top of the other (column) or side-by-side (bar), differentiated by coloured bars or strips. A stacked bar graph allows you to add in an extra variable to the data – the first (and main) variable is shown along the entire length of the bar, and the second variable is represented as stacks within each bar.

The graph on the following page is an example where the road fatality data for Victoria shows not only the data for the different age groups, but within each bar it also shows you the proportion of the subcategories of the road user.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.



Source: Transport Accident Commission

While stacked graphs are helpful for conveying multiple levels of meaning at the same time, they also have some drawbacks. Though it is fairly easy to interpret the values for the first bar or first strip in the graph, it can be difficult to judge the exact widths of any subsequent strips, or to compare the widths of two strips, as you can see in the example above.

Histograms

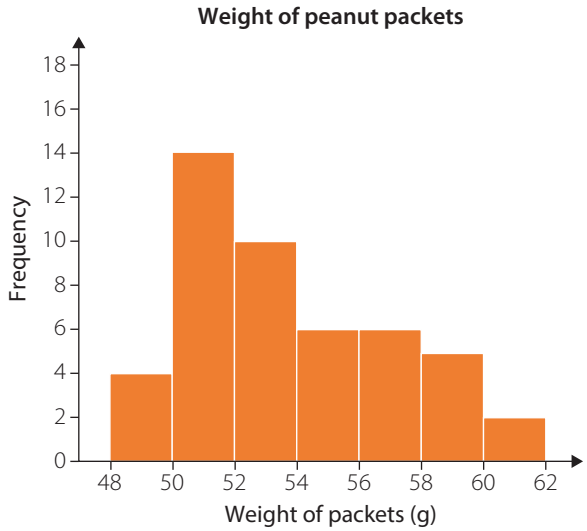
A **histogram** is similar to a bar chart, except that the bars represent groups or class intervals, and the heights of the bars represent the frequency for each class interval.

Using the frequency table for peanut packets from section 6C, we can construct a histogram to represent this data.

Weight of packets, g	Tally	Frequency
48 –	||||	4
50 –	𝍸 𝍸 ||||	14
52 –	𝍸 𝍸	10
54 –	𝍸 ||	7
56 –	𝍸 ||	7
58 –	𝍸 |	6
60 – 62	||	2
	Total	50

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

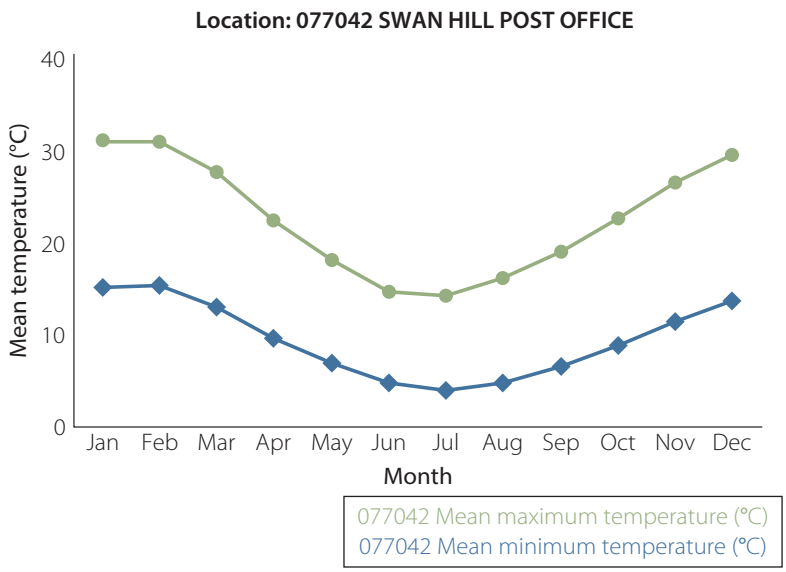
The data values are marked along the horizontal axis and the frequency is marked along the vertical axis. Each row of the frequency table is represented by one vertical column or bar in the histogram.



A spreadsheet application such Excel can be used to construct graphs such as histograms. This will be covered in section 6E.

Line graphs

A **line graph** is a chart with lines joining up the different values, which can be useful to see changes or trends in the data. Here it is used to see how temperature changes over a year. When the independent variable (horizontal axis) is in units of *time* or other continuous measures, the graph of choice is usually a line graph because every point along the line has a meaningful value.



Source: Bureau of Meteorology

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Back-to-back stem plots

Back-to-back stem plots (also called back-to-back stem-and-leaf plots) are useful when we need to compare two sets of results. The **stem** is the central number, and the **leaves** are the rest of each number moving outward in increasing order from the stem. The stem contains the first digit or digits of each number. For example, if you have scores like 32, 15 and 21, the stems are 3, 1 and 2 respectively.

Here is a table comparing the number of goals scored by two teams.

Team 1	1	2	4	6	9	11	13	20	23	24	31	32
Team 2	5	7	8	12	13	15	17	19	21	22	29	31

Every stem-and-leaf plot must have a key so that it can be read easily and accurately.

In this case, the key could be 1 | 2 = 12.

Key: 1 | 2 = 12 goals

Team 1	**stem**	**Team 2**
9 6 4 2 1	0	5 7 8
3 1	1	2 3 5 7 9
4 3 0	2	1 2 9
2 1	3	1

Scatterplots

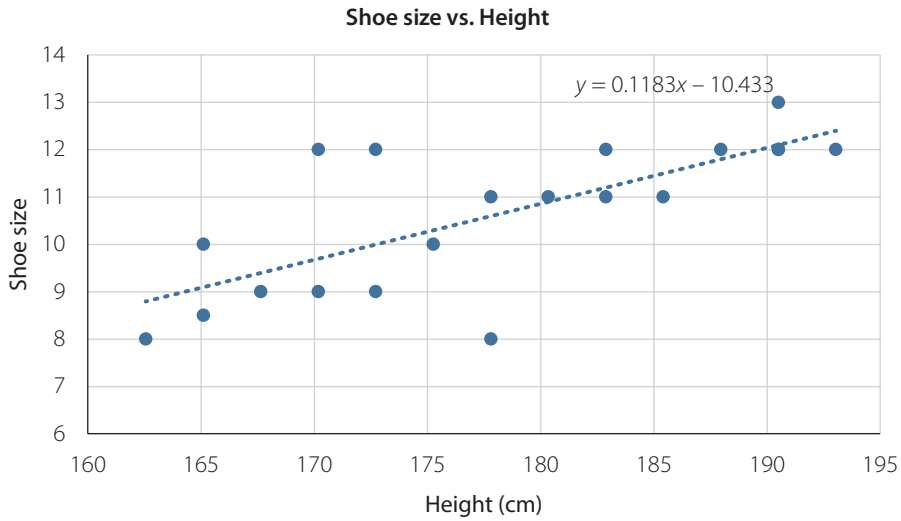
A **scatterplot** is a chart where each point on the graph represents one data point, and the individual points are not joined. This type of graph is generally used when looking at two variables that might be of interest and appear to be related, or what we call correlated, in some way. A scatterplot can help us to see if there is a **correlation** or not.

For example, maybe you're curious about whether there's a connection between the number of hours you practise playing your favourite sport and how well you perform. If you notice that the more hours you practise, the better your performance becomes, then that's a **positive** correlation. Alternatively, if you find that the more you practise, the worse your performance gets, that's a **negative** correlation. However, suppose you practise a lot, but your performance doesn't change much – in this case, there's no strong correlation at all.

The aim is to see whether the variables seem to be related. One way of investigating this is to draw a **line of best fit** or **trendline** through the points on a scatterplot of their values.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Here is some data that looks at whether there is a correlation between people's height and shoe size.



A line of best fit or trendline can be constructed and calculated using a software package such as Excel. The equation of the line can be used to make predictions based on the data that we have. The equation for the trendline in the scatterplot shown is $y = 0.1183x - 10.433$. Using the variable names of the actual data sets that have been used, this equation can be written as:

$$\text{Shoe size} = 0.1183 \times \text{height} - 10.433$$

So, if we want to predict the shoe size of a person of height 190 cm, we can substitute into the equation.

$$\text{Shoe size} = 0.1183 \times 190 - 10.433$$

$$= 12.044$$

So, we would predict that a person of height 190 cm might have a shoe size of 12.

Interpolation and extrapolation

When we make predictions **within** the range of the data set that is given (such as in the example above) this is called **interpolation.** If we were to try and use a trendline equation to make a prediction **outside** the range of data given (for example, if we used the equation above to predict the shoe size of a child that was 100 cm tall) then this prediction may not be very reliable and is called **extrapolation**. An extrapolation assumes that any existing trend in the data will continue beyond the known range.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Conventions of graphs

There are some basic properties or conventions of graphs you need to understand, especially if you want to plot the graph yourself on graph paper or get your computer software to do it for you. These include:

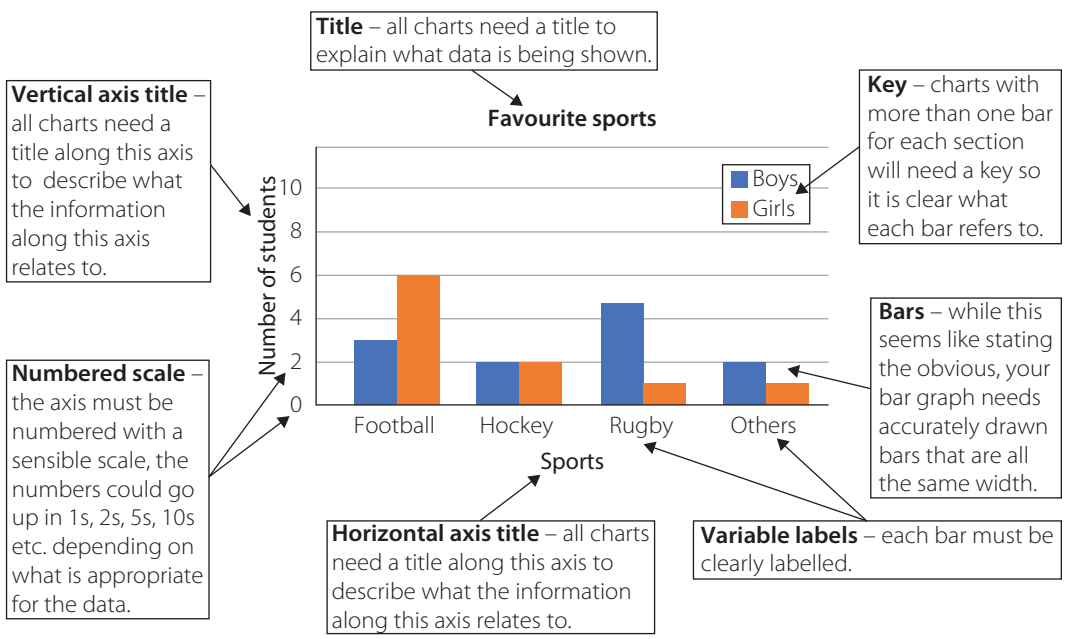
- the **axes**
- the **scale**
- the **labels**, including a **legend** or **key**.

The **axes** are the main lines that normally go up the left-hand side (vertical axis) and across the bottom of the graph (horizontal axis). Often the variable along the horizontal axis is the **independent** variable, while the variable along the vertical axis is the **dependent** variable.

The **scale** is the amount represented by each point or mark on both the horizontal axis and the vertical axis of a graph. It is essential that each mark on an axis represents the same amount.

And the graph will not make sense to anyone if it doesn't have **labels** – for each of the axes and for the overall graph. These tell you what all the figures and data are about. In a complex graph with more than one variable, there will be an extra label (the **legend** or **key**) to show which colour represents which variable.

All this information about axes, scales and labels is illustrated on the sample graph below.



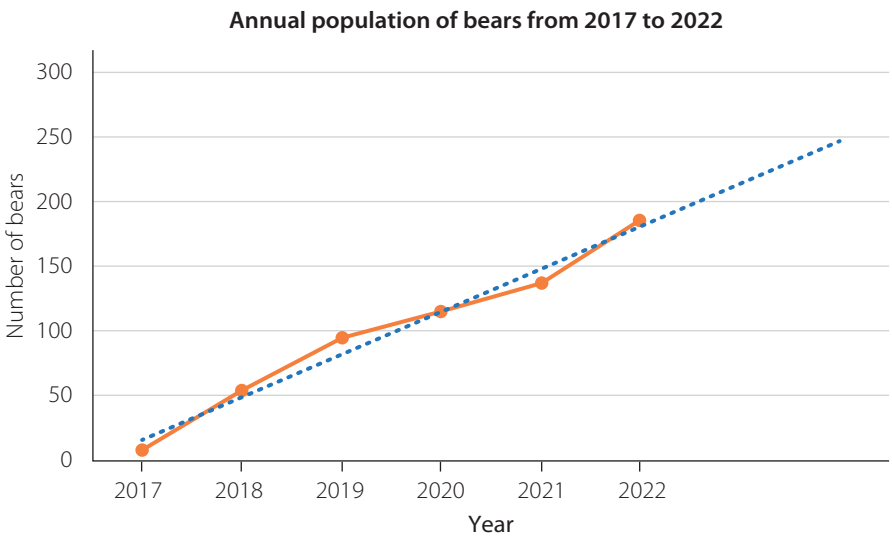
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Words about interpreting data and graphs

We use a range of key terms and words when describing data and statistical graphs and charts. Here are some common ones:

Maximum	The highest or greatest value.
Minimum	The lowest or smallest value.
Steady	The values (or the graph) aren't going up or down, but staying relatively horizontal. Also called stable.
Increase	The values (or graph) are rising or going up.
Decrease	The values (or graph) are going down.
Trend	Any pattern that is showing up on the graph: • **predictable**: shows a pattern (steady, increase, decrease) • **unpredictable**: shows no pattern • **fluctuates**: varies up or down

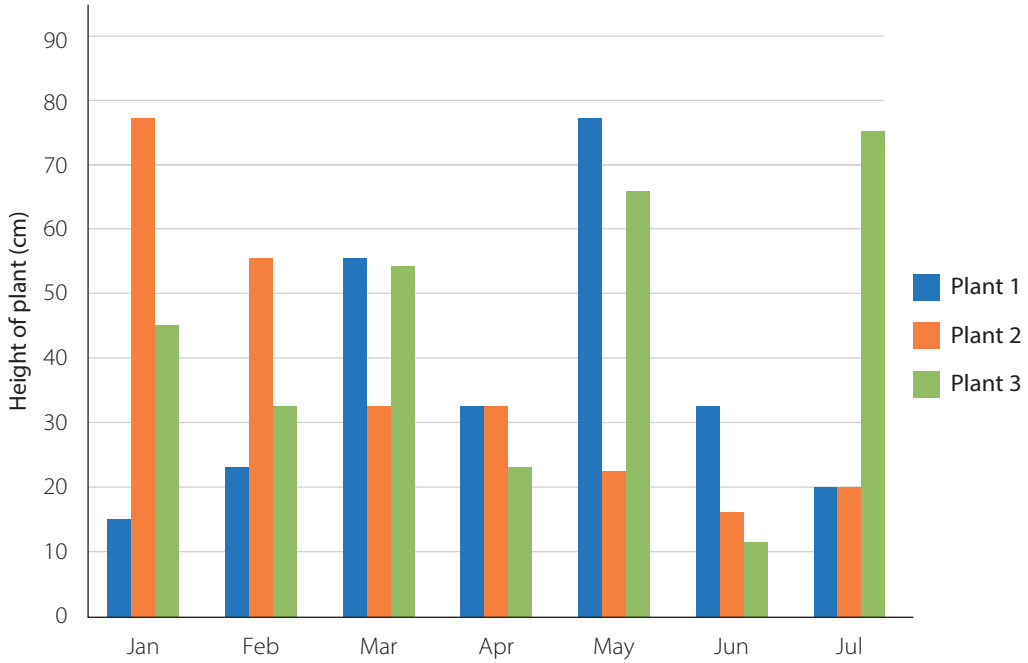
This is an example of a line graph with a predictable positive trend.



Source: excel-easy.com

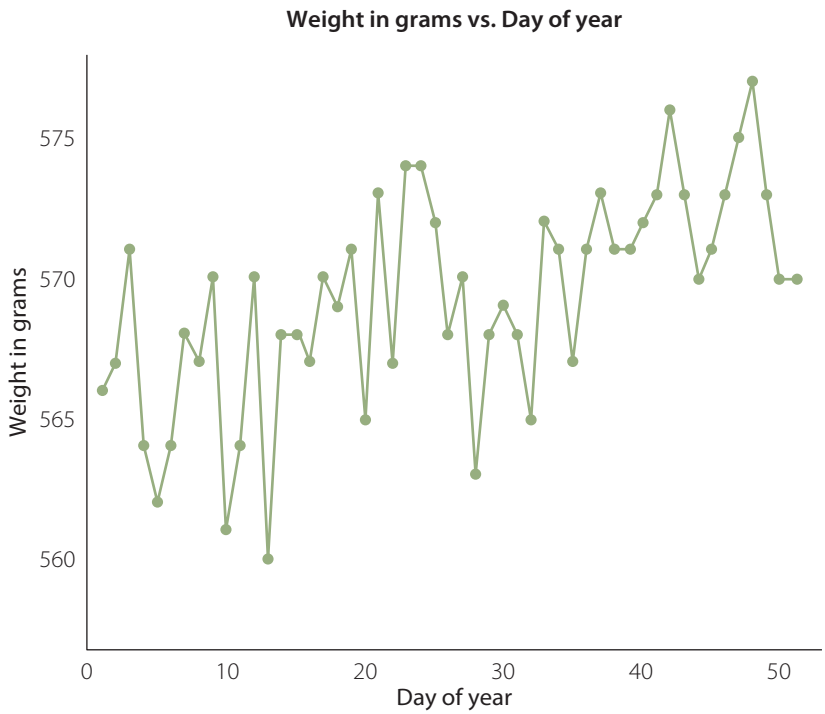
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

This is an example of a bar graph with no predictable trend.



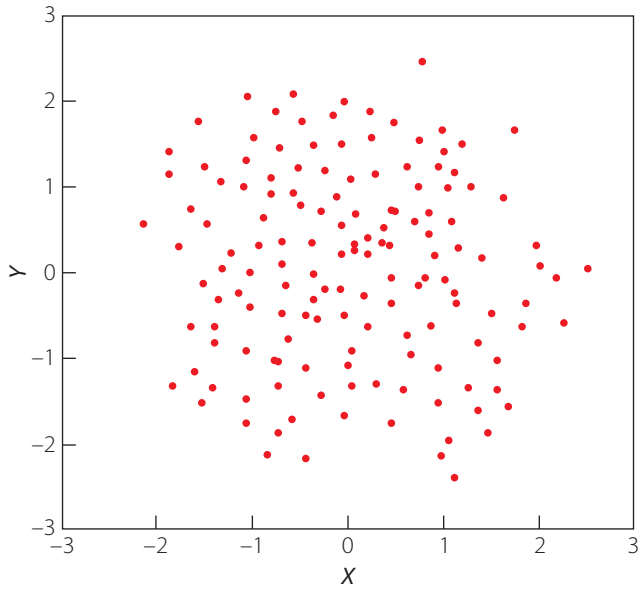
Source: Chart created using the QI Macros SPC Software for Excel developed by Jay Arthur, www.qimacros.com

This is an example of a line graph that fluctuates.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

This is an example of a scatterplot where the data is unpredictable.



6D Tasks and questions

Thinking task

1 Why is it important to use conventions when constructing graphs? Discuss with a small group of other students.

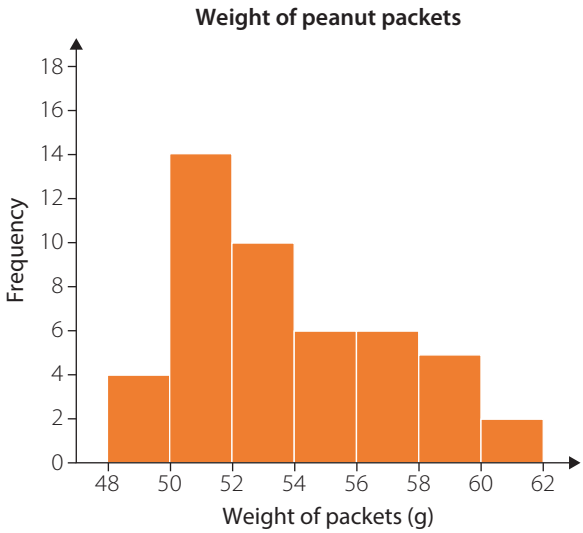
Skills questions

2 For each of the following graphs, state:

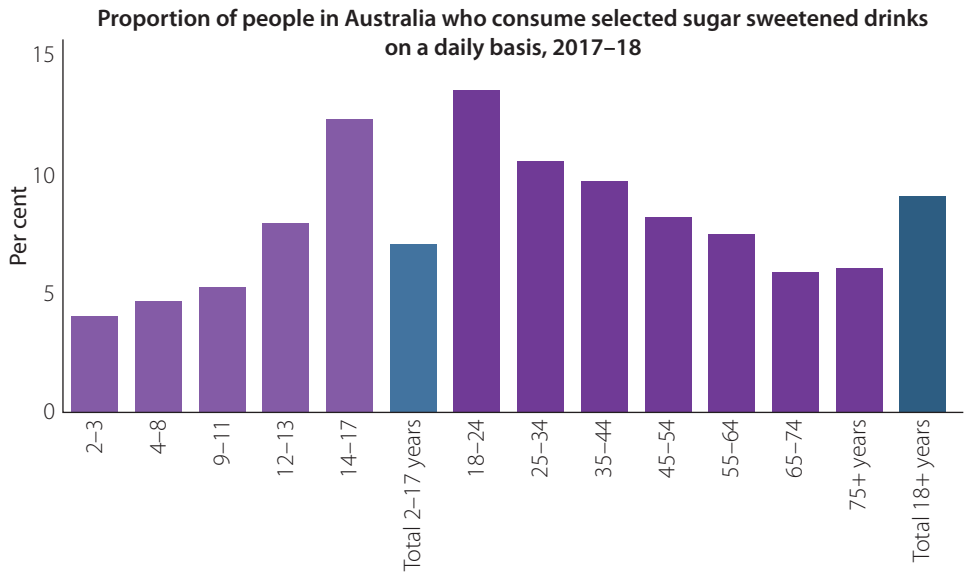
- **i** the minimum value
- **ii** the maximum value
- **iii** any trend in the values
- **iv** the independent variable on the horizontal axis
- **v** the dependent variable on the vertical axis.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

a



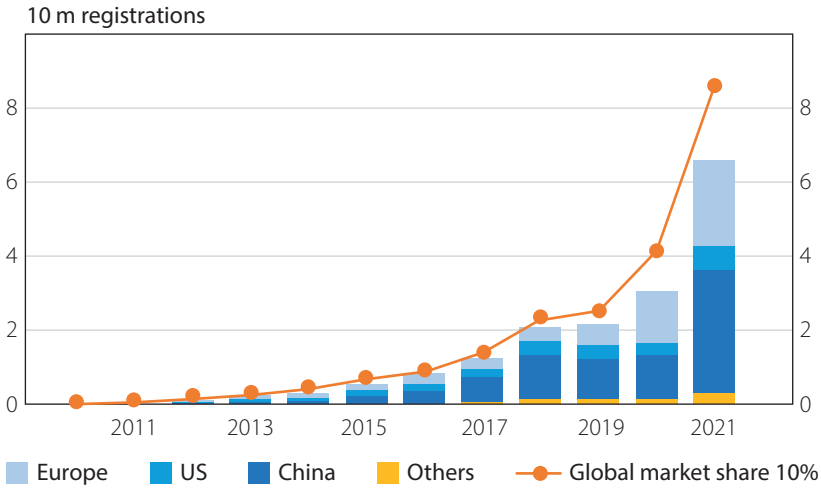
b



Source: ABS National Health Survey 2017–18

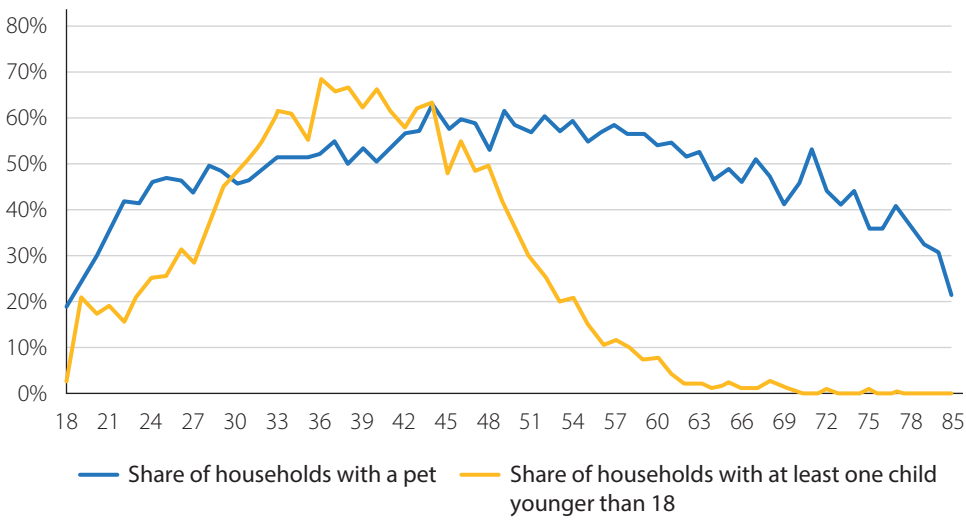
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

c **GLOBAL EV SALES AND MARKET SHARE, 2010–2021**



Source: International Energy Agency

d **Having children vs. Owning a pet, by age**



Source: 2017 American Housing Survey

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3 This stem-and-leaf plot records the daily temperature in two towns.

Beachview		Landtown
9 8 7 5	1	8 9
4 3 2 2 1 1 0 0	2	
9 9 8 7 6 5	2	8 9
3 2	3	3 3 4
8	3	5 5 6 7 7 7 8 8
	4	0 0 1 2
	4	5 6

Key: 1|5 = 15°C

a What is the maximum temperature for Beachview?

b What is the minimum temperature for Beachview?

c What is the maximum temperature for Landtown?

d What is the minimum temperature for Landtown?

Mixed practice

4 Employers track data about worker average attendance for different months of the year. Four scenarios are shown below. Match each of the descriptions A, B, C or D to the correct graph.

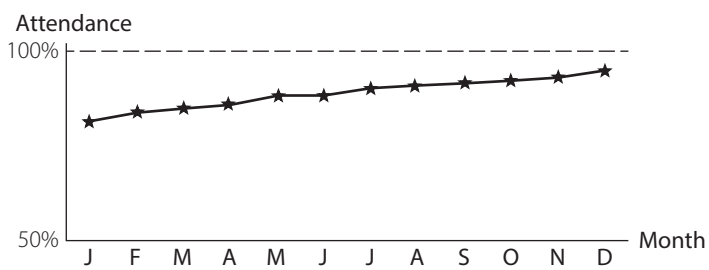
A Attendance getting better

B Attendance falls in winter

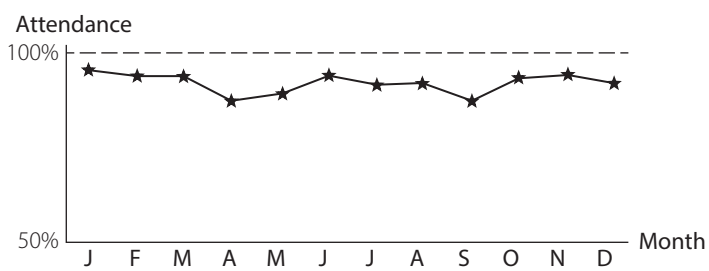
C Attendance always high

D Attendance is unpredictable

a

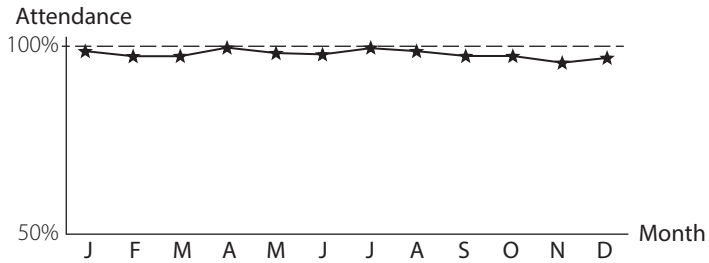


b

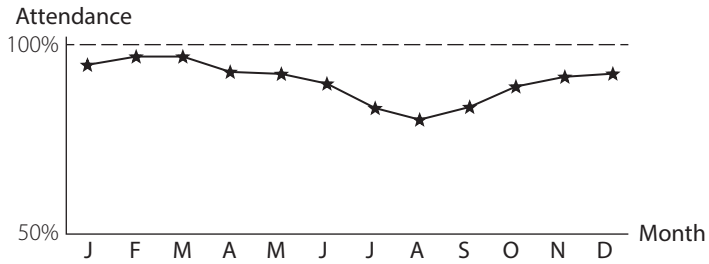


ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

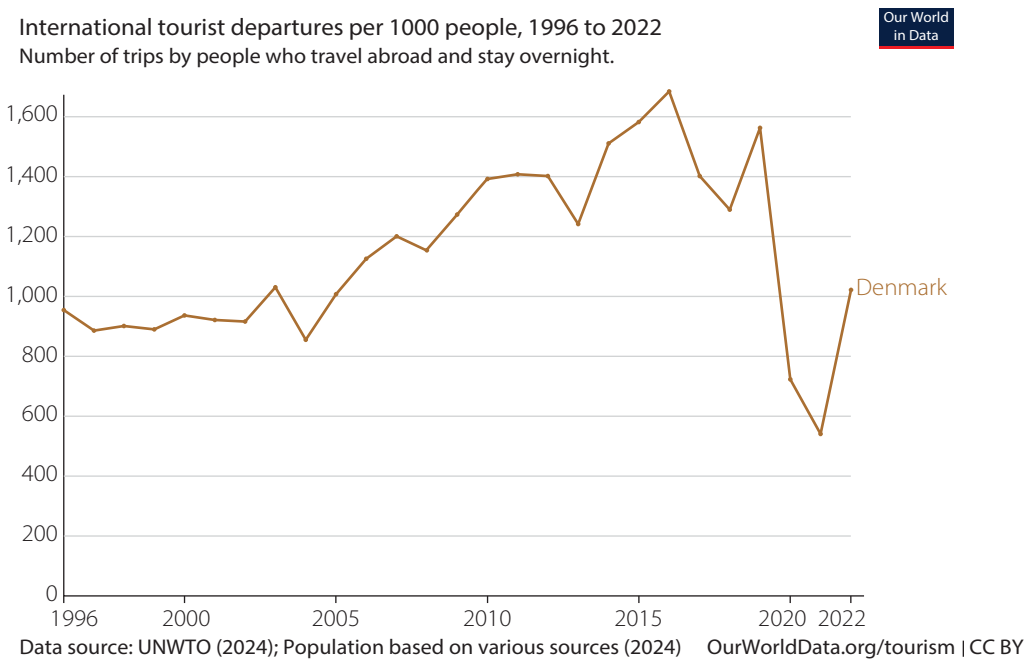
c



d



5 The graph below shows data for residents of Denmark. Use the graph to answer the questions.



a Explain what this graph is about.

b When were tourist departures lowest?

c When were tourist departures highest?

d Explain the type of trend in this graph.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6 The trendline for a set of data is $y = 8.7x - 0.5$. Use the equation of the line to predict, correct to 1 decimal place, the value of:

a y when $x = 3.5$ **b** x when $y = 12.6$.

Mathematical literacy

7 Copy and complete the following sentences by inserting these key terms.

axes	steady	labels	title	horizontal
increase	scale	fluctuate	numbers	pie chart
predictable	figures	minimum	unpredictable	vertical
decrease	maximum	trend		

a Labels and titles make it easier to read and understand data with lots of _____ and _____.

b A circular chart is a _____ .

c The _____ are the main lines that normally go up the _____ axis and across the _____ axis.

d The _____ is the amount represented by each point or mark on both the horizontal axis and vertical axis of a graph.

e It is very important to include _____ and a _____ to make the graph easier to read.

f A good starting point when reading a graph is to identify the _____ and _____ values.

g The values in a graph might stay _____ , or they might _____ or _____.

h The pattern or _____ in a graph might _____ or be _____ or be _____ .

Application task

8 Use the two infographics about the average daily time that Australians spent using media, shown on the next page, to answer these questions.

a Identify the main differences between the two infographics.

b Which types of media usage have increased?

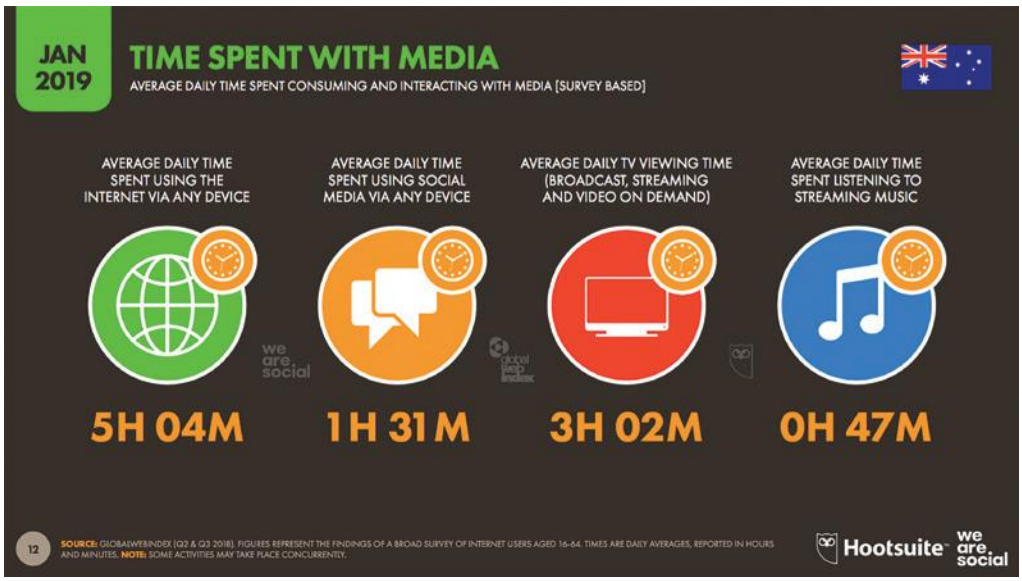
c Which types of media usage have decreased?

d Which types of media usage have incomplete data?

e What other information would you like to see included in these infographics?

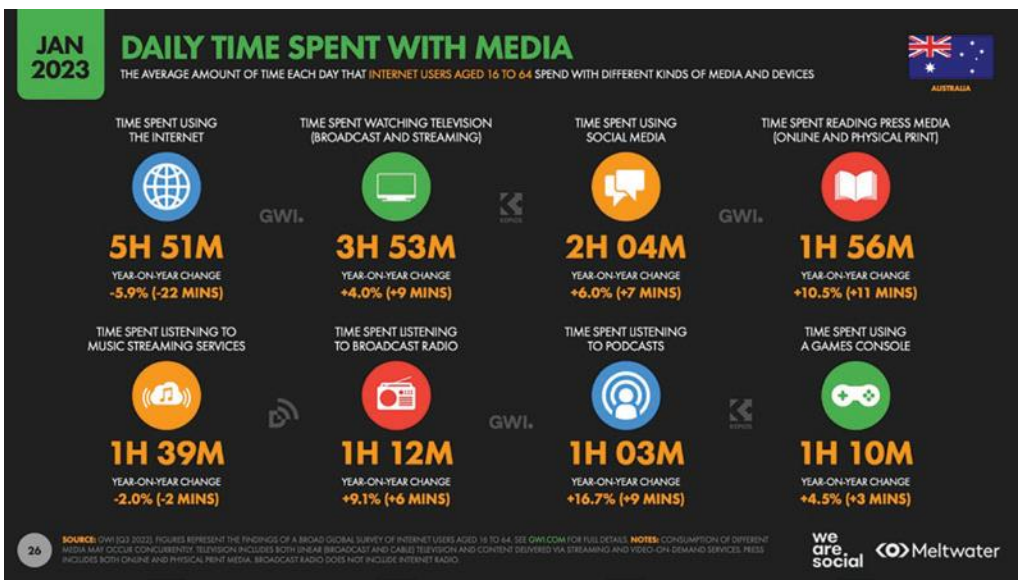
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Infographic A – January 2019



Source: Global web index (Q2 & Q3 2018)

Infographic B – January 2023



Source: Global web index (Q3 2022)

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6E Creating graphs and charts using Excel and Word

Being able to create graphs and charts from data is an important skill that lets you communicate mathematically and is an essential part of any statistical investigation task.

You will have learned in your earlier years of schooling about drawing graphs by hand, and you can ask your teacher for help and advice about how to draw graphs by hand if you need a refresher.

Using technology for drawing graphs

Computer software programs are very useful for plotting charts and graphs of data. Common word processing packages, such as Word, can create graphs, but the more powerful option is to use spreadsheet software, such as Excel. Spreadsheets are more powerful because they can also do other functions relating to collating and organising data, such as sorting and filtering, and undertaking a range of calculations for you, including statistical processes.

But there are a number of key reasons why technology is more helpful. These include:

- Data handling: Spreadsheets, in particular, are excellent for organising and analysing data. They allow you to create graphs directly from your numerical data, making it easier to visualise the data and see trends and patterns.
- Precision and accuracy: Technology offers precise tools for creating graphs, allowing for accurate measurements, consistent lines, and clear annotations.

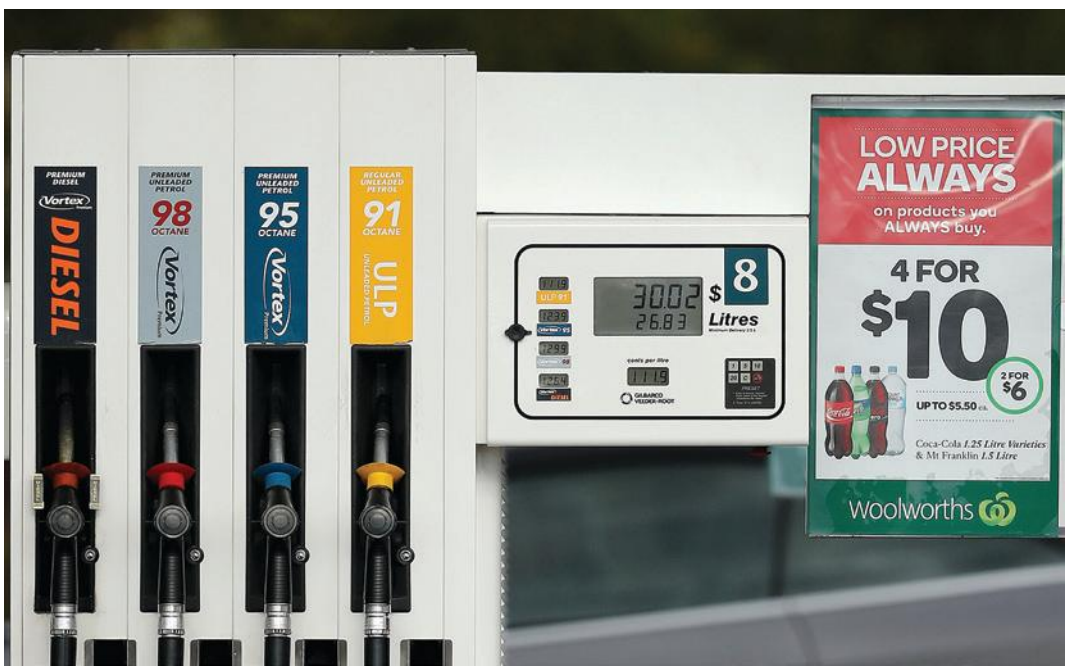
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- Efficiency: Drawing graphs by hand can be time-consuming, especially for complex graphs and charts. Technology allows you to work more quickly and efficiently.
- Revision and flexibility: Using technology supports easy revisions – you can modify a graph, adjust the data or variables, and explore different options without starting from scratch.

Here, we will briefly look at how to access the graphing functions of Excel as an example of how such programs work. Please make sure you ask your teacher for help and advice about using technology such as a spreadsheet to create your graphs and charts, especially if you are unsure about how to do this. You will need to use and apply these data skills throughout this chapter and the next.

Word and Excel have many chart types built in. They are accessed via the **Insert** menu. Select **Chart**, and the popup window shows more options than you would need for most purposes. Note that some countries refer to 'charts' rather than 'graphs', but the terms are interchangeable.

Example – petrol prices



Go to the website for the Australian Institute of Petroleum (AIP) and access the **Resources** tab. Search for 'AIP annual retail price data' and download the spreadsheet summary file.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Start a new spreadsheet of your own. Go to the **Average Petrol Retail** worksheet and copy the **Calendar Year** data from column A to column A in your spreadsheet. (Ignore the **Financial Year** data.) Then, copy the **National** values from column I that match the Calendar Year rows you have to column B in your spreadsheet.

Close the downloaded file and save your file with a suitable name. The first few rows of your file should look like this:

AVERAGE PETROL RETAIL PRICE	National
(inclusive of GST)	
Calendar Year	
2002	87.3
2003	90.4
2004	98.2
2005	111.8

You can use your saved spreadsheet to practise what you learn in Examples 2 and 3 that follow.

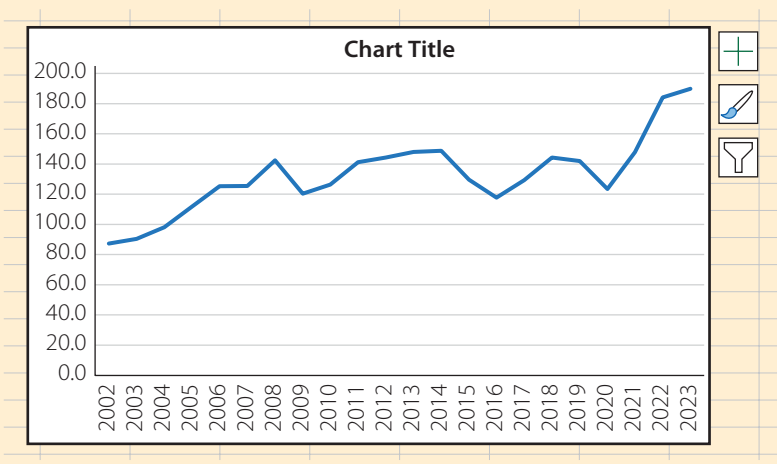
Example 2 Creating a line graph using Excel

Use the average retail petrol price data in your saved spreadsheet to create a line graph using Excel. Show axis labels and a title.

THINKING **WORKING**

STEP 1

Highlight the data, and click **Insert**, then **Recommended Charts**. Select the line graph (as the horizontal axis is Years), then click **OK**. Note that when you click on the graph, three buttons appear on the right.



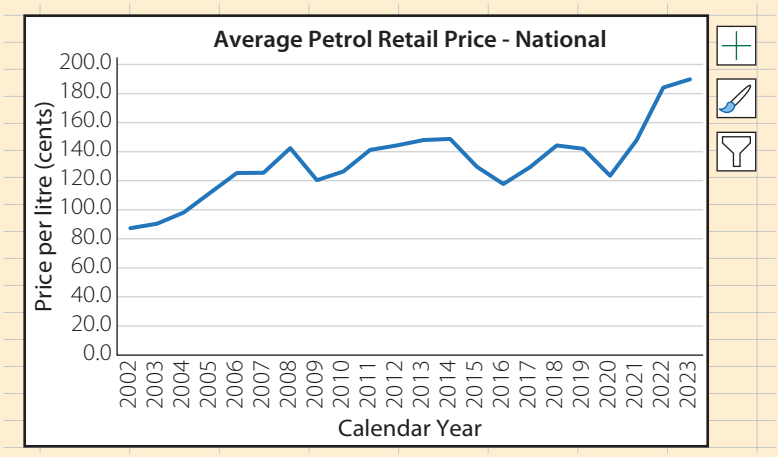
... continued

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING

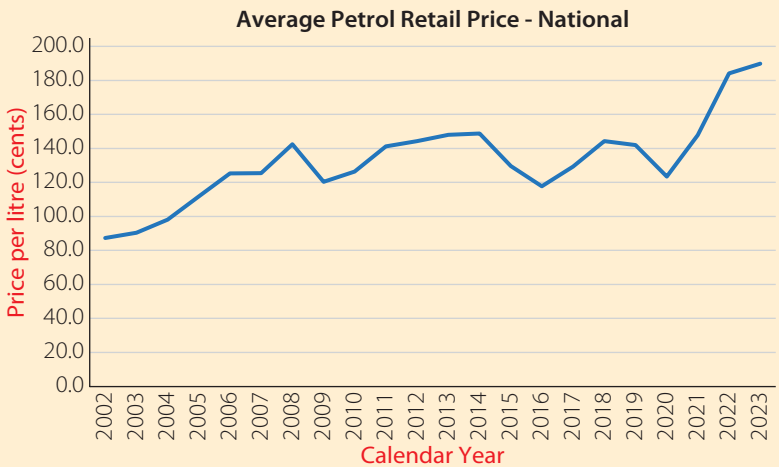
STEP 2

To add labels to the axes and a title at the top, use the + button to add **Chart Elements.** Select **Axis Titles**, then type into the text boxes next to each axis. Repeat the steps to add a **Chart Title** at the top.



STEP 3

Use the paint brush button (**Chart Styles**) to format the text in colour or bold, or change the colour of the actual line graph, and add a border etc. Experiment with these options until you are satisfied with the graph.



Tip: When you insert a chart and click on the graph, three small buttons appear to the right of it.

The **Chart Elements** button shows, hides or formats things like axis titles, chart titles or data labels.

The **Chart Styles** button can be used to quickly change the colour or style of the chart.

The **Chart Filters** button is a more advanced option that shows or hides data in your chart.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Using Word when making charts

Instead of using Excel, you can just work in Word if you prefer. The main difference is that a 'dummy' chart and table appear automatically in the Word document. In both Word and Excel, changing the data in the table automatically updates the chart.

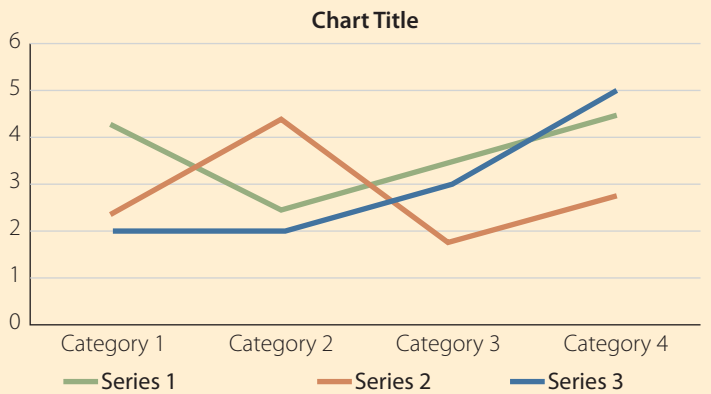
Example 3 Creating a line graph using Word

Use the average retail petrol price data in your saved spreadsheet to create a line graph using Word. Show axes labels and a title.

THINKING	WORKING

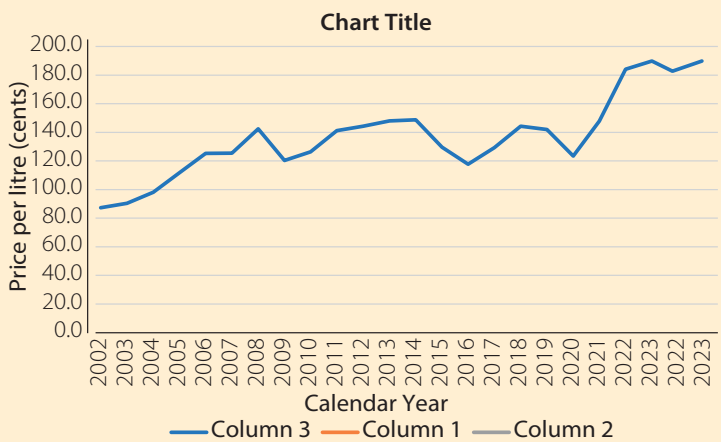
STEP 1

Open a new Word file. Go to **Insert** then **Chart** and select the type you want to create (in this case, a line graph).
A dummy chart will appear, and with it a small window that looks and works like Excel.



STEP 2

Click on the **Edit Data in Microsoft Excel** button that is highlighted in the top bar of the Excel window. Type or copy your own data into the table, and the chart will automatically update from the dummy data to your own data.



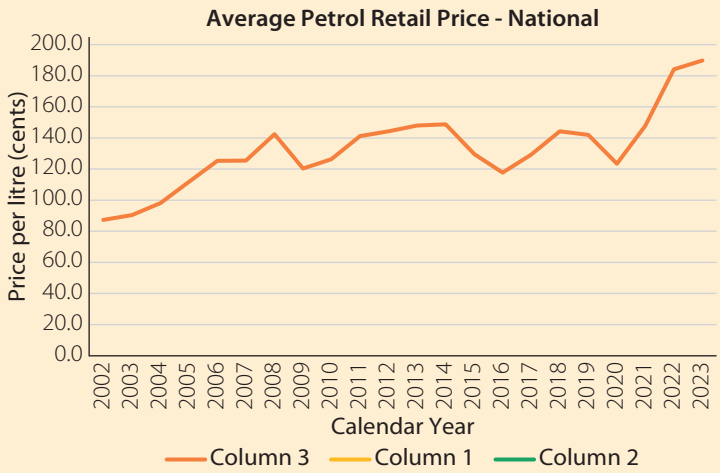
... continued

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING

STEP 3

Click on the chart and edit it as you wish, using the **Chart Elements** button and the **Chart Styles** button, as before. You can also change the colour of the line and the style of the chart using the **Chart Design** menu in Word.



Pie charts are good for showing comparisons of data categories that make up a whole sample. Using Excel, the sequence of steps is basically the same as in the previous examples. The data needs to be first organised as a table.

Example 4 Creating a pie chart using Excel

This data shows the party vote percentages from the 2022 election.
Create a pie chart of the data using Excel.

Party	Percentage vote
Coalition	35.7%
Labor	32.6%
Greens	12.2%
One Nation	5.0%
UAP	4.1%
Other	10.4%
Total	**100%**

THINKING	WORKING

STEP 1

Open a new Excel file and enter the data in two columns.

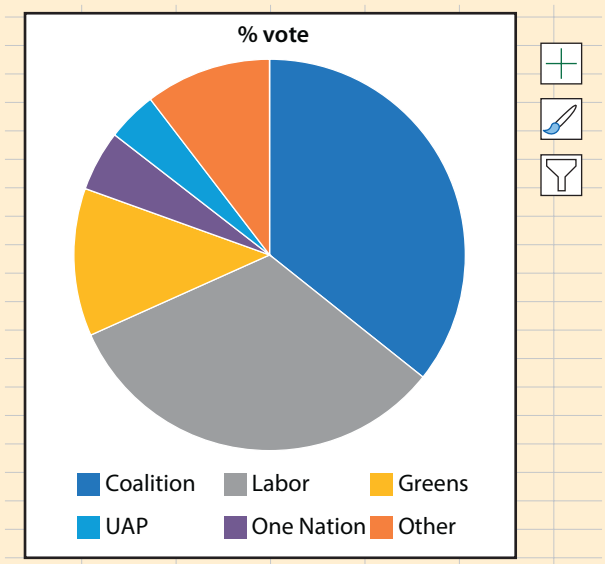
	A	B	C
1	**Party**	**% vote**	
2	Coalition	35.7%	
3	Labor	32.6%	
4	Greens	12.2%	
5	One Nation	5.0%	
6	UAP	4.1%	
7	Other	10.4%	
8	Total	100.0%	
9			

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING

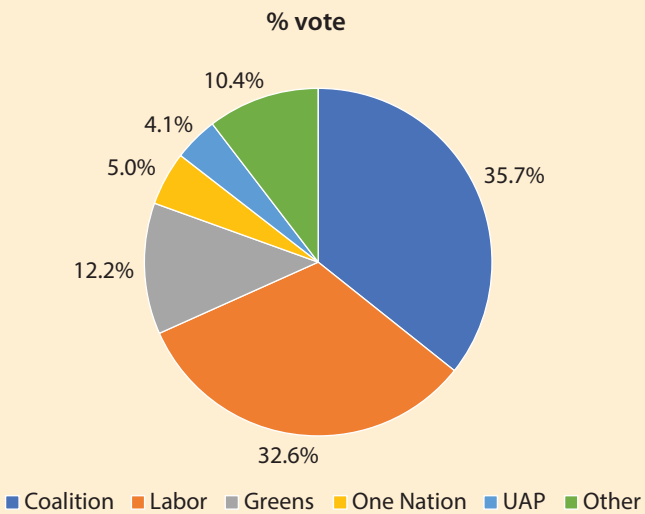
STEP 2

Highlight the data (from A1 to B7), click on **Insert**, then **Recommended Charts** and select the pie chart.



STEP 3

Use the (+) button to add in data labels and any other chart elements. Select **Outside End** for the data labels or drag the percentage values outside the chart to make them more readable. Format the text in colour or bold, or change the colours of the sectors of the pie, and add a border etc. Experiment with these options until you are satisfied with the graph.



Scatterplots can be used to look for possible relationships between two variables, such as height and shoe size.

The sequence of steps is basically the same as in the previous examples. Again, the data needs to be first organised as a table in Excel.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 5 Creating a scatterplot with a trendline using Excel

The following table shows the daily temperature at noon and the ice cream sales for a local business. Investigate a possible relationship between these two variables by creating a scatterplot of this data with a trendline. Write the equation of the trendline in terms of the variables *sales* and *temperature*.

Temperature (°C)	14	16	12	15	18	22	20	25	24	19	23	17
Ice cream sales ($)	214	323	180	312	406	525	412	625	544	421	447	380

THINKING **WORKING**

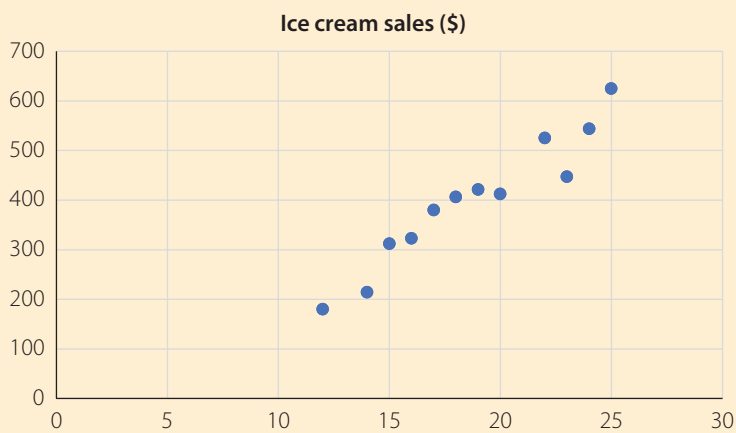
STEP 1

Open a new Excel file and enter the data in two columns.

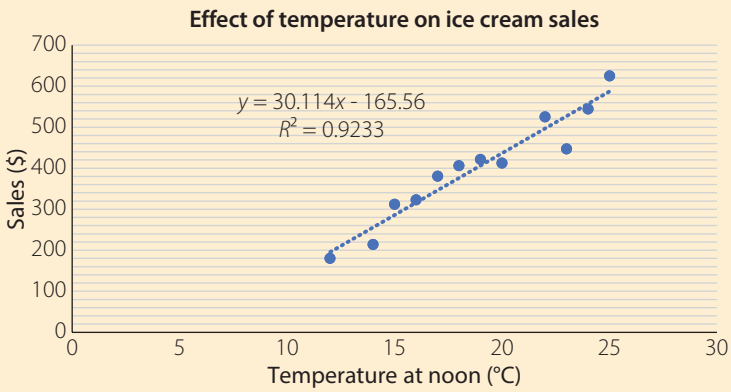
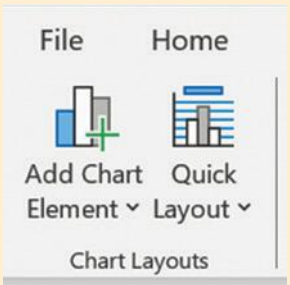
	A	B	C
1			
2		Ice cream sales vs Temperature at noon	
3		Temperature (°C)	Ice cream sales ($)
4		14	214
5		16	323
6		12	180
7		15	312
8		18	406
9		22	525
10		20	412
11		25	625
12		24	544
13		19	421
14		23	447
15		17	380
16			

STEP 2

Highlight the data (from B3 to C15), click on **Insert**, then **Recommended Charts** and select the scatterplot.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 3	
From **Chart Design**, select the **Quick Layout** menu at the top-left of the screen to select a chart that also shows the trendline and its equation (e.g. layout 9).	
 Use the + button to add any extra **Chart Elements.**	
STEP 4	
Write the equation of the trendline.	The equation of the trendline is $y = 30.114x - 165.56$. This means Sales = 30.114 × temperature − 165.56, where temperature is in degrees Celsius and sales is in dollars.

Notes:

- Notice that the trendline is linear, and its equation is $\boldsymbol{y = 30.114x - 165.56}$ with the x-axis showing the temperature and the y-axis showing the sales.
- The $\boldsymbol{R^2 = 0.9233}$ is calculated in Excel to show how well the actual data points fit to the trendline. The closer this value is to **1**, then the better the fit. It is not surprising to see that ice cream sales are related to the daily temperature.
- This trendline equation can then be used to predict sales for other temperatures.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Histograms are similar to bar or column graphs and are good for showing the overall distribution of data, especially continuous numerical data. You can see the peaks of the distribution, whether the distribution is skewed or symmetric, and if there are any outliers. Each bar covers a range of numerical values (the class interval) and the height plots the frequency of each of the class interval values.

Example 6 Creating a histogram using Excel

Consider the data below which shows the battery life (in minutes) of 30 mobile phone batteries.

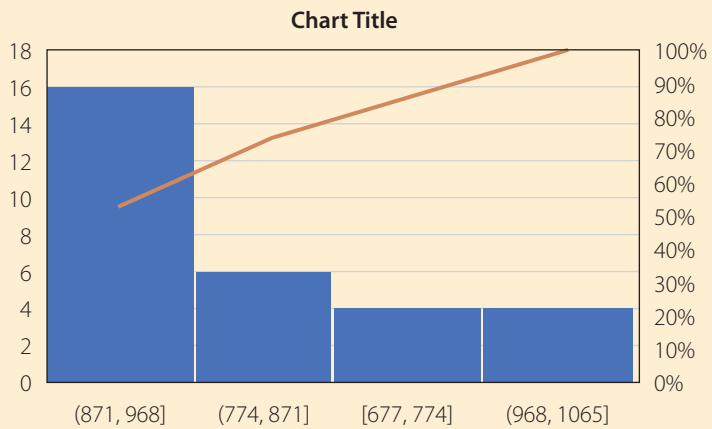
806	788	998	677	967	834
959	705	880	978	934	890
905	878	987	706	983	902
895	768	923	924	925	913
945	803	869	924	876	823

Create a histogram of this data.

THINKING **WORKING**

STEP 1

Open a new Excel file and enter the data as one column (the data does not need to be sorted or put into class intervals). Highlight the data, click on **Insert**, then **Recommended Charts** and select the chart that looks like a histogram.
With the default settings, this histogram is called a Pareto chart – where the data is sorted from the highest frequency to the lowest frequency. This needs to be changed.

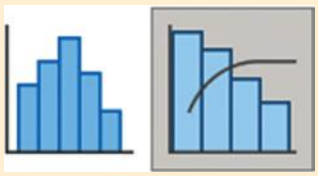


ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

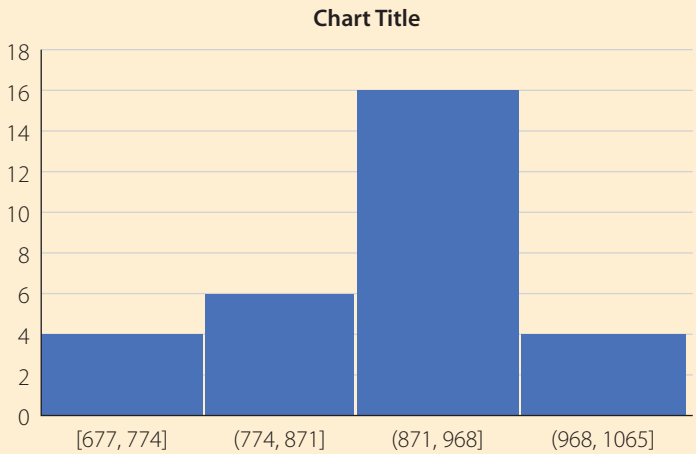
THINKING	WORKING

STEP 2

Right-click on the chart area and select **Change Chart Type**, which will give you two options.

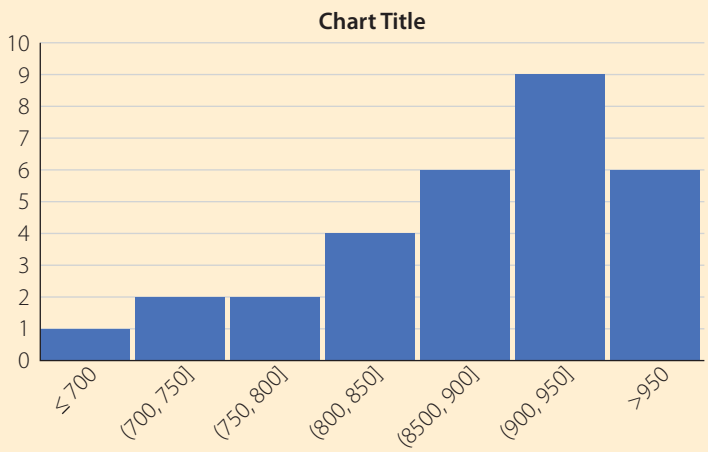


Select the option on the left to produce a histogram of the data. It will have a default setting for the size of the histogram bars. In this case, the number of class intervals or bins is not within the recommended range of 5 to 8.



STEP 3

To modify the width of the histogram bars (called **bin width**), hover over the horizontal axis and right-click, then select **Format Axis**. The **Format Axis** option menu will open up to the right of the spreadsheet. Adjust the bin width, overflow and underflow values.



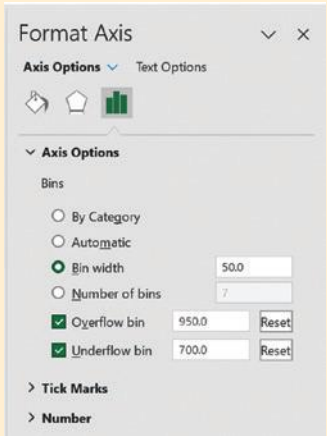
... continued

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING

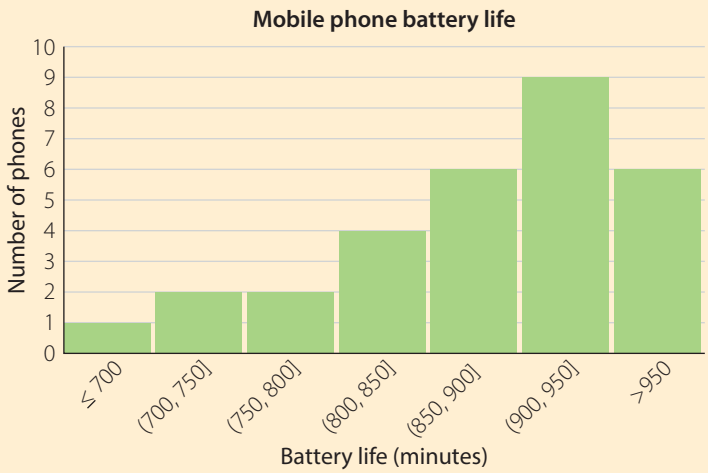
Bin width: 50, as this gives you between 5 to 8 class intervals.

- Set the overflow to a value that is a bin width below the highest value: 950.
- Set the underflow to a value that is a bin width above the lowest value: 700.



STEP 4

Use the + button to add any extra **Chart Elements**.
Format the text in colour or bold, or change the colours of the bars of the histogram, and add a border etc. Experiment with these options until you are satisfied with the graph.



6E Tasks and questions

Thinking task

1 The results of a survey about where to go on camp this year has produced a set of data. If you were asked to design a poster to give information on this set of data to Year 7 students, what form would this take? Share and compare your thoughts with your classmates.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Skills questions

2 Explain what features are accessed via the + button in chart elements.

3 Explain what features are accessed via the button in chart elements.

4 For what types of data are pie charts the best graph?

5 What is the main difference between scatterplots and line graphs?

6 Construct a line graph using the following data about the number of people attending a street event.

Time	10 a.m.	11 a.m.	12 p.m.	1 p.m.	2 p.m.	3 p.m.	4 p.m.	5 p.m.	6 p.m.
Number of people	28	52	104	185	151	97	65	40	32

7 Construct a pie chart using the following data about Jo's weekly spending.

Rent	Groceries	Bills	Car	Spending	Savings
$450	$225	$45	$120	$45	$65

8 The table below shows the weight (in grams) and the height (in cm) for 10 mice.

Height (cm)	5.4	5.6	8.2	4.3	9.2	4.8	7.2	6.1	10.0	8.2
Weight (g)	30.5	29.5	45	25.2	46.2	26.1	42.3	38.6	51.2	42

a Use Excel to construct a scatterplot of *height* versus *weight* for the mice. In this example, height would be placed on the horizontal axis and weight on the vertical axis.

b Add a trendline to your scatterplot and display the equation. Write the equation of the trendline in terms of the variables *height* and *weight*, correct to 1 decimal place.

c Using the trendline equation, predict the weight of a mouse that has a height of 8 cm.

d Is the prediction made in part **c** an example of interpolation or extrapolation?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9 A company has tracked the amount of money that was spent on advertising a particular product and the sales of the product over a 12-month period.

Month	Advertising ($1000s)	Number of products sold
January	90	45
February	110	75
March	94	52
April	150	105
May	180	145
June	200	175
July	200	175
August	190	130
September	175	121
October	100	82
November	90	48
December	60	25

a Use the data to create a scatterplot.

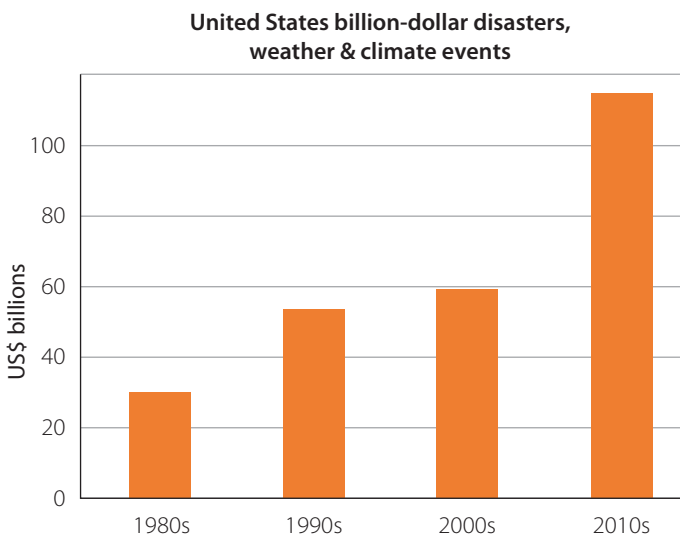
b Insert a trendline into your scatterplot.

c Describe the correlation between the amount of money spent on advertising and the number of items sold.

Mixed practice

10 Compare the two graphs shown below which display the cost of weather-related disasters.

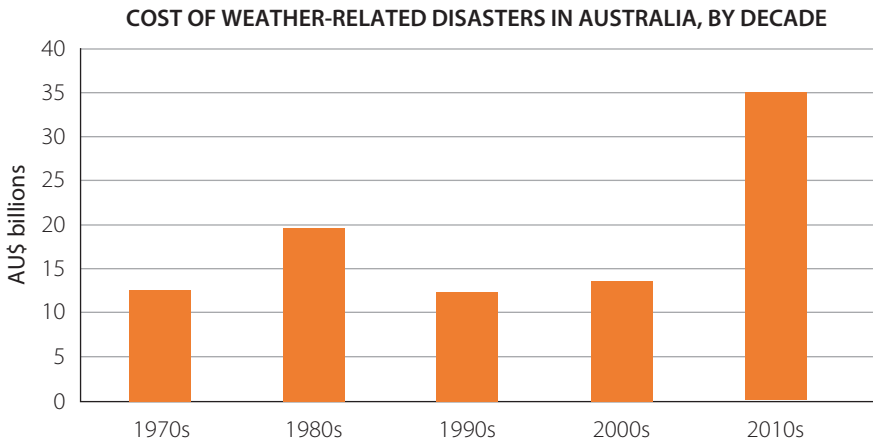
Graph A



Source: NOAA/NCEL

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Graph B

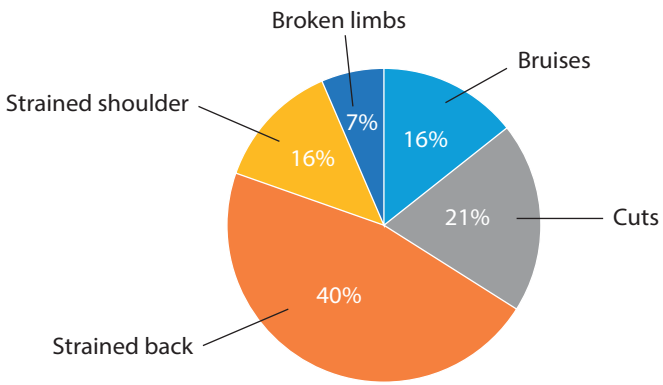


Source: EM-DAT, Climate Council

a What are the two main differences between these graphs?

b What is the trend of this data?

11 There are 150 employees in a factory who have sustained an injury in the last 10 years. The type of injury is shown in the graph below.



a In an Excel spreadsheet, create a set of data for the above information.

b Use your spreadsheet to construct a bar graph.

c What variables did you use to construct this graph?

d Based on this information, what is the main Occupational Health and Safety (OHS) issue in this factory?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Application task

12 The following data shows the top three motivations for adults to engage in sporting activities. It was collected in an AusPlay survey led by the Australian Sports Commission.

Age group	Physical health or fitness	Fun/enjoyment	Social reasons
	Estimate (000s)	Estimate (000s)	Estimate (000s)
15–17	143.8	157.4	87.2
18–24	487.0	351.6	267.5
25–34	838.5	513.8	394.7
35–44	755.6	421.6	373.7
45–54	658.0	340.6	265.3
55–64	596.3	296.6	238.3
65+	805.6	425.4	357.9
Total	**4284.8**	**2507.0**	**1984.5**

Source: AusPlay

a Use this data to create two different graphs. Be sure to include all relevant information, like the source and the year of the data.

b Explain why you selected the two different graphs.

c Interpret the data in the graphs.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6F Contemporary graphs

Graphs are used in the media, in advertising and the community because they convey the message in a form that most people can understand.

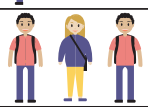
A well-chosen graph will effectively tell the story of the data. But how is the best graph selected? It depends on the purpose of the graph.

Some of the more contemporary graphs can be used to portray a very specific message.

Pictograms

Pictograms are graphs which use pictures or symbols to represent data values. They are used to make the data appear more visually engaging or to highlight the nature of the data. An image of a person could represent a specified number of people.

Pictograms must have a key to show what each picture represents. Each picture must be of identical size. For example, the graph below shows favourite sports for 20 students in a class.

Sport	Number of students
Athletics	
Swimming	
Cricket	
Soccer	
Cricket	
Netball	

= 2 female students

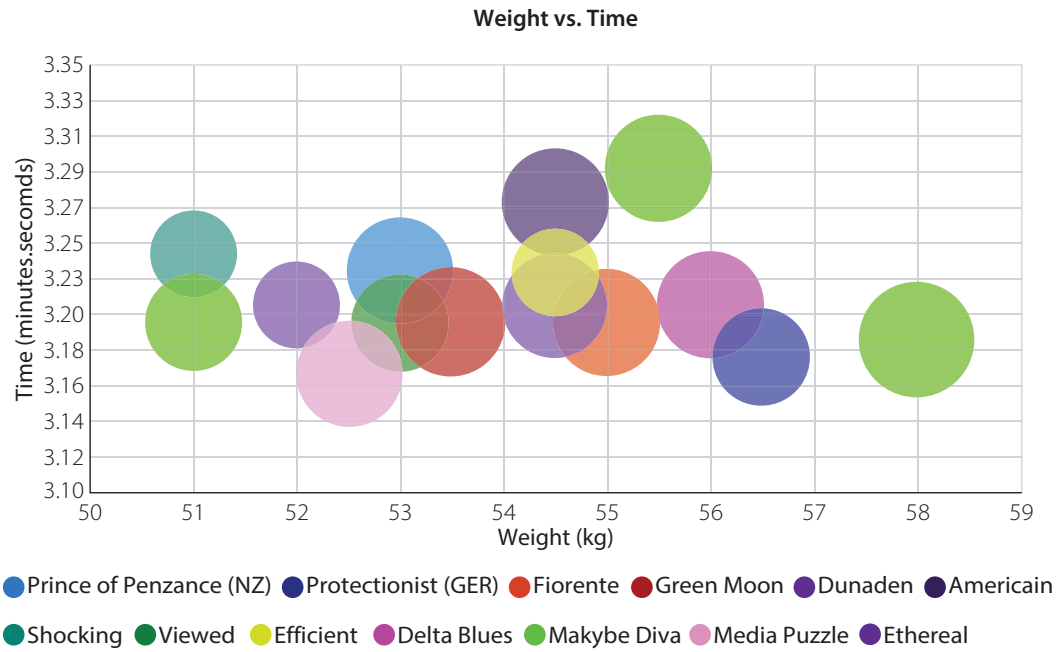
= 2 male students

Bubble graphs

Bubble graphs are used to visualise the relationship between three or more sets of data. One set of data is represented by the position along the horizontal axis, the second set of data is represented by the position along the vertical axis and the third set of data is represented by the size (area) of the bubble. Fourth and more sets of data could be represented by different coloured bubbles.

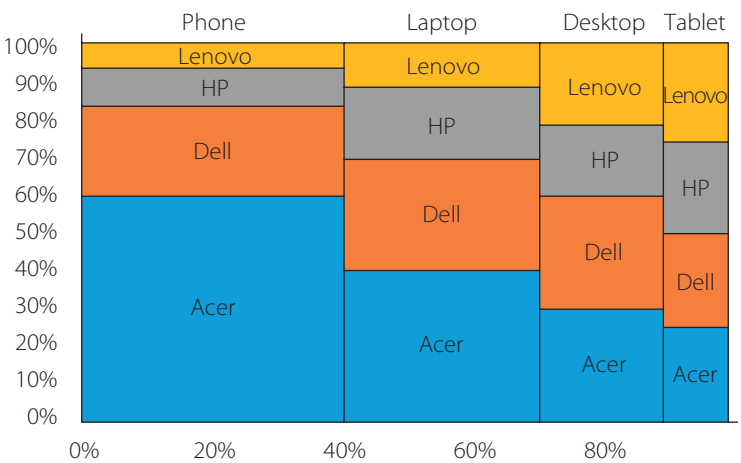
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

The bubble graph below displays recent winners of the horse race the 'Melbourne Cup'. The weight and finish time for each horse is represented by the position on the axes and the size of the bubble represents the horse's age.



Mekko chart

A Mekko (or Marimekko) chart is a special type of bar chart. Unlike standard bar charts which represent data values by varying the height of the bars, Mekko charts also vary the width of the bar. They display two numerical values for each category. Although they are valuable in being able to use fewer graphs to represent information, they are sometimes difficult for the audience to read as humans are good at observing differences in lengths but not so good at comparing differences in areas.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

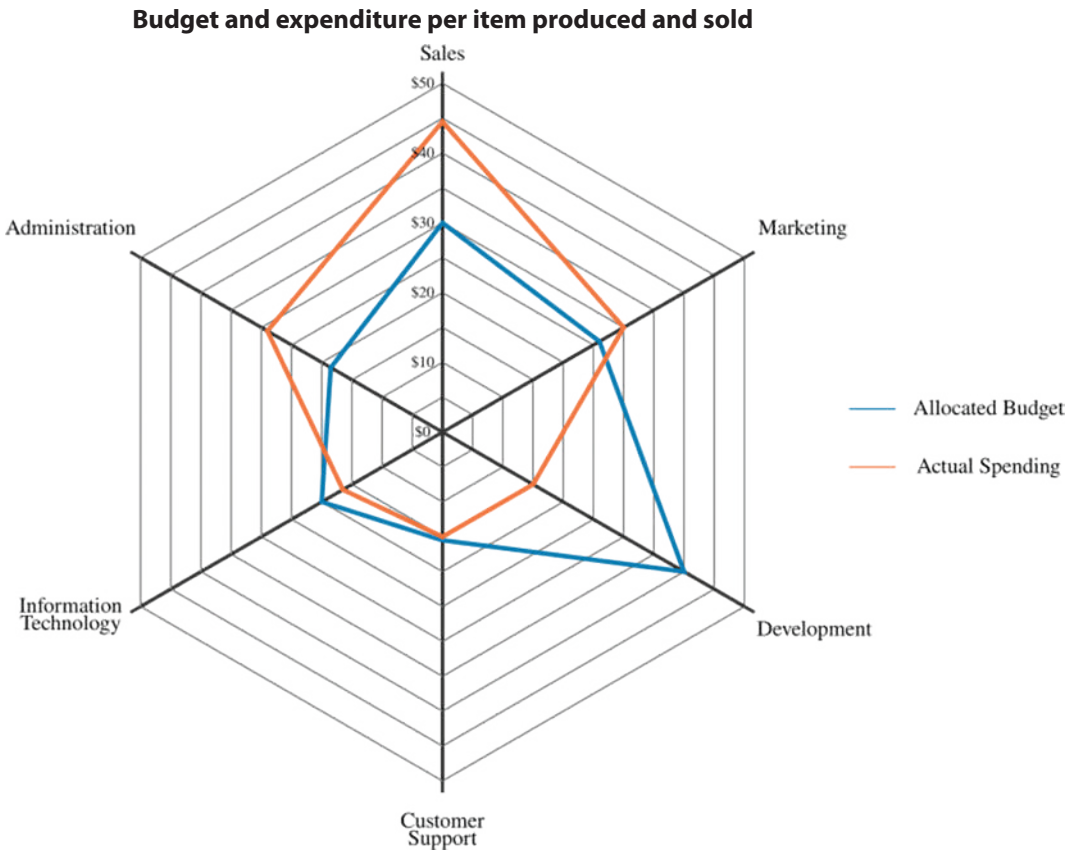
This example uses fake sales data about electronic devices to show the key points about these charts.

- Reading from left to right, it shows that 40% of all devices were phones, then 30% were laptops etc.
- Reading from bottom to top, it shows that 60% of all phones were from Acer, then 20% were from Dell etc.

Radar chart

Radar charts (also called spider charts) are used to compare multiple numerical variables. Each variable is represented by a spoke or axis which radiates from the centre of the chart. The values of these variables are represented by plotting the distance from the centre along these axes.

This radar chart plots the average departmental budget and expenditure per item produced and sold by a particular company.



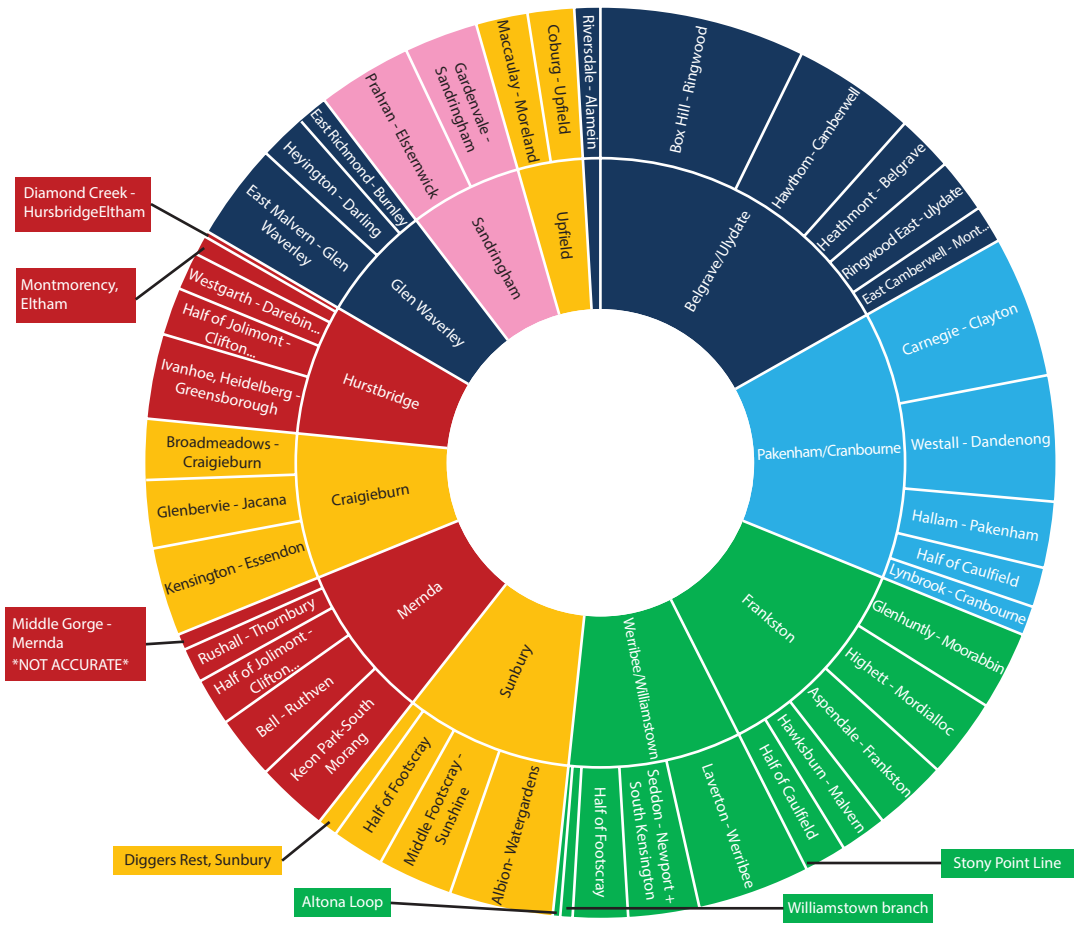
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Sunburst chart

Sunburst charts are used to display data that is hierarchical. They display hierarchy (levels) through radiating rings from the centre. They are similar to pie charts in that each ring is segmented into proportions representing the components of each level.

This sunburst chart illustrates the number of people using public trains in Melbourne from 2005–2019. The inner ring represents the train line and the outer ring represents the most used stations on that line.

Mebourne train patronage by line, excluding City (2018–2019)



Source: Phillip Mallis

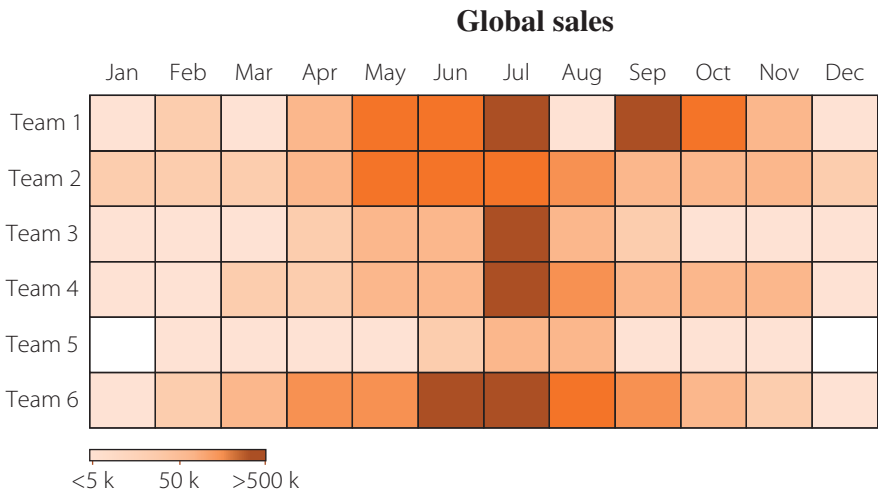
Heat map

A heat map is a graph that uses variation in colour to represent values of numerical variables. The main benefit of using heat maps is that they allow complex numerical data to be understood quickly. They are often used in business to highlight areas of high user purchase or engagement, for example customer interaction on a business website.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Online heat maps can also be interactive, so that when you scroll your mouse over a cell of the heat map, the numerical data will appear for that cell.

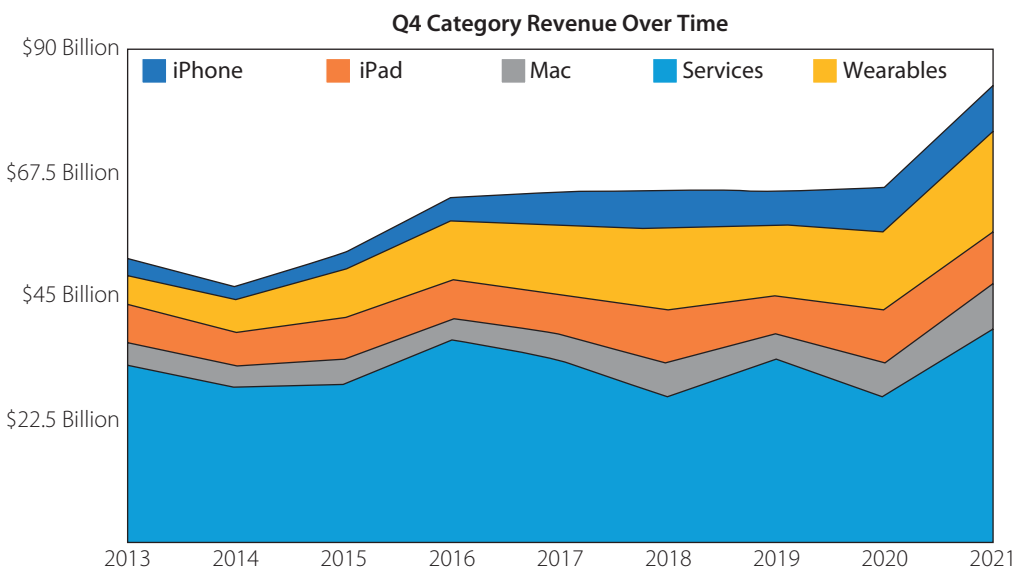
The heat map below shows the global sales achieved over a year by different teams. The darker the colouring, the higher the sales achieved.



Stacked area chart

An area chart is based on the line chart which tracks the value of a numerical variable against a second variable (usually time). A stacked area chart illustrates the progression of multiple numerical variables with the area between each line graph coloured differently.

The stacked area graph illustrates the revenue generated by Apple across its product categories over the period up to the fourth quarter (Q4) of 2021.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6F Tasks and questions

Thinking task

1 Suggest a suitable chart (from the list) which would be appropriate to display the following data. Give reasons for your selection.

- Pictogram
- Bubble graph
- Mekko chart
- Radar chart
- Sunburst chart
- Heat map
- Stacked area chart

a The relationship between life expectancy, wealth, and population for each country in the world.

b The area breakdown of states and electoral districts in Australia.

c A survey was carried out to find the mode of transport each student uses to travel to school.

d A business analytics company tracks the areas of a company website that customers visit.

Skills questions

2 The heat map below displays the mean (average) monthly maximum temperature recorded in Melbourne between 2012 and 2021.

Mean monthly maximum temperatures in Melbourne, 2012–2021

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2021												
2020												
2019												
2018												
2017												
2016												
2015												
2014												
2013												
2012												

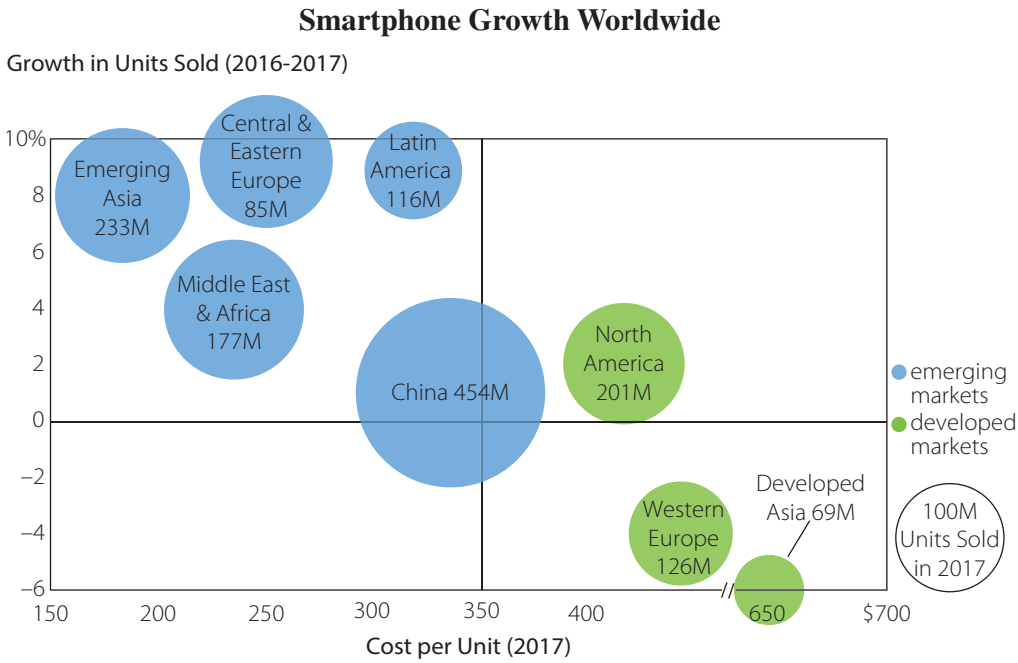
Source: Bureau of Meteorology

a Which colour represents the coldest temperature, and which colour represents the hottest temperature?

b Which month was the hottest month over the 10 years of recorded temperatures?

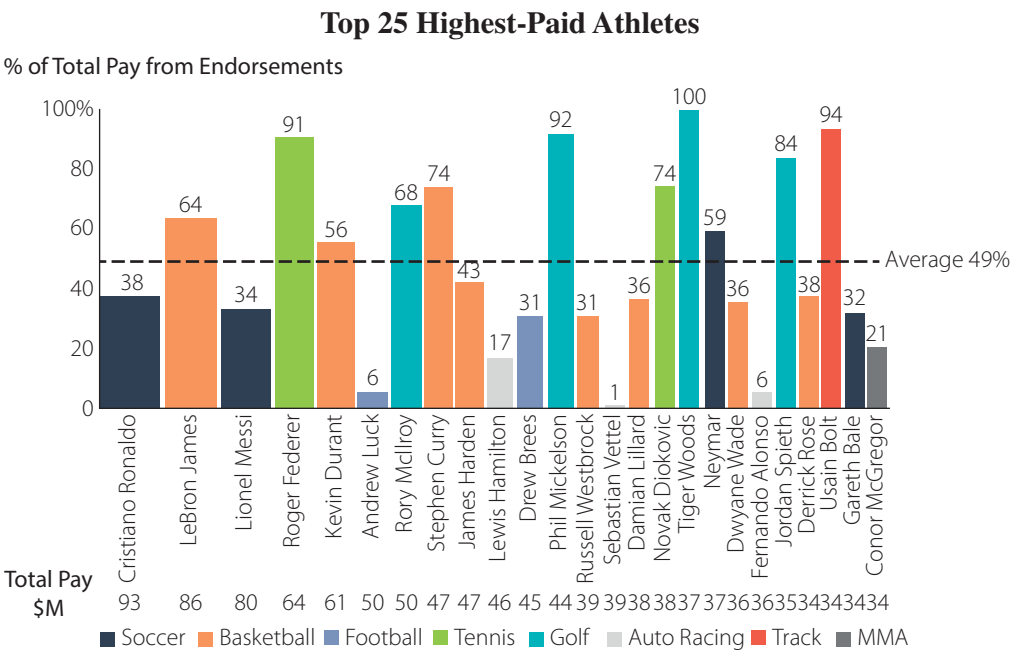
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3 The bubble graph below shows the cost per unit against growth in sales and total sales of smartphones across different global markets. Which market had the highest number of units sold?



Source: Mekko Graphics

4 This Mekko chart shows the top 25 highest-paid athletes in the world. The height of the columns represents the percentage of their pay from endorsements, and the width of the columns represents their total pay in millions of dollars (also shown in the numbers listed across the bottom).



Source: Mekko Graphics

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

a Who is the highest-paid athlete?

b Which athlete receives 100% of their pay through endorsements?

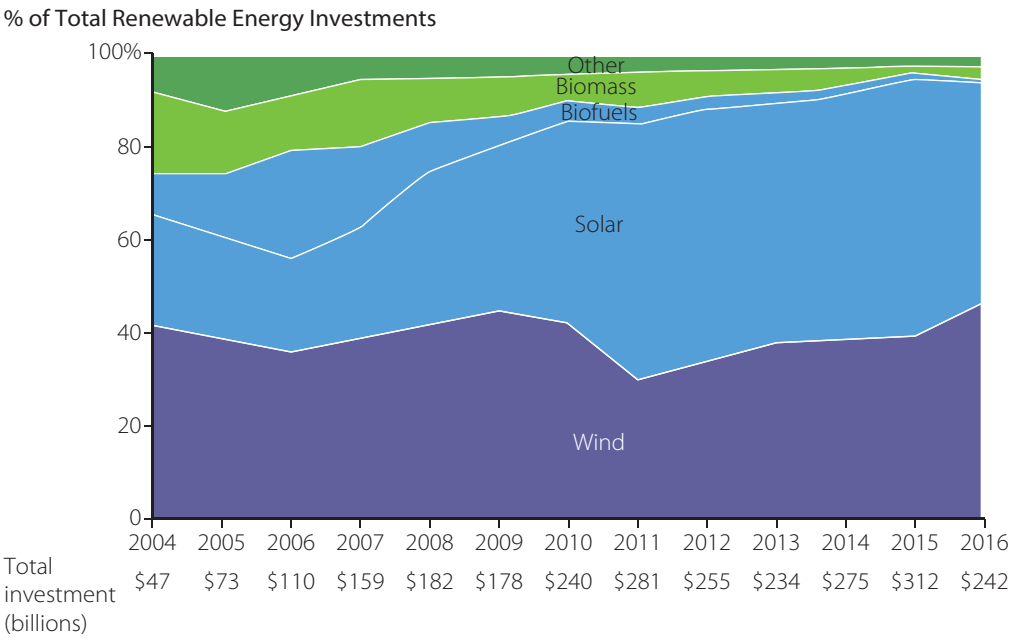
c How many basketball players are in the top 25 highest-paid athletes?

d Approximately, how much money (in dollars) does Roger Federer receive in endorsements?

e Of the top 25 highest-paid athletes, who received the least from endorsements and which sport do they play?

5 The percentage of new renewable energy investments from 2004–2016 is shown in the stacked area graph.

Renewable Energy Trends



Source: UN Environment, Bloomberg New Energy Finance

a In 2004, which renewable energy type had the highest investment?

b In 2016, which renewable energy type had the highest investment?

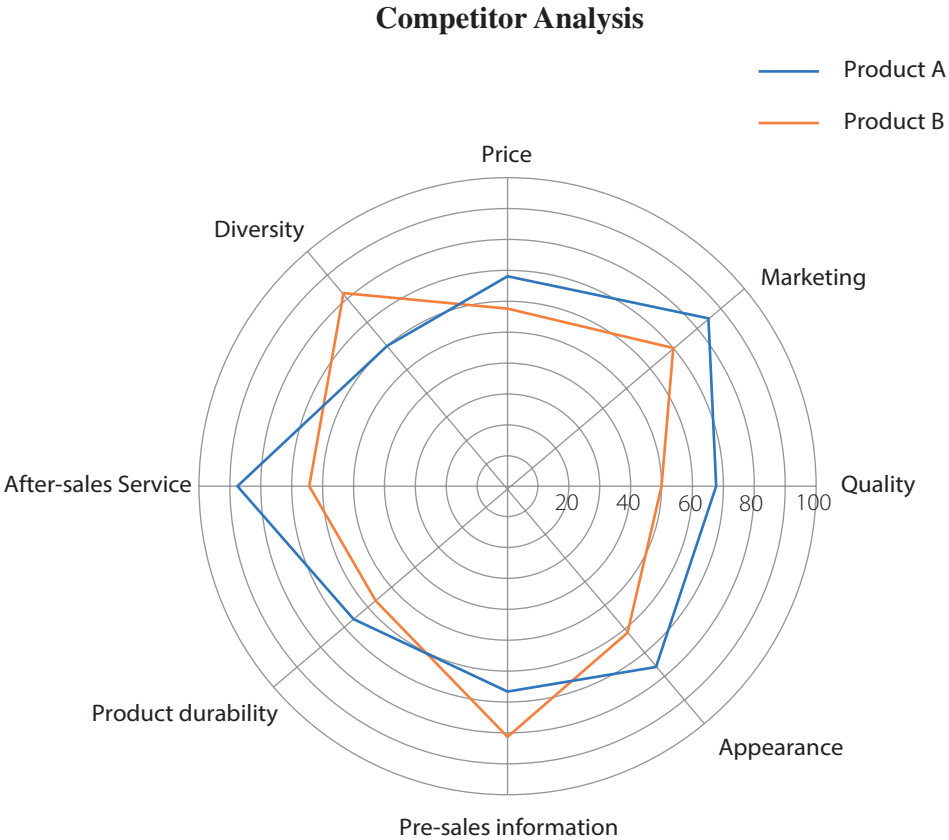
c In 2010, what percentage of new investment was made in solar energy?

d In what year (between 2004 and 2016) was investment in wind energy the lowest?

e Search to find more recent data on renewables investment. How have the percentages across the different energy types changed?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6 This radar (spider) graph is analysing various customer experiences of two products.



a Which product is rated as best quality?

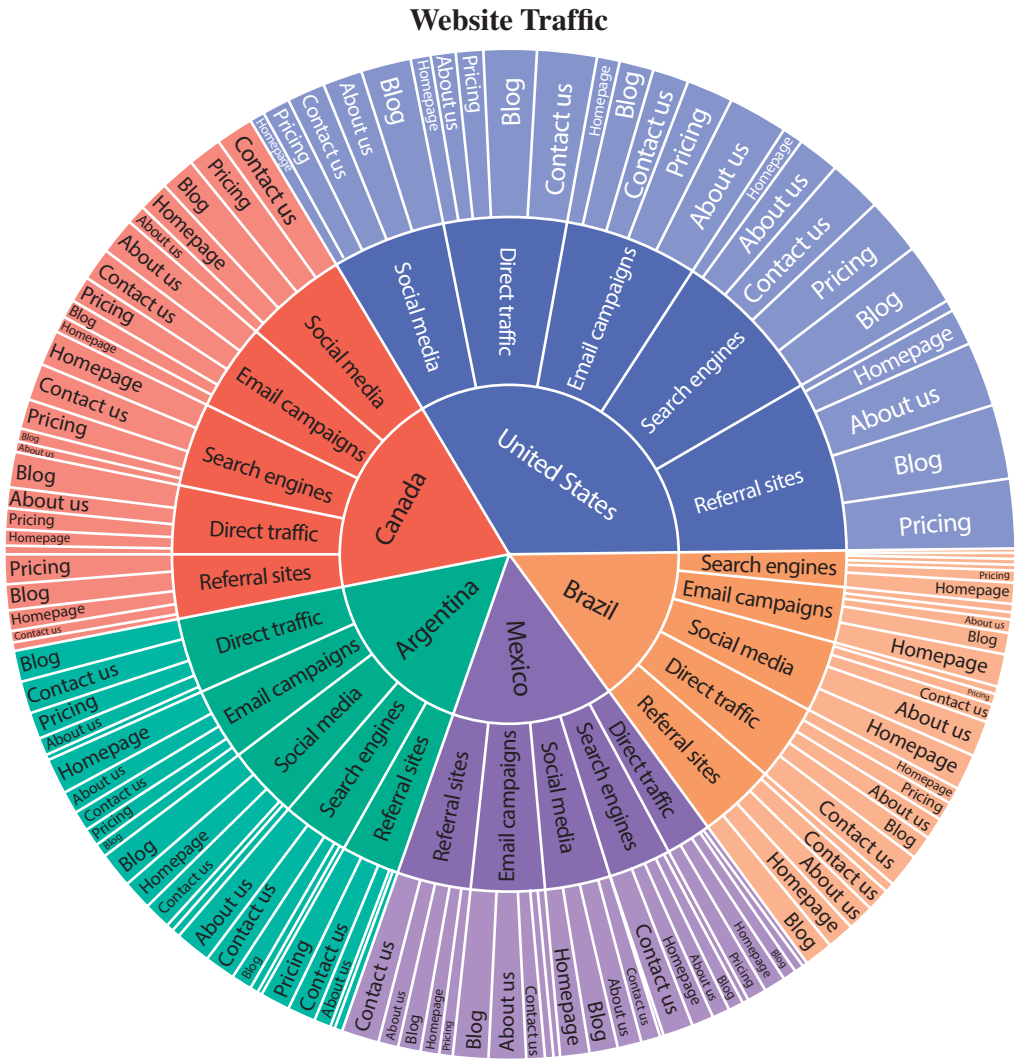
b Which product is rated worst for appearance?

c Which product is rated best for price?

d If you had to choose between these two products, explain which you would buy.

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

7 Use this sunburst chart to answer the questions that follow.



a What types of website traffic are being compared for the five countries in this graph?

b Which country has the greatest referral sites traffic?

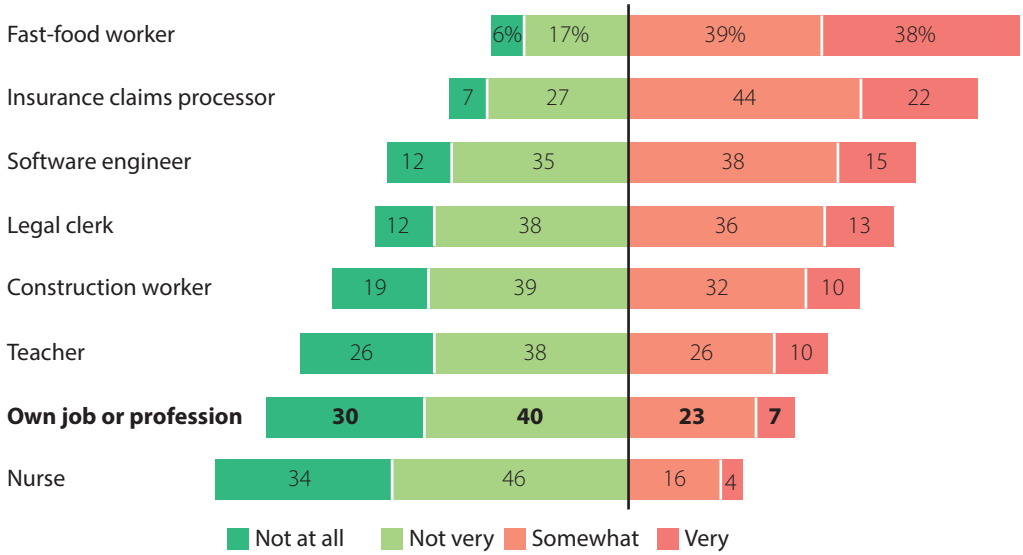
c Which country has the least search engine traffic?

d How does the social media blog traffic in Argentina compare with that of Mexico?

Mixed practice

8 People in different occupations were asked how worried they are about automation putting their jobs at risk. This is a graphical representation of the survey data.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.



Source: Graph created using Mekko Graphics and data from Pew Research Center

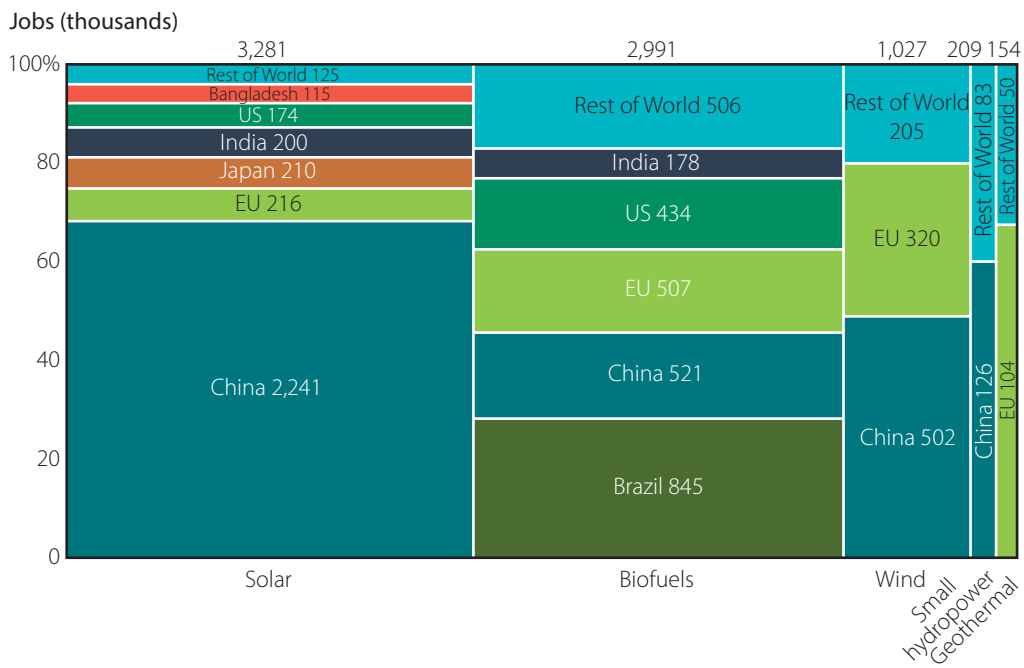
a Which occupation views automation as a major risk?

b Which occupation views automation as a minimal risk?

c Which occupation is about evenly split between worried and not worried?

d What could explain the 4% of nurses being very worried?

9 This graph shows the worldwide number of jobs in renewable energy.



Source: Chart created using Mekko Graphics and original data from International Renewable Energy Agency

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

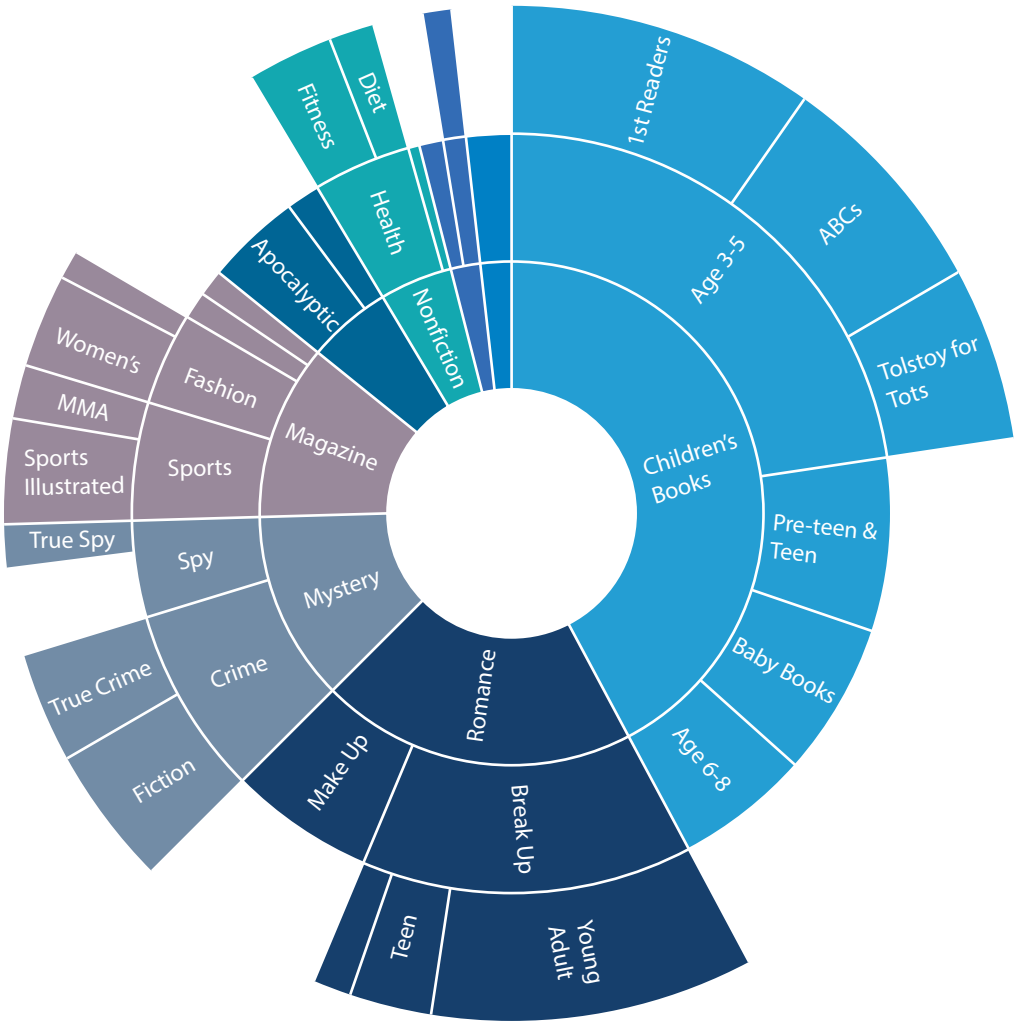
a Which country has the greatest number of jobs in renewable energy?

b Which are the renewable energies that employ the most people?

c What reason can you give to explain the Geothermal figures for the EU?

d What further information would you want from this data?

10 Look at this sunburst graph and answer the questions below.



a What could be the scenario that generated this graph?

b Which type of reading material is the most popular?

c Which two types of reading material are about the same in popularity?

d What types of reading materials do you think the missing data could be?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Application tasks

11 Many households are installing solar panels on their roof and harnessing the energy from the Sun to generate electricity. Depending on where you live, the amount of sunlight that is captured by solar panels varies. Use the Bureau of Meteorology internet site to download the global solar exposure for the capital cities in Australia for each month.

Use the 'conditional formatting' feature in an Excel spreadsheet to create a heat map of global sunlight exposure for each month across capital cities. (There are YouTube videos that explain the process – it is easier than you might think.)

a Which city receives the highest exposure of sunlight in a year?

b In what month and city is the solar exposure the lowest?

c In cities where the solar exposure is low, how can people install solar panels to achieve the greatest efficiency in generating electricity?

12 As fuel costs increase, people are often looking to buy cars with greater fuel economy. Use the internet to research 5–10 popular cars sold in Australia over the previous year and record the fuel economy and number of cars sold in a spreadsheet with the following column headings.

	A	B	C	D	E
1	**Car model**	**Fuel economy**	**Sale price**	**Number of cars sold in previous year**	
2					
3					
4					
5					

a Use an application such as Word or Excel to create an appropriate graph to present the data collected.

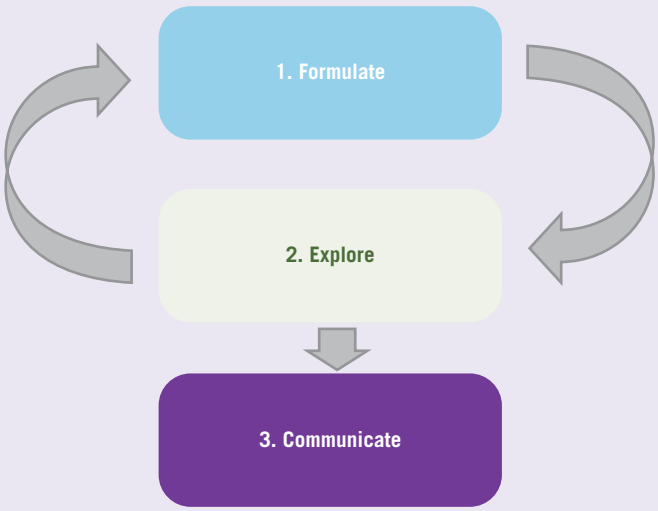
b What does the data display say about car buying habits of Australians last year? Do Australians prefer cars that are more fuel economic?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Investigations

When undertaking your investigations, remember the problem-solving cycle steps:

- **Formulate** – Sort out and plan what you need to know and need to do to solve the problem.
- **Explore** – Use and apply the mathematics required to solve the problem.
- **Communicate** – Record and write up your results.



1 The population of Australia

This investigation looks at Australia's changing population over the last 60 000 years.

Background information: The first immigrants

The first immigrants are believed to have travelled across from Sunda (modern Indonesia) to Sahul (Australia) at the time of an ice age when sea levels were low. This is believed to have occurred 60 000 years ago.

When the First Fleet arrived, it is believed that there may have been 750 000 Indigenous people living in Australia. The First Fleet landed 980 people at Sydney Cove in 1788. What percentage of Australia's inhabitants at that time were not Indigenous?

For a variety of reasons, it is difficult to obtain absolute figures for the Indigenous Australian population over time. However, the following set represents *minimum estimates* of Indigenous populations.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Year	Indigenous Australian population
1788	314 000
1861	180 402
1871	155 285
1881	131 666
1891	110 919
1901	94 564
1911	83 588
1921	75 604
1933	73 828
1947	117 000
1954	100 048
1961	117 495
1966	132 219
1971	150 076
1991	265 500
1996	353 000
2001	410 000

The following table compares the estimated Indigenous Australian population in the states in 1788 and 1861. What can you tell from the way that most of the values are rounded to thousands?

	1788	1861
NSW	48 000	16 000
Vic.	15 000	2 384
Qld	120 000	60 000
SA	15 000	9 000
WA	62 000	44 500
Tas.	4 500	18
NT	50 000	48 500
ACT		
Australia	314 500	180 402

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Formulate

a What other data is available about Australia's changing population? For example, can you find data for the Australian population from 1788? How could you look at trends? Is it possible to compare data for Indigenous population and non-Indigenous population? How?

Some key sites to explore to see what is available include:

- ABS (Australian Bureau of Statistics):
- Statista

b What key questions about Australia's changing population could you pose to investigate based on the available data?

Explore

c Locate and save any recent data you can find to update the tables provided on the previous page. Copy the data into Excel, and analyse the data, including representing data in graphs to enable you to look at trends up to the present day. Some possible questions that you could try to answer along the way include:

- Can you estimate the date when the Indigenous and non-Indigenous populations were equal?
- In what periods was Australia's population growing quickly?
- Can you predict what Australia's population will be in 2050?

Communicate

d Write up and present the findings of your investigation into Australia's changing population of Indigenous and non-Indigenous peoples. You could choose to write up a report or create a presentation that explains what you found out and your results.

You should:

- include displays of your data in graphs and tables
- compare the shapes of graph and charts you created to report on any trends you found
- highlight the statistical tools you used to do your research
- reflect on your research and what you found. Were you surprised? In what ways? Why?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

2 Florence Nightingale

This investigation explores the life of Florence Nightingale and the important role that mathematics, especially in graphical representation of data, played in her work and discoveries.

Background information

In the 1800s, Florence Nightingale became a very influential figure in the fields of nursing and public health, including sanitation and care of wounds. She is sometimes referred to as 'the lady with the lamp' visiting sick patients at night to check on their condition. Behind her success was her training in mathematics and the application of statistics in decision making.

Formulate

a Conduct research into the life and work of Florence Nightingale. Approach this investigation as a historian of mathematics and be sure to quote references for any information used. You may wish to explore in more detail the social effects of her work, again with reference to data from the time. Read about her life, taking note of key dates and events, and summarise your findings in a few paragraphs.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Your notes should include:

- a timeline showing events in her long life as well as major contemporary events in history
- the statistical knowledge and understanding amongst decision makers in military and political leadership at the time
- Florence Nightingale's role in relation to understanding data analysis.

Explore

b Based on what you found in the formulate stage, research how Florence Nightingale used her mathematical and statistical knowledge to analyse and interpret available data of her times.

- Include the tabular and graphical representations she used in her work in areas such as public sanitation, military hospitals and proper care of wounds.
- Decide on what data and issues you will research and document for your analysis and recreate some of her data and charts using Excel or Word.

Communicate

c You now need to write up and present the findings of your investigation into Florence Nightingale and the important role that mathematics and statistics played in her work and discoveries. You could choose to write up a report or create a presentation that explains what you found and your results.

You should:

- include a summary to highlight what calculations and use of statistics and data representations you encountered and needed to undertake in order to do your research.
- list the technology used in your research and presentation. What technology may have been used by Florence Nightingale to perform her work?
- reflect on your research and what you found. Were you surprised? In what ways? Why?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key concepts

- The standard ways or **conventions** in the way we write and represent statistical tables and graphs create better understanding and clearer communication about the information being studied.
- A **data table** is a universal tool for organising data, prior to analysing the data by graphs and statistical calculations. They can be a way of gathering raw data, which is then sorted into a **frequency table** as a step towards graphing and analysing the data. It is usually a good idea to have about 5–8 rows in such a table, so you need to decide on the **class interval** that covers the range of the data in steps of equal size.
- The most **common graphs** you see are pie charts, bar graphs (also called column graphs), histograms, line graphs and stem-and-leaf plots. The following features or conventions are important.
  - **Axes** which show the independent variable on the horizontal axis and the dependent variable on the vertical axis
  - **Scale** which shows the values of the variables and the units of measurement, with tick marks evenly spaced along the axes
  - **Legend** (or **key**) which shows which colour in a graph represents which variable
  - **Labels** which show the names of the variables
  - **Maximum** which is the highest or greatest value
  - **Minimum** which is the lowest or smallest value
  - Shape which may:
    - be **steady** when the graph isn't changing, it stays relatively horizontal (also called stable)
    - **increase** when the values (or graph) are going up (from left to right)
    - **decrease** when the values (or graph) are going down (from left to right)
  - **Trend** or pattern that is:
    - **predictable**: shows a pattern (steady, increase, decrease)
    - **unpredictable**: shows no pattern
    - **fluctuates**: varies up or down randomly.
- When **creating graphs or charts**, make them clear and professional looking to help the reader understand the information. Software such as Excel and Word have built-in tools for creating many different graph types from tabulated data. The **Chart Elements [+]** button allows you to change the appearance of the graph's axes, axis title, chart title, data labels, data table, gridlines and legend.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

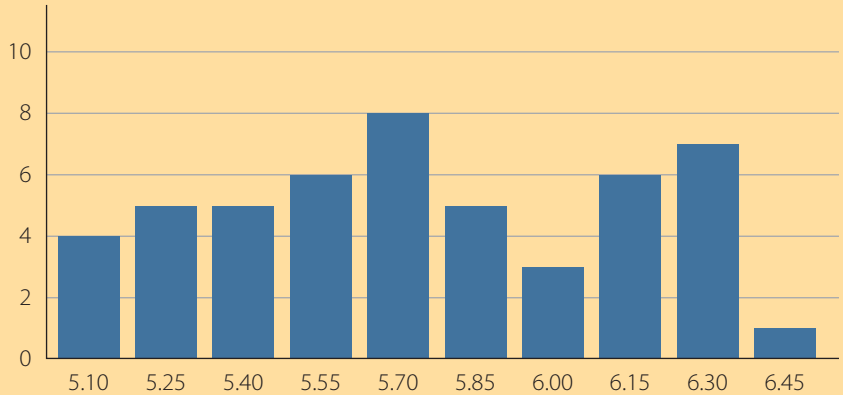
- A well-chosen graph will effectively tell the story of the data. But selecting the best graph depends on the purpose of the graph. As a student you will not be expected to create such complex graphs, but as a citizen/consumer you need enough familiarity to be able to read and interpret them.
- Some of the **contemporary graph types** are:
  - **Pictograms** use pictures or symbols to represent data values. Pictograms must have a key to show what each picture represents. Each picture must be of identical size.
  - **Bubble graphs** are used to visualise the relationship between three or more sets of data. One set of data is represented by the position along the horizontal axis, the second set of data by the position along the vertical axis and the third set of data by the size (area) of the bubble.
  - **Mekko charts** are a special type of bar chart. Standard bar charts represent data values by varying the height of the bars, but Mekko charts also vary the width of the bar. They display two numerical values for each category.
  - **Radar charts** (also called spider charts) compare multiple numerical variables. Each variable is represented by a spoke or axis which radiates from the centre of the chart. The values are represented by plotting the distance from the centre along these axes.
  - **Sunburst charts** display data that is hierarchical (in levels) through radiating rings from the centre. They are similar to pie charts in that each ring is segmented into proportions representing the components of each level.
  - **Heat maps** use variation in colour to represent values of numerical variables. Complex numerical data can be understood visually and quickly.
  - **Stacked area charts** are more complex line charts which track the value of a numerical variable against a second variable (usually time). The area between each line is shaded with colour or textures.
- A data set has known values. It can be useful to use the known values to determine what the other values are **within** the range of data (called **interpolation**), or to make an educated guess what the values might be **outside** the range of data (called **extrapolation**). An extrapolation assumes that any existing trend in the data will continue beyond the known range. A trendline for data sets can be used to make predictions based on the data.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

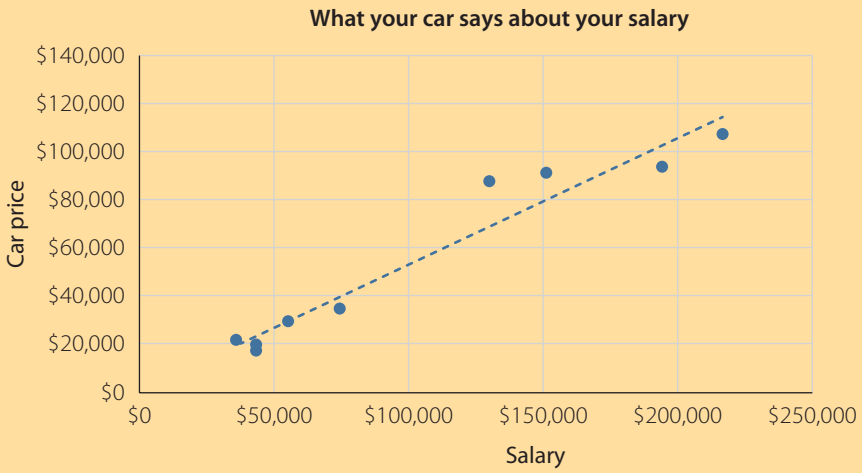
Success criteria and review questions

☐ I can work within the conventions of statistical representations.

1 Give two reasons why you consider this to be a poor histogram.



2 Examine this scatterplot.



Source: excel-easy.com

a Give five reasons why this could be considered a good scatterplot.

b Describe one way that you would make this scatterplot better.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

I can construct a frequency table, by hand or in a spreadsheet, and analyse its data.

3 Consider this frequency table.

Score x	Tally	Frequency f
3	|	1
4	||	2
5	|||	3
6	||||	4
7	~~||||~~ |	6
8	~~||||~~	5
9	||||	4
		25

a Give two reasons why this could be considered a good frequency table.

b Describe two ways that it could be improved.

I can interpret data from a frequency table.

4 The table below shows the results of a class of students voting for their favourite pizza from five options. Use the table to answer the questions that follow.

Type of pizza	Number of votes
Margarita	8
Cheese	6
Hawaiian	2
Veggie	4
The Works	5

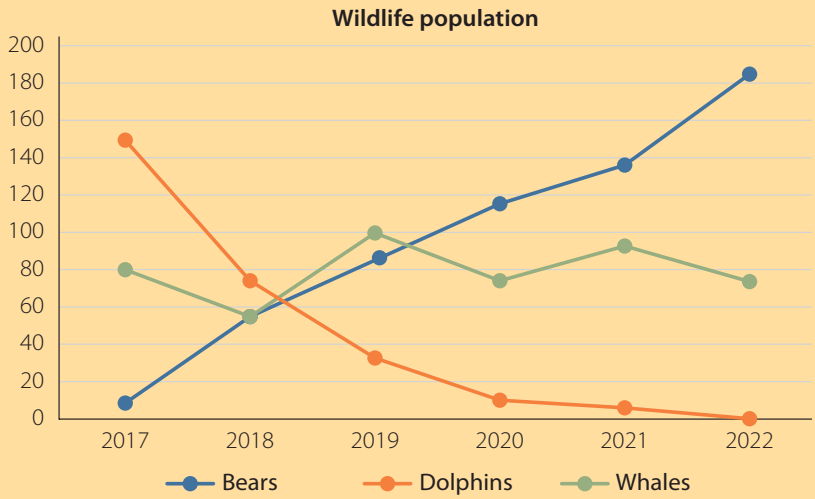
a How many students were surveyed?

b How many students would be happy with either Hawaiian or Cheese pizza?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

☐ I can read and interpret information in common graph types.

5 Use the line graph to answer the following questions.



Source: excel-easy.com

a What is the period of the data?
b What is the trend of bear population?
c What is the trend of dolphin population?
d What is the trend of whale population?
e What else would you want to know about the information given by this graph?

6 The back-to-back stem plot shows the percentage smoking rates for females and males in 20 countries. Use the stem plot to answer the following questions.

Key: 1 | 2 = 12%

Female		Male
9 8 8 6 6 5 4 3 2	1	3 7 8 9
9 7 6 6 6 6 6 4 2 1 0	2	1 2 4 4 5 6 8 8 8
	3	0 1 1 2 7 7
	4	6

a What is the highest percentage of female smokers?
b What is the highest percentage of male smokers?
c What is the most common percentage of male smokers?
d Is the percentage of female smokers lower and less variable than for the males? Explain your answer.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

I can use software to create graphs showing conventional title, labels and scales.

7 **a** Which common software program is the easiest to use when you need to construct a graph?

b How do you quickly and easily insert the title, labels and scales when you are constructing a graph using this program?

c What happens to your graph when you change the data in the table?

d Explain how to adjust the number of class intervals for a histogram.

8 Use a software program to construct an appropriate graph for the following sets of data.

a Scores made by a basketball player in a season

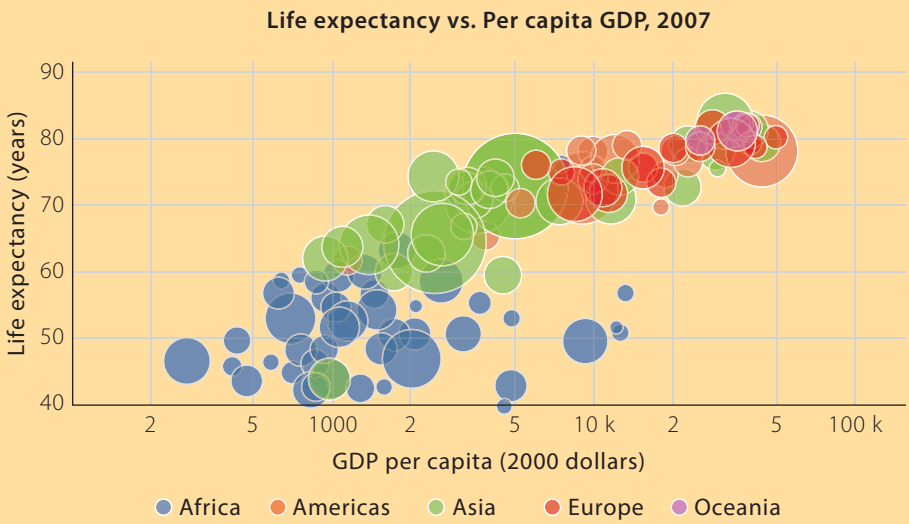
12	14	2	16	22	14	8
6	12	10	4	7	21	16
11	3	5	17	6	12	7
11	9	4	15	19	5	8

b Favourite flavoured milk of students in a class

chocolate	vanilla	salted caramel	chocolate	strawberry
mint choc	chocolate	mint choc	strawberry	coffee
mint choc	chocolate	vanilla	mint choc	mint choc
coffee	chocolate	salted caramel	chocolate	strawberry

I can read and interpret contemporary graph types that have special purposes.

9 Use this bubble graph to answer the questions that follow.

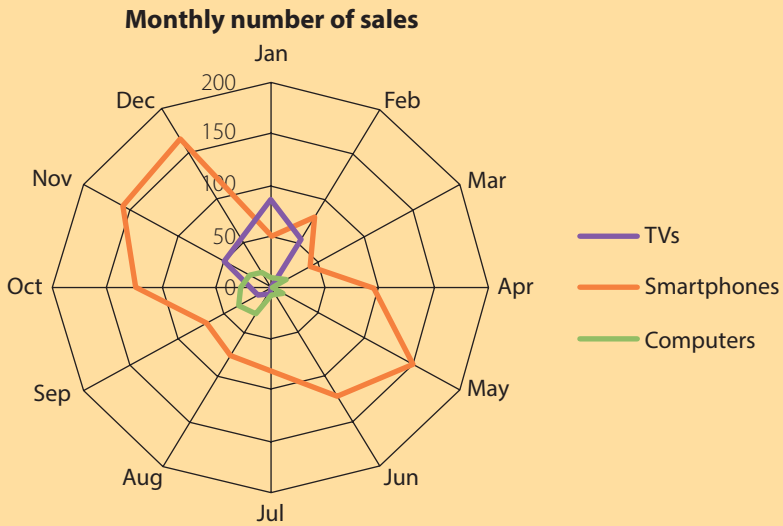


ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

a What's the graph about?
b What does it show about African countries?
c What does it show about the Americas?
d What's the relationship between a country's GDP and the life expectancy of the population?

10 If you needed to make a graph that shows male/female/gender-neutral incomes in a specific industry over a set time period, what sort of graph would you make?

11 Use this radar (spider) chart to answer the questions that follow.



Source: Chart created using the QI Macros SPC Software for Excel developed by Jay Arthur, www.qimacros.com

a According to this radar chart, which item sold more than the others?

b Which was the peak month for TV sales?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mathematical toolkit

1 Reflect on the range of different calculations, technologies and tools you used throughout this chapter, and how often you used them for undertaking your work and making calculations. Indicate how often you used and worked out results and outcomes for each of these methods and tools.

Method and tools/ applications used	How often did you use this?
• Calculating and working in your head, and using algorithms	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using pen-and-paper	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using a calculator	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using a spreadsheet	Not at all: ☐ A little: ☐ Quite a bit: ☐
• Using measuring tools – name the tool, technology or application: _____ _____	Not at all: ☐ A little: ☐ Quite a bit: ☐ Not at all: ☐ A little: ☐ Quite a bit: ☐
• Using other technology or apps – name the technology or application: _____ _____	Not at all: ☐ A little: ☐ Quite a bit: ☐ Not at all: ☐ A little: ☐ Quite a bit: ☐

2 Did this chapter and the activities help you to better understand how you use different tools and technologies in using and applying mathematics in our lives and at work? In what areas and ways? Write down some examples.

3 In one sentence, explain something relating to tools and technologies that you learned in the unit. Write an example of what you learned.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key vocabulary

Here is a list of this chapter's key maths terms and their meanings.

Term	Meaning
Back-to-back stem plot	Two *stem-and-leaf plots*, one with its leaves on the left of the stem and the other with its leaves on the right. Useful for comparing two variables.
Bar chart/graph	A graph where the values are plotted as rectangles or bars.
Bin width	In the USA and some other countries, this is a common way of referring to *class interval*.
Class interval	When raw data is organised into groups of values, the width of each group of values is called the class interval. The class intervals should have the same width for the whole data set. In the USA, this is called *bin width*.
Column graph	See *Bar chart/graph*.
Conventions	Agreed and standard ways of working with and displaying data 'as expected'.
Correlation	Correlation is about seeing if variables seem to be related to each other – is there a connection or interdependence between two or more things.
Dependent variable	The variable being tested and measured in a study or experiment. The dependent variable is 'dependent' on the *independent variable*. It is usually shown on the vertical axis of a graph.
Excel	A software program by Microsoft that uses spreadsheets to organise, display and analyse data.
Extrapolation	Using a set of known values to make an educated guess what the values might be **outside** the range of data. An extrapolation assumes that any existing trend in the data will continue beyond the known range.
Frequency	The number of times a value occurs in a set of data, i.e. how many there are of each measurement.
Grouped data	A large amount of raw data is organised into a smaller number of groups of values.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

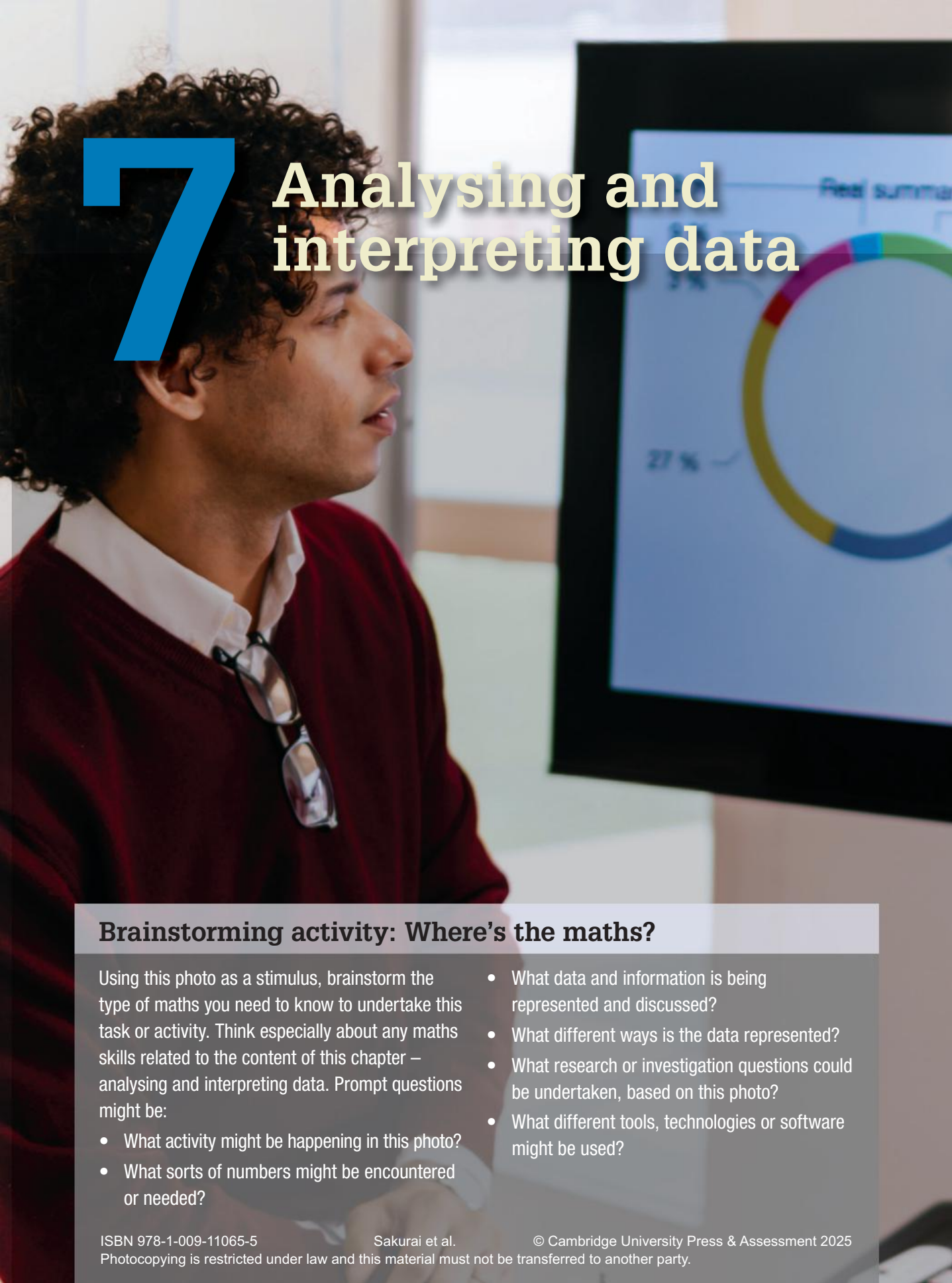
Term	Meaning
Histogram	Similar to a bar graph, but a histogram groups numbers into equal ranges or *class intervals*, usually when displaying the frequency distribution of continuous numerical data.
Horizontal axis	The border line that runs along the bottom of a graph (can be referred to as the *x*-axis). The *independent variable* is usually on the horizontal axis.
Independent variable	The variable that is changed or controlled in a study or experiment to test the effect on the *dependent variable*. It is usually shown on the *horizontal axis* and its value usually changes in regular steps.
Interpolation	When known values are used to determine what other values are **within** the range of data.
Interpreting	Reading data or a graph and deciding and talking about what is happening with the data.
Line graph	A graph where the values are represented by single points that are joined together by straight lines. Often used when the *horizontal axis* represents a time variable.
Line of best fit	See *Trendline*.
Maximum	The highest or greatest value in a table or on a graph of a set of data.
Minimum	The smallest or lowest value in a table or on a graph of a set of data.
Percentage frequency	The *frequency* expressed as a percentage of the total number of frequency values.
Pie chart/graph	A chart or graph where the set of values is represented as parts of a circle.
Relative frequency	The *frequency* expressed as a decimal proportion or fraction of the total number of frequency values.
Scale	The marks or graduations on the axes that give you the values being recorded.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Term	Meaning
Scatterplot	A graph displaying the relationship between two variables. Each pair of data values is represented by a point.
Stem-and-leaf plot	A method of displaying numerical data in which each data value is split into two parts, a 'stem' and a 'leaf'; for example, the notation 5 | 3 7 shows the values 53 and 57. Stem plots provide a visual indication of spread. Each stem-and-leaf plot must have a key.
Table	A way of presenting data in columns and rows.
Trend	Any pattern that is showing up on a graph, such as: • predictable – shows a pattern (increase, decrease, steady or stable) • unpredictable – shows no pattern • fluctuates – varies up or down randomly.
Trendline	A line that portrays the overall trend of the points on a graph (usually a scatterplot). It is also called a line of best fit.
Vertical axis	The border line that (normally) runs up the left-hand side of a graph (can be referred to as the y-axis). Some more complex graphs may also have a vertical axis up the right-hand side. The *dependent variable* is usually on the vertical axis.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

7 Analysing and interpreting data



Brainstorming activity: Where's the maths?

Using this photo as a stimulus, brainstorm the type of maths you need to know to undertake this task or activity. Think especially about any maths skills related to the content of this chapter – analysing and interpreting data. Prompt questions might be:

- What activity might be happening in this photo?
- What sorts of numbers might be encountered or needed?
- What data and information is being represented and discussed?
- What different ways is the data represented?
- What research or investigation questions could be undertaken, based on this photo?
- What different tools, technologies or software might be used?

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter contents

Chapter overview and Spotlight

7A Starting activities
7B Tuning in
7C Interpolation and extrapolation
7D Measures of central tendency
7E Measures of spread
7F Seeing the bigger picture
7G Telling the story
7H Twisting the data
Investigations
Chapter review

From the Study Design

In this chapter, you will learn how to:

- accurately read and interpret charts, tables and graphs including prediction, interpolation and extrapolation of data
- calculate summary statistical data using common measures of central tendency and spread, including standard deviation
- use statistical language to describe, compare and analyse data sets, in terms of centre, spread, relationship and sample size
- draw inferences and conclusions, and explain any limitations and implications of a statistical study
- identify and interpret any errors and misrepresentations in data sets (Units 3 and 4, Area of Study 2).

© Victorian Curriculum and Assessment Authority 2022

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter overview

Introduction

Analysing data allows us to make informed decisions based on evidence. Data has high importance in today's society as it is collected and used in most spheres of life. For instance, it is unusual to buy something without your data being collected. Have you ever questioned what happens with that data and how it is used and analysed? We are bombarded by data and data requests multiple times each day, so it is important to understand how data is used and analysed.

Given the importance placed on decisions backed by data, the ability to critically review the data you are exposed to and any published analysis or information is vital. Whether it's choosing a career path, voting in elections, or managing personal finances, analysing and understanding data helps you weigh up options and choose wisely. Interpreting data can be used for crucial decisions in personal life, such as whether to have a life-saving medical intervention, or in business such as for targeting advertising.

This chapter focuses on the final two stages of the statistical cycle: analysing data and interpreting results. Data analysis isn't just for experts – it's a skill that every citizen can develop to navigate the complexities of the modern world.

Learning intentions

By the end of this chapter, you will be able to:

- understand interpolation and extrapolation
- find summary statistics and measures of centre and spread for data sets
- read and interpret different types of graphs
- critically analyse graphical representations
- understand how data may be portrayed incorrectly
- determine limitations of data presentations and analysis.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Spotlight: Katherine Carfi

An interview with a project developer

Tell us about your job and some of the work that you do.

I work at one of the leading universities in Victoria managing the delivery of major projects that align with the university's strategic ambitions. This is great because it can be quite varied. One day I can be managing the development and launch of new academic programs to market or working with our amazing research centres, and the next I can be coordinating major service improvements for our students.

What maths do you use regularly in your work?

Statistics and accounting without a doubt. The first step of any major project is to define the objective and the scope of tasks required to deliver that. To help define that objective, we conduct competitor research or 'sector scans' to see what opportunities exist in the market. Once we have defined the objective and tasks, we need to establish what it will cost to deliver the project and what revenue it will bring in as a return for the attributed ongoing costs. I then work very closely with our finance team to track that, ensuring we stay on budget throughout delivery.

What is the most useful maths-related tool or piece of technology in your work?

I use commonplace project management tools daily (MS Project, SmartSheets, Excel etc.) that have built in functionality to assist with these tasks. However, I am always checking to see what else is out there that may be more accurate or efficient. My workplace also has an in-house generative AI tool that we can use securely to analyse data. It's incredibly important to stay abreast of emerging technology in this space, however I would always double-check the accuracy of any output. Technology is great, but it doesn't beat human consideration!

What was your attitude towards learning maths in school?

Very apathetic! I had a personal interest in humanities and creative arts, and maths did not come naturally to me at all. I saw maths as a series of confusing formulas and equations and didn't understand its applications. I completed maths in year 10 and didn't look at maths again until the second year of my undergraduate degree. I would say my attitude towards maths has now changed very much. Early in my career I began to see just how much of my work would revolve around maths. I realised I would need to 'go back to school' and relearn so many things I didn't previously consider important. While I wouldn't think of maths as a passion of mine, there is a huge satisfaction now in delivering my projects knowing I have the data and financials to back up my work.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

7A Starting activities

Activity 1: Hands-up

Survey your class to gather data on two of the following questions.

- If you could be any Australian animal, which animal would you be?
- If you were a hamburger, which hamburger would you be?
- If you were an emergency services worker, which emergency services worker would you be?
- If you could be an Olympian, which sport would you compete in?

1 Graph each **data set** using a different display for each graph.

2 Give three statistical facts about each data set.

3 Present your findings to the class using visual displays.

Activity 2: Human graph

Make x- and y-axes on the floor using masking tape.

The x-axis should represent the hours of sleep each night, and the y-axis should represent the hours each night spent using social media.

Without using data values, students should position themselves on the graph.

1 What kind of graph did you make?

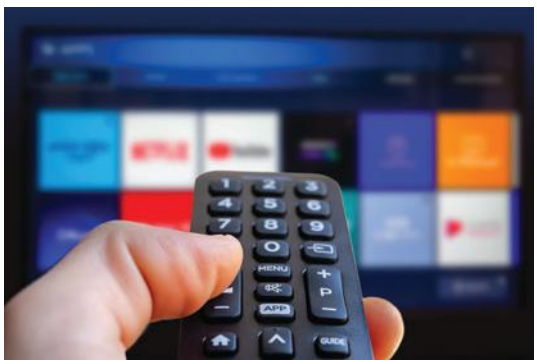
2 Can you see a trend or pattern based on where people are standing?

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

7B Tuning in

Epic Success: Netflix and big data

The big success of streaming services such as Netflix is the ability to predict what users want to watch. In 2022, Netflix had revenue of $30 billion! That is, $30,000,000,000 USD. How has Netflix reached this pinnacle?



One of the main reasons for their success is their ability to **collect, analyse and use data** to build a library of shows and movies that their users want to watch.

Netflix collects data from all of their subscribers worldwide, such as which shows are watched, how fast they were viewed, and how quickly series were consumed. They can tell when users pause and restart, or rewatch and more. They collate user profiles and use this to predict future viewing preferences, offering shows to their customers that, through their profile builder, they know the consumer will enjoy.

The mathematics behind all this data is called *data analytics*, and they use 'big data' to build mathematical models and algorithms.

Discussion questions

1. Make a list of all the data that might be collected about you by a streaming service.
2. Do different services target different demographic groups?
3. Research the streaming services in Australia from most popular to least popular.
4. Find articles or information and data about their usage, especially those that provide some graphics or infographics that show their usage.
5. Did they use any measures of spread or central tendency? Which ones?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Practice questions

1 Make a list of at least five digital applications or software that you know of or can find that could be used for data collection and or analysis. What does each one allow you to do?

2 List three organisations or companies from different industries that use big data. For each company explain how big data improves or supports their business.

3 Find an organisation or company that produces and publishes the results of data they collect and analyse. For example, it could be a state, national or international sports team or organisation.

   a Find some examples of their data and how they report it.

   b How do they provide access to the data or results? For example, do they provide tables, downloadable spreadsheets, charts or infographics?

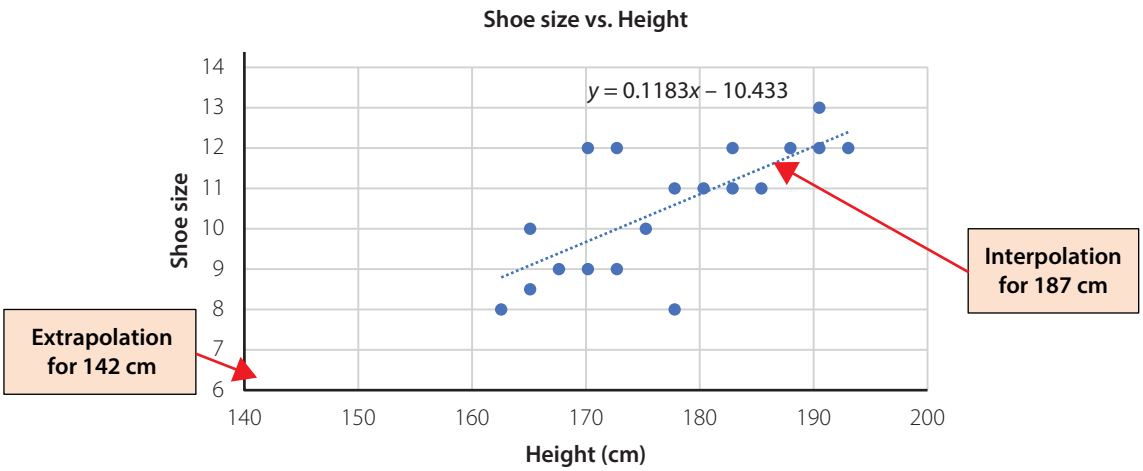
   c Write a brief report about how they do this and what statistical processes they use.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

7C Interpolation and extrapolation

Sometimes when we look at data sets, we find that the data can have gaps or that we need to find values that lie outside that data set.
In Chapter 6, we looked at some data about the relationship between people's height and shoe size, and we introduced the idea of **interpolation** and **extrapolation.**

Here is that data again, with an extended horizontal scale. The trendline represents the 'line of best fit' for the data, and its equation can be used to give the 'best estimate' in a statistical sense for any value being interpolated or extrapolated from the data.



Interpolation is when we make predictions **within** the range of the data set that is given. For example, estimating the shoe size for someone who is 187 cm tall.

Extrapolation is the prediction of numbers **outside** of a data set. For example, to predict the shoe size of a child that was 142 cm tall, we could use the equation of the trendline but this prediction may not be very reliable. An extrapolation assumes that any existing trend in the data will continue beyond the known range.

Note: Extrapolation is a method used to make predictions about the future or hypothetical situations based on existing data. It involves extending known information beyond the observed range. For example, extending the line or curve that you've created through interpolation beyond the range of your data. Extrapolation should be used with caution as it assumes that the trend observed within the data will continue outside the range of the data, which may not always be the case.

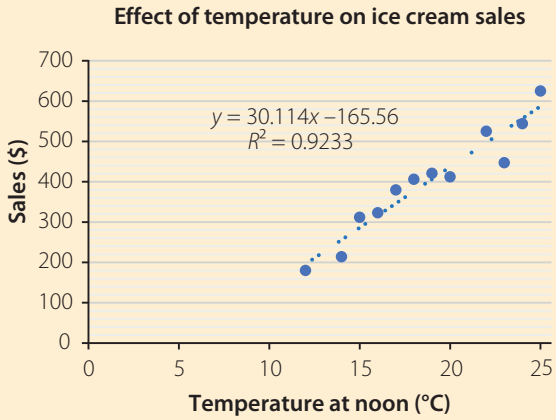
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 1 Using a trendline for interpolation and extrapolation

In Chapter 6, we used Microsoft Excel to graph data and generate a trendline and its equation for the effect of daily temperatures on ice cream sales.
Use the equation of the trendline to answer the following.

a What is the estimated sales value if the noon temperature is 21°C?

b What is the estimated sales value if the noon temperature is 35°C?



THINKING	WORKING
STEP 1	
Write the equation of the trendline. The variable shown along the x-axis is temperature and the variable shown along the y-axis is sales of ice cream.	$y = 30.114x - 165.56$ where x is the temperature at noon (in °C) and y is the sales of ice cream (in $)
STEP 2	
Since we are making estimates, round each number to the nearest integer.	For estimating values, we can use $y = 30x - 166$
STEP 3	
Substitute each noon temperature into the equation. That is, substitute a value for x to find the corresponding y value. Write your answers.	**a** $x = 21$ $y = (30 \times 21) - 166$ $= 464$ (interpolated value) On a 21°C day, the sales are expected to be about $464. **b** $x = 35$ $y = (20 \times 35) - 166$ $= 884$ (extrapolated value) On a 35°C day, the sales are expected to be about $884.

Notice how the last three data points on the graph seem to be rising quite fast. The trendline may be different if we had actual values for temperatures in the high 20s or low 30s range.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

7C Tasks and questions

Thinking task

1 Not all data lends itself to interpolation or extrapolation. Use the internet to find the following four sets of data. Explain your choice in each case.

a One set that can be extrapolated

b One set that can be interpolated

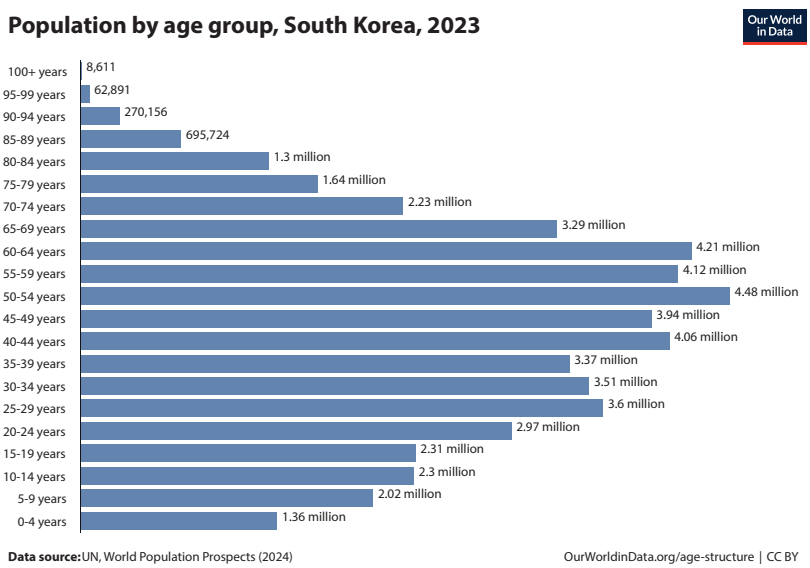
c One set that cannot be extrapolated

d One set that cannot be interpolated.

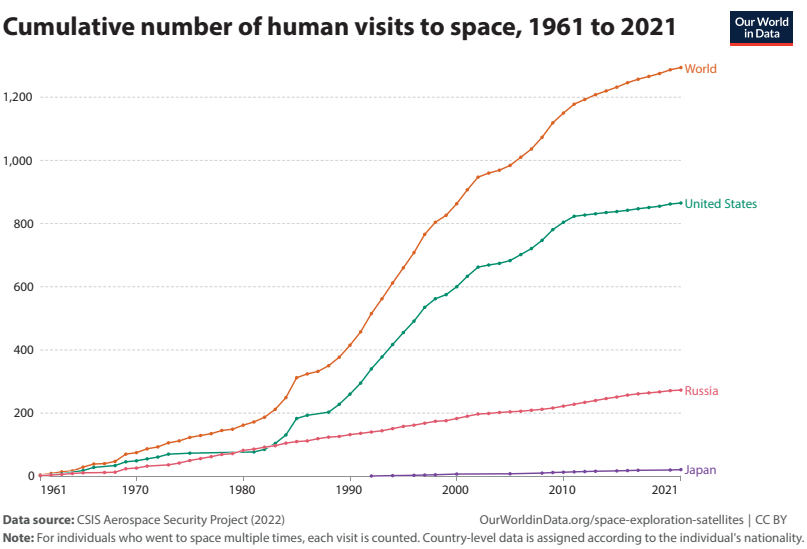
Skills questions

2 For each of the following graphs, determine if values could be interpolated or extrapolated from the data. Give a reason for each decision.

a

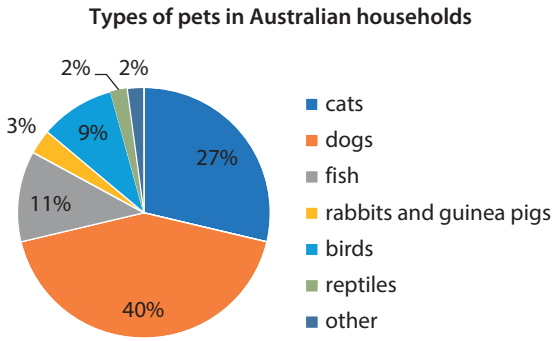


b



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

c



3 For the following data sets, interpolate and/or extrapolate the data as stated.

a The table shows the average score on knowledge-based tests for the top-performing AI systems between July 2019 and December 2023.

Date	Average test score
Jul 19	27.9%
Nov 19	32.4%
Sep 20	53.9%
Dec 21	60%
Oct 22	74.1%
Mar 23	86.5%
Dec 23	90%

Source: Our World in Data

Estimate the AI test scores for:

i March 2019

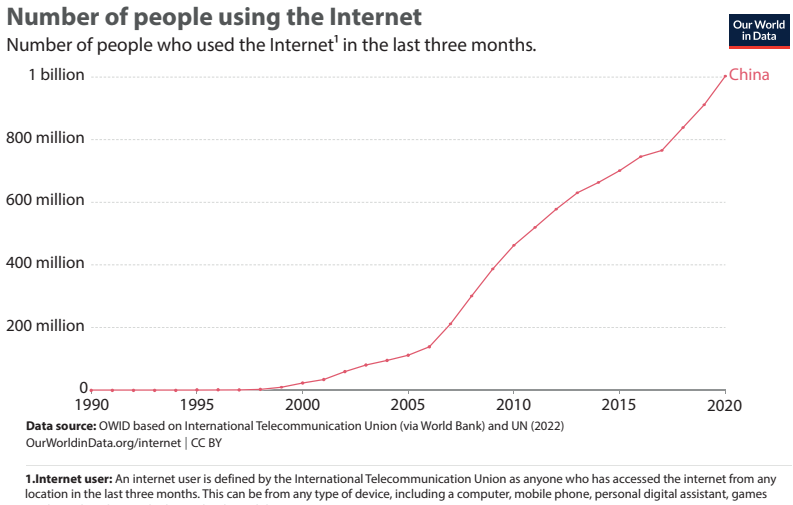
ii June 2020

iii April 2022

iv April 2024

v December 2024.

b The number of internet users in China from 2010 to 2020 is shown below.

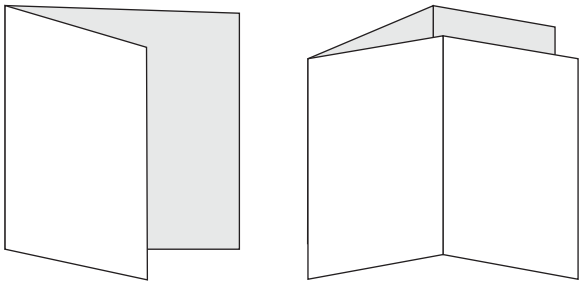


Estimate the number of users in:

i 2011 **ii** 2017 **iii** 2021 **iv** 2025

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4 Now we're going to use our data recording and interpretation skills to extrapolate an answer to a problem that we can't do physically, because it is very difficult to fold a piece of paper more than six or seven times.



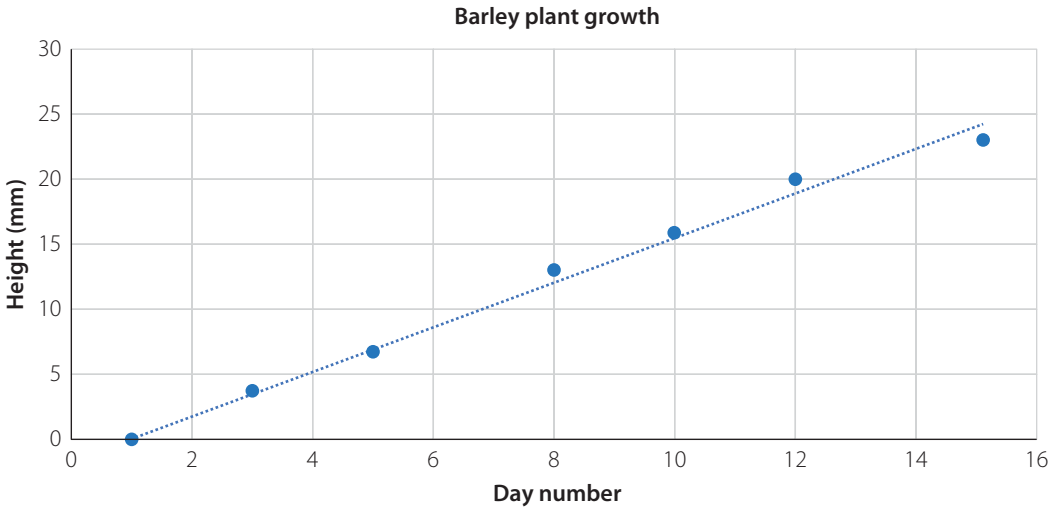
When you take an ordinary piece of paper, it has a thickness of one sheet and has no creases. Fold this piece of paper in half. It now has a thickness of two sheets and has one crease. Now fold it in half again, but make sure that you fold it in the **same direction**. It now has a thickness of four sheets and has three creases.

a How many thicknesses and creases will the piece of paper have if you could fold it in half, in the same direction, ten times? Create a table for this data.

b Show the results of your table as a graph of your choice.

Mixed practice

5 The height of a barley plant is measured over a two-week period. The graph of height versus day number is shown below.



a From the graph, predict the plant height on day 6. Is this an example of interpolation or extrapolation?

b From the graph, predict the plant height on day 20. Is this an example of interpolation or extrapolation?

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6 The following data set shows the annual total health expenditure per person in Australia from 2010 to 2020 (in Australian dollars).

Year	Health expenditure per person ($)
2010	3608.06
2011	3791.20
2012	3807.51
2013	4182.51
2014	4689.07
2015	k
2016	5059.31
2017	5136.07
2018	5337.98
2019	5389.84
2020	5929.98

Source: Our World in Data

a Graph the data using technology and include a title, axis titles and scale.

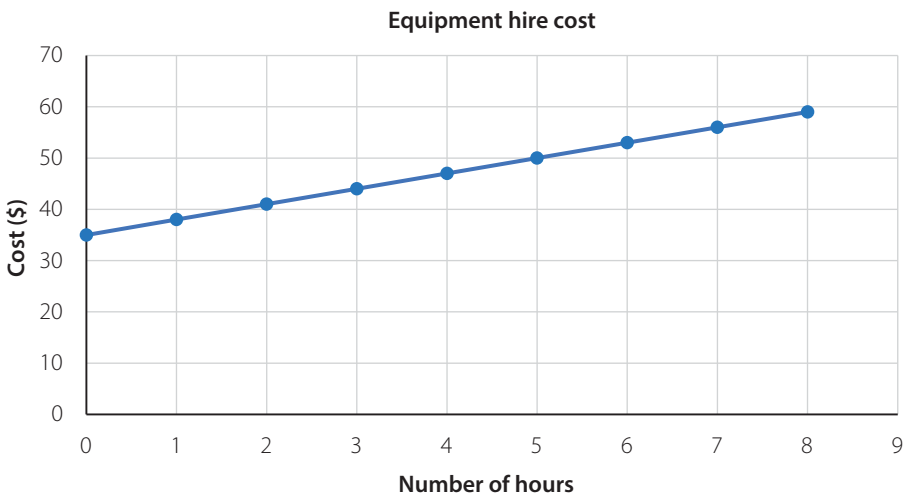
b Generate a trendline and its equation.

c Use the equation to interpolate the missing value (k) for 2015.

d Extrapolate a value beyond the data.

Application task

7 Bhai has a water blasting machine that he rents out. The cost structure is reflected in the graph below.



a If you have $50, how many hours can you rent a machine for?

b How much will it cost to rent a machine for 2 hours?

c How much will it cost to rent a machine for 9 hours?

d Write a formula for the cost of renting the machine.

e Using the formula, show how much it will cost to rent the machine for 20 hours.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

7D Measures of central tendency

In our lives, we often talk about averages – it might be about the average temperature, or it might be about the average fuel consumption of cars, or even our average scores on tests at school or in the sports we play. Averages are often used in relation to wages, average rental values or house prices. The **average** is a useful piece of information to have – it gives a quick overview or summary of a large amount of data.

Summary statistics help us understand what's typical or common in a group of numbers or set of data. Measures of **central tendency** refers to a summary statistic that represents the **middle** of a data set.

In this section, we will look at three different types of averages, the **mean**, **median**, and **mode**, and how they are calculated.

It is important to understand that these summary statistics may or may not be useful depending on the context of the data. Refer back to Chapter 6 of the Units 1 & 2 textbook if you need to refresh your skills.

The **mode** is the most commonly occurring data value, or the most frequent value in the data set. It's possible to have no mode, one mode, or more than one mode.

The **median** is the middle value of all the values when they are in order from smallest to largest. That means that there will be a half or 50% of all the values less than the median value, and 50% higher than it. If there is an odd number of values, then there will be exactly one central value, but if you have an even number of values, you will need to find halfway between the middle two values as your median.

If the data set is small, this can be done manually, but with larger sets of data, the position of the middle value can be calculated as follows:

The position of the median for n data points is located at the $\left(\frac{n+1}{2}\right)$th position.

- If the number of data points (n) is odd, the number in the middle of the list is the median – the middle value is unique.
- If the number of data points (n) is even, then the median is the simple average of the middle two numbers.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

The **mean** is found by adding together all the values we have and dividing by the number of values there are. The mean is commonly called the **average**.

The formula for calculating the mean of a list of numbers is:

$$\text{Mean} = \bar{x} = \frac{\sum x_i}{n}$$

where $\overline{x}$ is the mean, and:

$\sum$ is the symbol for 'the sum of' (meaning to add everything together)

x_i represents each value in the data set

n is the number of values in the data set.

Let's start by looking at a simple set of data.

Example: Daily number of hamburgers sold

Here is some data for the daily number of hamburgers sold at a local café for the last fortnight.

18	15	30	30	17	21	15
17	30	19	30	13	18	21

If we sort these data values in order from smallest to largest, we get:

13 15 15 17 17 18 18 19 21 21 30 30 30 30

For the **mode**, the value with the highest number of values is 30, so the mode is 30 hamburgers.

For the **median**, we find the middle value or values. Here, because there are an even number of values, the position will be calculated as the number that is halfway between the two middle numbers. Because there are 14 values, the middle two values are the 7th and 8th values.

Alternatively, using the formula for n data points, the median is at the $\left(\frac{n+1}{2}\right)$th position.

With $n = 14$, the median is at the $\left(\frac{14+1}{2}\right)$th position or 7.5th position, which agrees with our thoughts above.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

The median value is therefore halfway between the 7th and 8th values.

13 15 15 17 17 18 18 19 21 21 30 30 30 30

Halfway between 18 and 19 is 18.5. So, the median number of hamburgers sold daily was 18.5 hamburgers.

For the **mean**, we need to add all the data values together to find the sum of the data set first, then divide by the number of values (14).

$$\text{Mean} = \bar{x} = \frac{\text{sum of data values}}{\text{number of data values}}$$

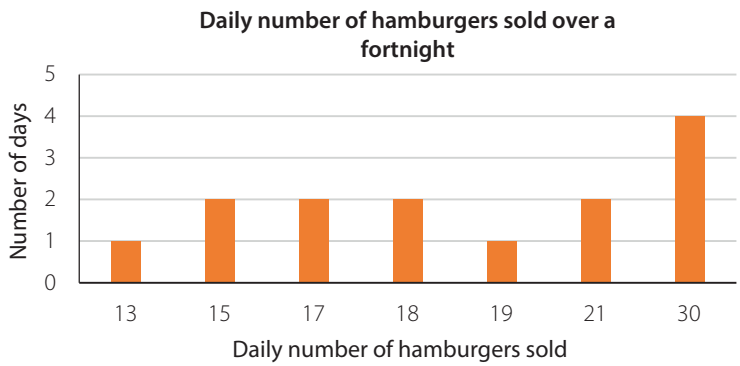
$$\bar{x} = \frac{13+15+15+17+17+18+18+19+21+21+30+30+30+30}{14}$$

$$= \frac{294}{14}$$

$$= 21$$

The mean number of hamburgers sold daily was 21 hamburgers.

In this example, you can see that the mode (30), the median (18.5) and the mean (21) are all quite different values. This indicates that the data is not a regular or symmetrical spread of values. This is best seen from a graph of the data.



To further investigate the measures of central tendency and how they can be used to help analyse a more complex and realistic data set, we will look at the following example.

Example: AFL data set

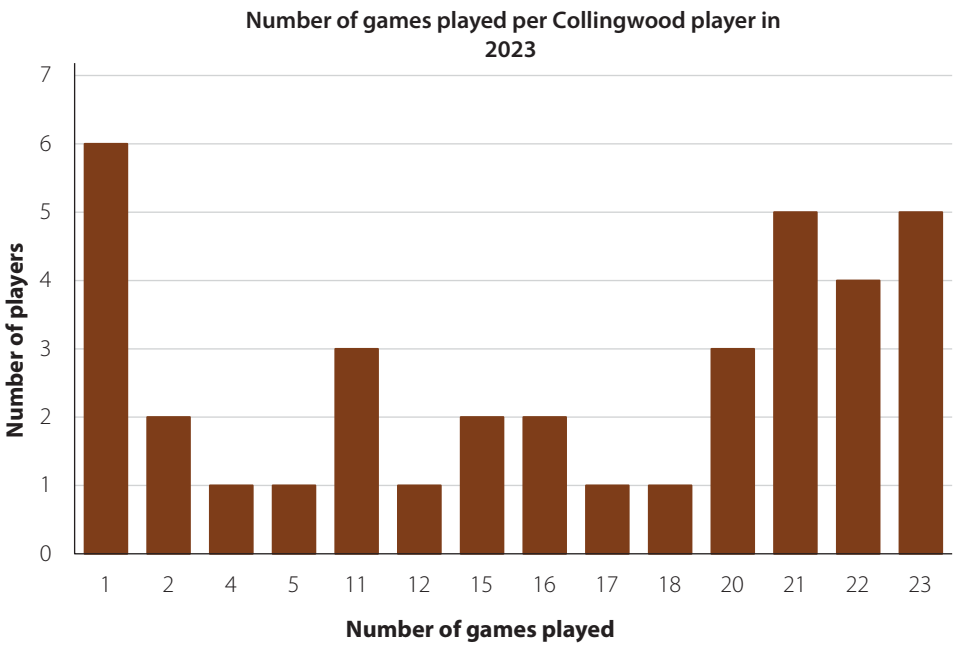
Data on the number of games played by Collingwood football players in the 2023 AFL season was collected. Over the regular season, 23 games were played, and 37 different players played at least one game. The data is shown in the following table.

We often call the number of times each value in the data set occurs the **frequency**, and represent this using the letter *f*.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Number of games played	Number of players (frequency)
1	6
2	2
4	1
5	1
11	3
12	1
15	2
16	2
17	1
18	1
20	3
21	5
22	4
23	5
Total	**37**

This data can be shown in graphical form.



Let's work out the mode, median and mean of this set of data.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

It is clear from both the graph and the table that most players played one game only.

- 1 on the horizontal axis has the largest value (6) on the vertical axis.
- More players played one game than any other number of games.

Therefore, the **mode** of this data set is 1 game played during the season.

For finding the median, there are 37 data values.

$$\text{Median} = \frac{(37+1)}{2}\text{th value} = 19\text{th data value}$$

Interpreting this in terms of the number of games played, tells us that we need to find the 19th player when they are in order from smallest to highest number of games played. Looking at the table, you can add up the number of players as you work down the table (running total) until you get to the 19th value. This appears against 17 games played.

Note: The running total is also called the **cumulative frequency** – we will look at this again later.

Number of games played	Number of players (frequency)	Running total
1	6	6
2	2	8
4	1	9
5	1	10
11	3	13
12	1	14
15	2	16
16	2	18
17	1	19
18	1	20
20	3	23
21	5	28
22	4	32
23	5	37
Total	**37**	

Therefore, the **median** number of games played by the Collingwood players in 2023 was 17 games.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

To calculate the mean from a frequency table, we use a variation on our formula for the mean where to get the total we multiply each value (x) by its frequency (f) and then add all of those values up to get the overall total. This is shown in this formula.

$$\text{Mean} = \bar{x} = \frac{\sum(f \times x)}{\sum f} = \frac{\text{sum of all our data values}\left(\text{frequency} \times \text{value}\right)}{\text{sum of frequencies}\,(n)}$$

Here is our table of values with (frequency × value) calculated and shown in the third column.

Number of games played (value, x)	Number of players (frequency, f)	Frequency × value ($f \times x$)
1	6	6
2	2	4
4	1	4
5	1	5
11	3	33
12	1	12
15	2	30
16	2	32
17	1	17
18	1	18
20	3	60
21	5	105
22	4	88
23	5	115
Total	**37**	**529**

$$\begin{aligned}\text{Mean} = \bar{x} &= \frac{\sum(f \times x)}{\sum f} \\ &= \frac{529}{37} \\ &= 14.297\,297\ldots\end{aligned}$$

Rounding to a whole number, the **mean** is 14 games played per player over the season.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

In this example, you can see that the mode (1), the median (17) and the mean (14) are all quite different values.

Why do you think these three measures of centre are quite different?

Which measure of central tendency do you think is the best measure? Why?

Look back at the graph of the data to help you.

In some cases, the mean is not the best measure of central tendency to consider, such as when the data is skewed to the left or right or it has little regular patterns in the data. The mean is good to use when the data is uniformly spread around the middle values (we call this a bell-shaped curve or a **normal distribution**). If you look at the graph above of our data about the number of games played, you can see that it is not a regular or **symmetrical distribution**.

Also, in a data set with an extreme value, called an **outlier**, the mean may be distorted. We will look further at this issue of skewness in section 7G.

Below is some more explanation about outliers.

Outliers

Outliers are data points that significantly deviate from the average or the rest of the data set. They can have a substantial impact on statistical analyses and lead to inaccurate or misleading interpretations of the data. One of the key issues about outliers is that they can distort the mean of the set of data. This happens when there are one or two extreme values in the data being collected. A quick example is probably the best way to demonstrate this.

Here are some values for the number of faulty products made off a process line each hour of a workday: 6, 9, 8, 11, 90, 6, 10

If we put these numbers in order they are: 6, 6, 8, 9, 10, 11, 90

- The mean of the data is 20.
- The median is 9.

Looking at this data, the value for the mean is much higher than all but the one extreme value of 90. It certainly doesn't reflect the whole set of numbers. This one outlier value of 90 distorts the mean dramatically. It probably indicates that in that one hour there was something seriously wrong with the process. In this case, it is much better to use the median of 9 as a representative value of the data.

House prices is a good example where commonly collected data can have a few extremely high values which can distort the mean value. So, if you look at statistics for house prices, you will see that the average they use and talk about is the median house price.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Working with grouped data

To help make it easier to work with large sets of data, we group data into **class intervals**. To determine the summary statistics for **grouped data,** we use the centre of each class interval as the representative value of the class interval when we analyse the data. The class centre is the middle score of each class interval.

However, there is a difference depending on whether the data is **continuous** (like for measurements of time, height etc.) or **discrete** (like for the number of games players play).

There are different ways we can write the class intervals. The main ways are illustrated in the following tables.

Continuous data

Class interval format examples	Midpoint	Description
0 to less than 10 0 to < 10 0–< 10 0– 0–9.9	$\frac{0+10}{2}=5$	Include the lower endpoint and all numbers up to but not including the start of the next interval. This means that the interval 0 to less than 10 includes all numbers, starting at exactly 0 and going up to, but not including, 10.
10 to less than 20 10 to < 20 10–< 20 10– 10–19.9	$\frac{10+20}{2}=15$	Include the lower endpoint and all numbers up to but not including the start of the next interval. This means that the interval 10 to less than 20 includes all numbers, starting at exactly 10 and going up to, but not including, 20.

Note:

1. If all data is measured or recorded to a particular level of accuracy (e.g. 0–9.9; 10–19.9 etc.), then this method includes all possible values in that range.
2. Although each example gives the same midpoint, we will use only one method for writing the class intervals for continuous data in this chapter: 0–< 10; 10–< 20 etc.

Discrete data

Class interval format examples	Midpoint	Description
0–9	$\frac{0+9}{2}=4.5$	Both endpoints, 0 and 9, are included as they are discrete values.
10–19	$\frac{10+19}{2}=14.5$	Both endpoints, 10 and 19, are included as they are discrete values.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Calculating the estimated mean from grouped data

To calculate an estimate of the mean from a frequency table with grouped data we use a variation on our formula for mean, where we need to use the midpoint of each class interval as the value that represents that range of values. Hence, this is an estimated value of the mean.

$$\text{Mean} = \bar{x} = \frac{\sum(f \times x)}{\sum f} = \frac{\text{sum of all our data values}\,(\text{frequency} \times \text{value})}{\text{sum of frequencies}\,(n)}$$

The table below shows the heights in centimetres (cm) of 100 male basketball players who were playing in national basketball competitions across Australia in 2023. The table includes the calculations required for working out the mean. Note that this is continuous data (heights).

Height (cm)	Frequency (f)	Midpoint (x)	$f \times x$
165–< 170	1	167.5	167.5
170–< 175	0	172.5	0
175–< 180	0	177.5	0
180–< 185	4	182.5	730
185–< 190	8	187.5	1500
190–< 195	16	192.5	3080
195–< 200	26	197.5	5135
200–< 205	24	202.5	4860
205–< 210	12	207.5	2490
210–< 215	8	212.5	1700
215–< 220	1	217.5	217.5
Total	**100**	**Total**	**19 880**

$$\begin{aligned}\text{Mean} = \bar{x} &= \frac{\sum(f \times x)}{\sum f} \\ &= \frac{19\,880}{100} \\ &= 198.8 \text{ cm}\end{aligned}$$

Therefore, the mean height of these 100 basketball players is approximately 199 cm.

Let's now work out the mode and the median of the player's heights.

The mode is the value with the highest frequency, which is in the class interval 195–< 200 cm, so using the midpoint, the modal height is about 197.5 cm.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

The median of this set of data will be the value between the 50th and 51st values, and if you use the running total, you can see from the table above that the 50th and 51st values are both in the class interval 195–< 200. So, like the mode, the median is about 197.5 cm. We will look at another way to calculate the median later, using the cumulative frequency graph.

Do you think this set of data is symmetrical or skewed or not?

Using technology

Technology can be extremely helpful when calculating measures of centre for large data sets. Inputting data into a calculator by hand can be tedious and prone to error. Large data sets are usually presented using a spreadsheet such as Excel or Google Sheets.

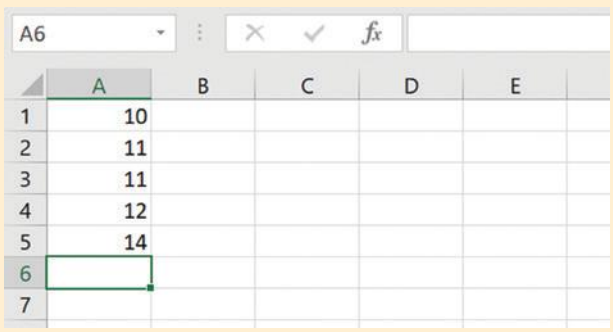
Example 2 Calculating the mean, median and mode using Excel

Enter the following data into a spreadsheet and calculate the mean, median and mode.
10, 11, 11, 12, 14

THINKING	WORKING

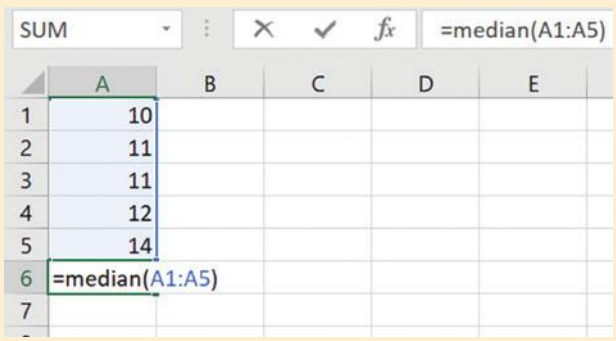
STEP 1

Enter the five data values into a column of a spreadsheet.



STEP 2

For the median, type:
=median(A1:A5)
You need to select or name the cells you wish to calculate and use a colon to separate the first and last cells.
Common errors are to forget the equals sign (=) or the brackets.

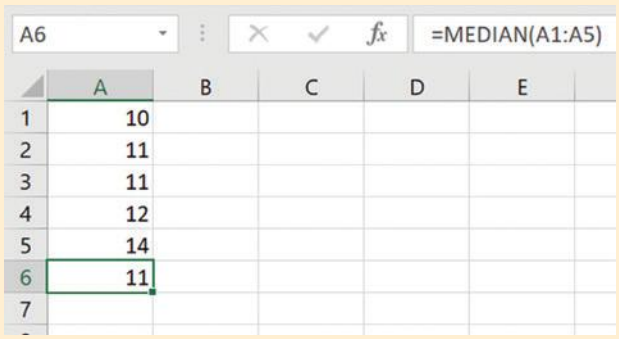


ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING

STEP 3

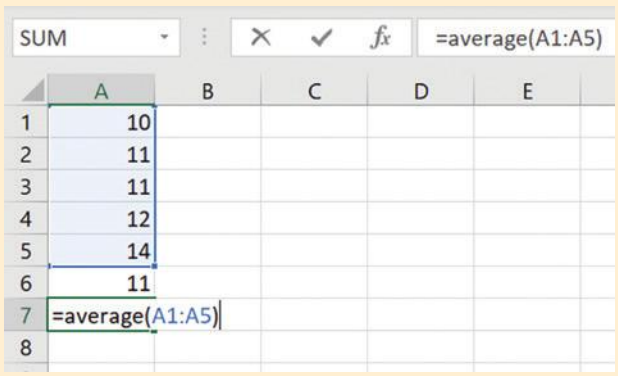
Press the Enter key to see the result for the median in cell A6.



The median of this data set is 11.

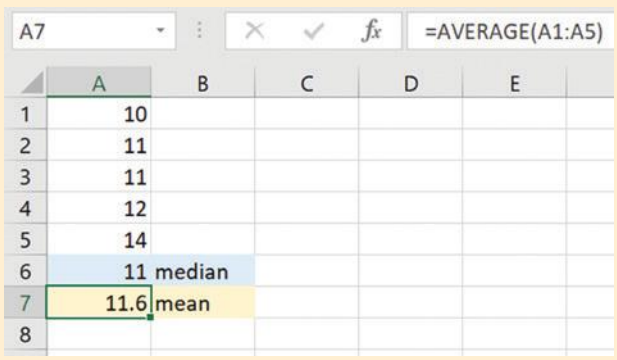
STEP 4

For the arithmetic mean, type:
=average(A1:A5)
Common errors include selecting the mean or geometric mean.



STEP 5

Press the Enter key to see the result for the mean in cell A7. You may like to include the name beside each measure of centre and highlight the cells with colour.



The mean is 11.6.

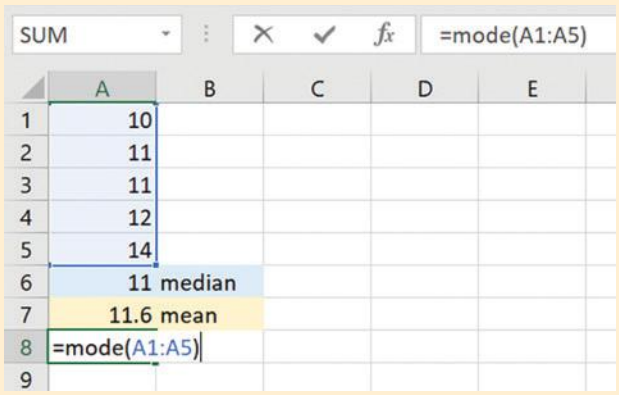
... *continued*

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING

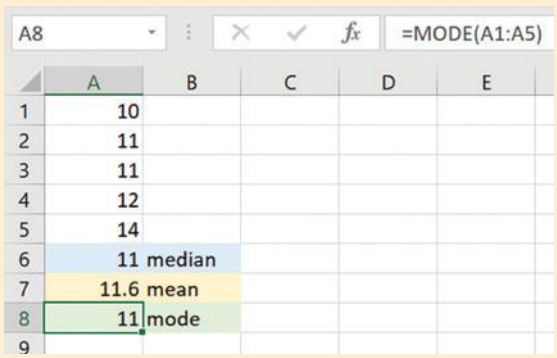
STEP 6

For the mode, type:
=mode(A1:A5)



STEP 7

Press the Enter key to see the result for the mode in cell A8.



The mode is 11.

7D Tasks and questions

Thinking task

1 Describe some real-world applications of mean, median and mode. Share and compare these with your classmates.

Skills questions

2 For the given data sets, calculate the median and the mode.

a 18, 3, 7, 43, 24, 45, 34, 2, 4, 30, 27, 18

b 22, 22, 24, 25, 26, 26, 28, 29, 29, 29, 29, 29, 30, 32, 36

c 1001, 987, 1064, 2006, 768, 2003, 1984, 1678, 1432, 988

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3 Calculate the median and mode for this data set.

Year	Capture fisheries production Australia (tonnes)
2000	219 713.0
2001	217 108.0
2002	217 973.0
2003	240 089.2
2004	255 833.0
2005	273 833.3
2006	229 131.0
2007	211 880.3
2008	212 315.7
2009	200 064.5

Year	Capture fisheries production Australia (tonnes)
2010	218 659.5
2011	217 720.1
2012	216 678.0
2013	201 837.5
2014	198 323.2
2015	203 270.7
2016	220 959.4
2017	229 645.4
2018	225 436.7

Source: Food and Agriculture Organization of the United Nations (via World Bank)

4 For the given data sets, calculate the mean, median and mode.

a 34, 37, 37, 38, 38, 38, 39, 39, 39, 39, 39, 40, 40, 42

b 2008, 1999, 1934, 2022, 967, 1567, 1683, 2009, 1387, 1935

5 The following set of sulphur dioxide (SO_2) emissions is indexed data – that is, all the values are relative to the 1990 value where it was set at 100. Calculate the mean, median and mode.

Year	Sulphur dioxide (SO_2) emissions Australia
2000	151.73
2001	163.13
2002	173.74
2003	173.24
2004	157.00
2005	162.05
2006	155.14
2007	157.18

Year	Sulphur dioxide (SO_2) emissions Australia
2008	168.46
2009	167.16
2010	153.02
2011	151.43
2012	150.47
2013	148.32
2014	146.84
2015	145.46

Source: OECD Stats

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6 For the following data sets, calculate the mean, median and mode.

a

Values (x)	Frequency (f)	$f \times x$
17	2	
18	4	
20	5	
21	4	
24	6	
26	4	
28	2	
31	2	
32	1	
Total		

b

Values (x)	Frequency (f)	$f \times x$
85	9	
90	12	
95	12	
100	18	
105	21	
110	20	
115	25	
120	20	
125	15	
130	8	
Total		

7 For the following grouped discrete data, calculate:

i the midpoints for each class interval **ii** the approximate mean.

a

Values	Frequency (f)	Midpoint (x)	$f \times x$
0–4	6		
5–9	5		
10–14	7		
15–19	2		
20–24	8		
25–29	5		
Total			

b

Values	Frequency (f)	Midpoint (x)	$f \times x$
0.02–0.04	56		
0.05–0.07	43		
0.08–0.10	67		
0.11–0.13	34		
0.14–0.16	50		
0.17–0.19	62		
Total			

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

8 For the following grouped continuous data, calculate:

i the midpoint for each class interval

ii the approximate mean.

a

Values	Frequency (f)	Midpoint (x)	$f \times x$
0–< 5	4		
5–< 10	7		
10–< 15	9		
15–< 20	12		
20–< 25	14		
25–< 30	20		
30–< 35	31		
35–< 40	38		
40–< 45	45		
Total			

b

Values	Frequency (f)	Midpoint (x)	$f \times x$
140–< 150	3		
150–< 160	5		
160–< 170	6		
170–< 180	9		
180–< 190	12		
190–< 200	5		
Total			

c

Values	Frequency (f)	Midpoint (x)	$f \times x$
100–< 200	16		
200–< 300	14		
300–< 400	17		
400–< 500	10		
500–< 600	15		
600–< 700	10		
700–< 800	18		
Total			

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mixed practice

9 Use the data table below to calculate the mean and median of road deaths per year in Australia.

Year	Road deaths
1999	2092
2000	2050
2001	1973
2002	1930
2003	1890
2004	1828
2005	1784
2006	1755
2007	1752
2008	1739
2009	1711
2010	1665
2011	1617
2012	1568
2013	1515
2014	1523
2015	1549
2016	1545
2017	1558
2018	1584
2019	1595

Source: IHME, Global Burden of Disease (2019)

10 For each set of data, find the mean, median and mode.

a

Values	Frequency
0–< 10	9
10–< 20	11
20–< 30	12
30–< 40	16
40–< 50	18
50–< 60	14
60–< 70	12
70–< 80	8

b

Values	Frequency
0–9	43
10–19	80
20–29	120
30–39	367
40–49	400
50–59	298
60–69	298
70–79	150
80–89	42
90–99	23

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Application task

11 CSIRO, Australia's national science agency, provides data on global mean sea levels (GMSL). Examine the data from 1990 to 2009.

Year	GMSL (mm)
1990	0.7
1991	3.8
1992	6.6
1993	2.1
1994	5.5
1995	10.7
1996	14.4
1997	22.6
1998	15
1999	21.7

Year	GMSL (mm)
2000	22.6
2001	27.1
2002	26.1
2003	35.1
2004	34.5
2005	34.1
2006	35.6
2007	39.1
2008	49
2009	55.5

Source: CSIRO

a What do you notice about the general trend?

b Can you find a **mode**? Does the mode help tell the story of this data?

c What is the **median** global mean sea level (GMSL) between 1990 and 2009? What does the median tell you about GMSL?

d What is the **mean** global mean sea level (GMSL) between 1990 and 2009? What does this statistic tell you about GMSL?

e Using technology, graph this data and identify any trend you might observe.

f Extrapolate (predict) what the global mean sea level might have been in 2020. Use the internet to check the accuracy of your answer.

g Extrapolate (predict) what the global mean sea level might be today.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

7E Measures of spread

When thinking about jobs or when changing careers, it is worth knowing a bit about what salaries you can earn. Wages and salaries are often compared using the normal measures of central tendency, either the mean or the median. However, a few very high salaries can distort the mean, so organisations such as ABS use the median as their measure of the middle of wages and salaries.

But it is also important to see how salaries vary too, and hence, you will often see other measures used when finding out about salaries. Below are a few examples of how data can be reported for the salaries of different jobs. The bar in the centre gives you the middle range of the values of current annual salaries for each occupation.

Source: Seek

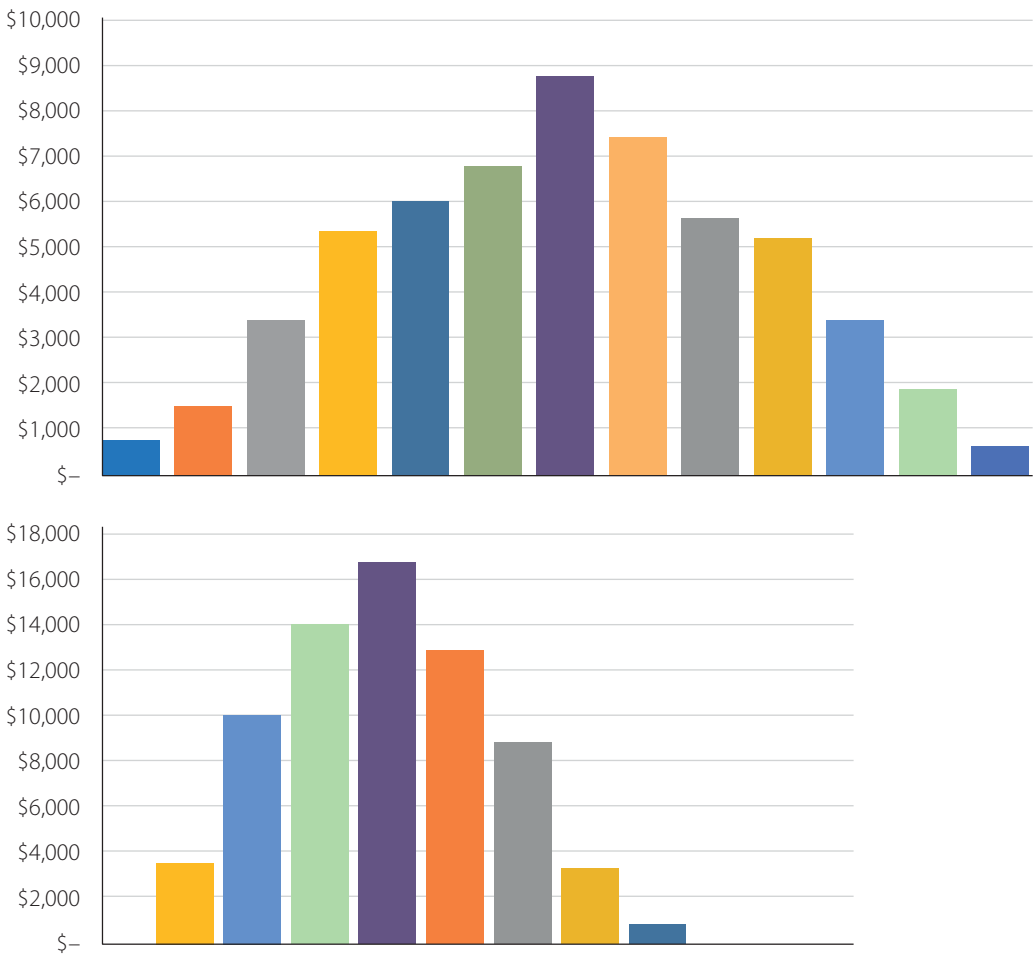
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Using this measure of the spread around the middle of the salaries enables you to compare and see what you might be able to earn. Even though these three examples show around the $60,000 mark for their average salary, the Teacher's Aide salary has a much wider spread of values – you can earn somewhere between $55,000 and $70,000, on average. It has a much broader range, and potentially allows people to earn more. This is better information that just having the single central value – the average (the mean or median).

Measures of spread

As well as knowing the central value of a data set, it is useful to know the spread of the data, as this can tell us about the distribution of the data values. The idea is to gain an indication of how far the values in the data set are spread out from the middle or from each other. Measures of spread include the **range**, **interquartile range** and **standard deviation**.

Looking at these two column graphs of wages, you can see that the top one has a much larger spread than the bottom one.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

The **range** simply tells us the difference between the highest and lowest values in a data set. It does not provide information about where the other values lie, or the shape of the data. The range can be misleading if the data includes outliers.

To calculate the range, you must first identify the **highest (maximum)** and **lowest (minimum)** values in your data set.

For example, for the data set $279 $367 $387 $399 $406 $545

the highest value is $545 and the lowest $279,

therefore, the range is $545 – $279 = $266

Quartiles, as the name suggests, are the three values that divide a list of data that is arranged in ascending order into four equal-sized subgroups each containing one-quarter of the data values. The quartiles are labelled:

- **Q1** for quartile 1 or lower quartile (the value below which one-quarter or 25% of the data lies)
- **Q2** for quartile 2 (the value below which one-half or 50% of the data lies) – usually we call this the **median**
- **Q3** for quartile 3 or upper quartile (the value below which three-quarters or 75% of the data lies)

We use the quartiles to calculate the **interquartile range (IQR).** The IQR measures the spread of the middle half, 50%, of your data. The interquartile range (IQR) is the upper quartile minus the lower quartile

$$IQR = Q3 - Q1$$

Let's look at an example.

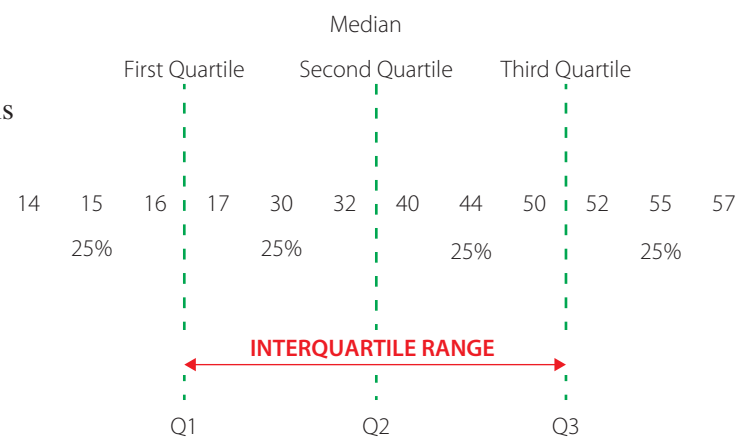
We have a data set of 12 numbers:

30 15 44 55 14 17 40 16 52 32 50 57

If we sort them into order from lowest to highest we get:

14 15 16 17 30 32 40 44 50 52 55 57

Then we can break these up into four equal-sized subgroups, as shown in this diagram.



ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

The median, Q2, is the middle value in the data set. As there is an even number of data values, there are two middle numbers (32 and 40). Q2 is halfway between the two numbers so this can be worked out as (32 + 40) ÷ 2, which gives 36.

Then find the middle value of the lower half (Q1) and the middle value of the upper half (Q2) of the data set.

Q1 = halfway between 16 and 17, which is 16.5

Q3 = halfway between 50 and 52, which is 51

Therefore, the interquartile range (IQR) is:

$\text{IQR} = \text{Q3} - \text{Q1} = 51 - 16.5 = 34.5$

Example 3 Finding the value of each quartile in a data set

Calculate the quartiles of the data set: 8, 3, 1, 10, 9, 1, 7, 8, 4.

THINKING	WORKING
STEP 1	
First order the data set from smallest to largest.	1, 1, 3, 4, 7, 8, 8, 9, 10
STEP 2	
Find Q2, the median, by locating the middle value in the data set. There are 9 values so the 5th value is the middle value.	1, 1, 3, 4, 7, 8, 8, 9, 10 Median = 7
STEP 3	
Find Q1 and Q3 by locating the middle value of the lower half and the middle value of the upper half of the data set. For both quartiles there are two middle numbers, so we find the average of the two middle numbers.	1, 1, 3, 4, 7, 8, 8, 9, 10 $\text{Q1} = \frac{1+3}{2} = 2$ $\text{Q3} = \frac{8+9}{2} = 8.5$
STEP 4	
Write the values of each quartile.	$\text{Q1} = 2$ $\text{Q2} = 7$ $\text{Q3} = 8.5$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 4 Finding the IQR for a data set

Find the interquartile range for the data set: 1 3 5 7 7 9 12 14 16 18.

THINKING	WORKING
STEP 1	
The data set is already ordered from smallest to largest so we can find Q2, the median, by locating the middle value in the data set. As there is an even number of data values there are two middle numbers, so we find the average of the two numbers.	1 3 5 7 7 9 12 14 16 18 $\text{Median} = \text{Q2} = \frac{7+9}{2} = 8$
STEP 2	
Find Q1 and Q3 by locating the middle value of the lower half and the middle value of the upper half of the data set.	1 3 5 7 7 9 12 14 16 18 $\text{Q1} = 5$ $\text{Q3} = 14$
STEP 3	
To calculate the interquartile range, subtract the value of Q1 from Q3.	$\text{IQR} = \text{Q3} - \text{Q1}$ $= 14 - 5$ $= 9$

Outliers and measures of spread

As we saw in relation to measures of central tendency, outliers can have a substantial impact on statistical analyses and lead to inaccurate or misleading interpretations of the data. They can also distort measures of spread, particularly the range.

The problem with using the range to measure the spread of a set of data is that it depends entirely on just two values – the highest and lowest scores. Let's look at two sets of data:

3, 3, 4, 5, 5, 5, 6

3, 3, 4, 5, 5, 5, 20

These are almost identical distributions, but the first set of numbers has a range of 3 (6 – 3 = 3), and the second has a range of 17 (20 – 3 = 17).

A measure of spread that is not so dramatically affected by one or two extreme values is the interquartile range. Both sets of data above have the same interquartile range of 2.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

A **percentile** is the value below which a percentage of data falls. **Percentiles** are the cut-off values for each of 100 equal groups into which a set of data has been arranged in ascending order, e.g. 60% of the data values lie at or below the 60th percentile.

You can also link the relationship between percentiles and quartiles.

- Q1, the cut-off at the first quarter of a data set, is the 25th percentile.
- Q2, the cut-off at the second quarter of a data set is the 50th percentile (median).
- Q3, the cut-off at the third quarter of a data set is the 75th percentile.

Cumulative frequencies

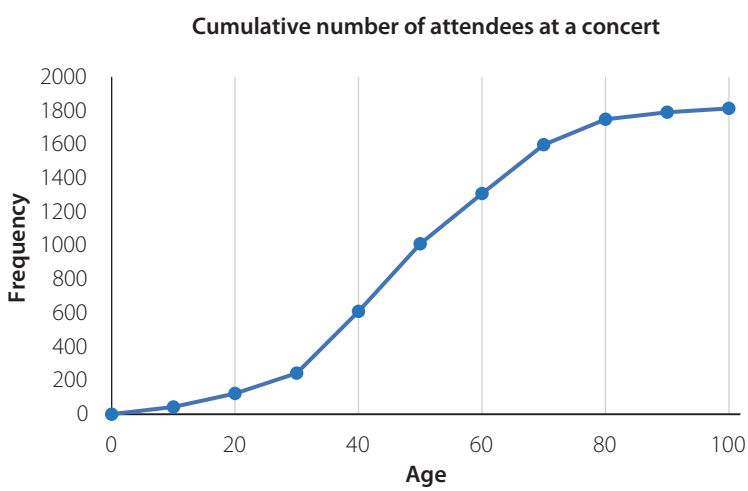
Cumulative frequencies are useful if more detailed information is required about a set of data. They can be used to find the median and interquartile range, along with percentiles.

A cumulative frequency graph is a graph that represents the running total of frequencies for each value in a data set.

Here is the data about the number of people in each age group attending a free concert at the Myer music bowl. A column has been added to calculate the cumulative frequency which is the running total of the frequencies.

Age group	Frequency	Cumulative frequency
0–9	43	43
10–19	80	123
20–29	120	243
30–39	367	610
40–49	400	1010
50–59	298	1308
60–69	290	1598
70–79	150	1748
80–89	42	1790
90–99	23	1813
Total	1813	

Graphing the **upper** value of the age group against the cumulative frequency gives this cumulative frequency graph.



Graphing **cumulative percentage frequency** makes it easier to determine percentiles, medians, quartiles etc.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

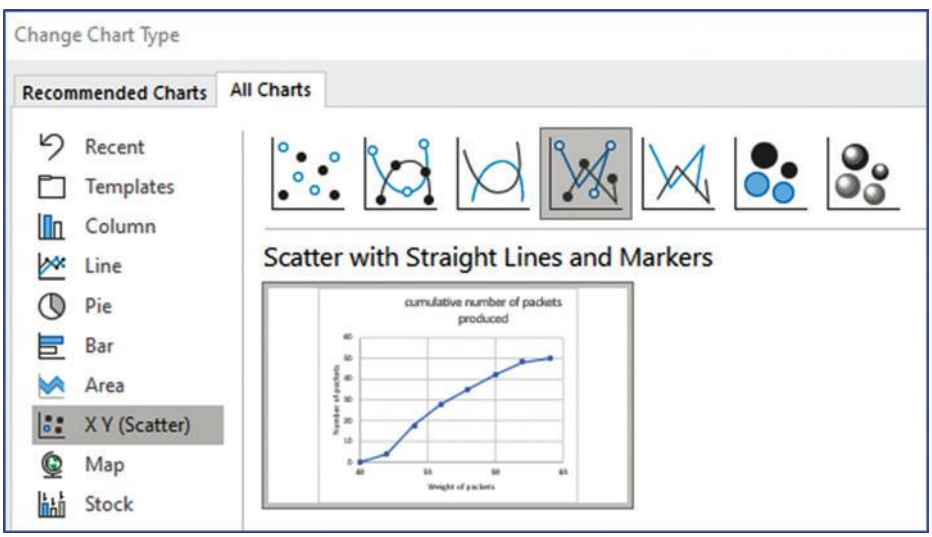
The following example illustrates the method for constructing a cumulative percentage frequency graph.

A sweets factory produces packets of sweets which all fall within a range of weights. In a sample of 50 packets that were checked for quality control, the following analysis resulted.

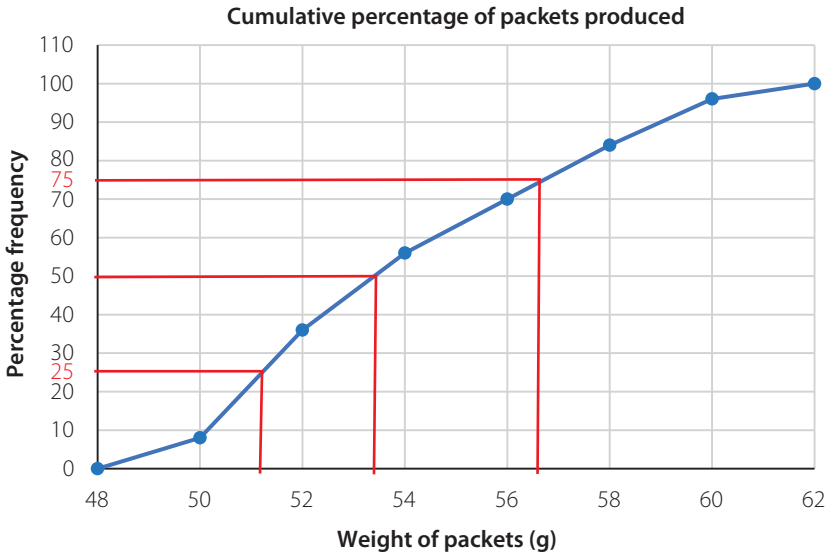
Weight of packet (grams)	Number of packets or frequency	Cumulative frequency	Cumulative percentage frequency
48–< 50	4	4	8%
50–< 52	14	18	36%
52–< 54	10	28	56%
54–< 56	7	35	70%
56–< 58	7	42	84%
58–< 60	6	48	96%
60–< 62	2	50	100%
Total	**50**		

Graphing this information gives us the cumulative percentage frequency graph.

In a spreadsheet, you need to select **X-Y (Scatter)** and then **All Charts and Scatter with Straight Lines and Markers**. You can also select **Scatter with Smooth Lines and Markers**.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.



Note: When you plot the data for a cumulative frequency graph, you use the upper boundary of each class interval. This is because, as in the example above, a cumulative frequency of 18 packets shown against the 50–< 52 grams class interval means that there were a total of 18 packets that had a weight less than the upper value of 52 grams.

A cumulative frequency graph should always start at 0 and end at 100% on the right-hand side of the graph.

Using the information on the graph, we can find the 25th, 50th and 75th percentiles, which are the lower quartile, the median and the upper quartile. Looking at the red lines on the above graph, this example shows that:

- the median weight (50%) of the packets of sweets occurs in the interval 52–< 54 grams.
- the first quartile (the 25th percentile) occurs in the interval 50–< 52 grams.
- the third quartile (the 75th percentile) occurs in the interval 56–< 58 grams.

7E Tasks and questions

Thinking task

1 If you lined up all the students in your class from shortest to tallest, would there be a significant difference in heights, or would they all be similar? How do you think the spread of heights in your class would compare to the spread of heights in a Year 7 class. Do you think the measures of centre would be similar?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Skills questions

2 For the following data sets, identify the:

- **i** minimum
- **ii** maximum
- **iii** median
- **iv** first quartile
- **v** third quartile
- **vi** range
- **vii** interquartile range

a 58 23 72 41 15 67 34 87 19 50 81 29 64 38 76 12 45 83 26 55

b 12 28 44 19 33 8 41 25 9 148 122 138 114 131 17 146 117 129 6

c 192 109 231 287 229 110 136 172 200 276 155 117 299 231 284 213 248 269 116 162 250

3 Identify the maximum and minimum values and then state the range for the following data sets. The data is compiled by the Environment Protection Authority in Victoria (EPA) and describes the number of reports by the public to the EPA in the financial year 2018–19 by category.

	Gippsland	Metro	North East	North West	Not Assigned1	South West	Southern Metro	TOTAL
a Dust	75	395	35	70	31	124	143	873
b Noise	66	898	120	56	117	325	242	1824
c Odour	188	1909	187	257	58	846	743	4188
d Smoke	50	148	90	31	48	105	79	551

Source: Environment Protection Authority (EPA)

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mixed practice

4 The following two data sets (Bonds lodged and Bond repayments) are from Consumer Affairs about bonds from rental properties in Victoria.

Type of residential tenancies service provided	2012–13	2013–14	2014–15	2015–16	2016–17	2017–18	2018–19
Bonds lodged	216 400	221 623	228 955	236 971	241 489	241 534	244 756
Bond repayments	190 100	197 500	203 614	210 963	212 749	219 603	219 297

Source: Consumer Affairs Victoria

Answer the following questions using the data for all of the residential tenancies services provided.

a State Q2.

b Find the range.

c Evaluate Q1 and Q3.

d Find the interquartile range (IQR).

e Find the 50th percentile. Is this the same as part **a**?

f Find the median. Is this the same as parts **a** and **e**?

5 This data shows the number of people looking for work according to age group.

Age group (years)	Number of people (thousands)
15–24	0.3
25–34	1.4
35–44	2.2
45–54	1.6
55–64	0.4
65 and over	0.1

a Construct a cumulative percentage frequency table.

b Construct a cumulative percentage frequency graph.

c What is the 25th percentile?

d What is the median?

e What is the 75th percentile?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mathematical literacy

6 Use the words and numbers in the box to complete the sentences below.

percentage	median	equal-sized	smallest			
third	50%	range	75%	first	four	25%

a The _____ of the data is calculated by subtracting the _____ number from the largest number in the data set.

b Quartiles are calculated by dividing the data into _____, _____ subgroups.

c The second quartile is the _____ of the data set.

d _____ of the data lies below the first quartile, _____ of the data lies below the second quartile and _____ of the data lies below the third quartile.

e The interquartile range is calculated by subtracting the _____ quartile from the _____ quartile.

f Percentiles give the values below which a certain _____ of the data is.

Application tasks

7 The following data was collected by Alison and John Doley. It shows the bird sightings in one large property in the wheatbelt region of Australia over a 30-year period of observations from 1987 to 2016. For each bird's data set, find the:

i lowest and highest values

ii the median

iii the lower quartile (Q1) and the upper quartile (Q3)

iv the range and the interquartile range.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

	January	February	March	April	May	June	July	August	September	October	November	December
a Australian shelduck	17	40	64	91	117	120	117	107	73	35	13	5
b Wedge-tailed eagle	94	91	90	97	106	88	79	65	70	57	68	85
c Red-tailed black cockatoo	102	106	113	115	116	116	108	103	99	95	92	99
d Brown songlark	33	22	18	26	22	36	59	83	93	67	46	41

8 Compare the four bird's data sets shown in question **7**. What conclusions can you draw from the measures of spread you found?

9 Sustainability Victoria compiles data on waste and recovery in Victoria each year. The tables **a–d** show recovery and reprocessing data for different types of waste in 2010 to 2020.

For each data set, answer the following.

- **i** State the maximum and minimum data values.
- **ii** Calculate the range.
- **iii** Find Q1, Q2 and Q3.
- **iv** Calculate the IQR.
- **v** Give one key finding or conclusion from your measures of spread.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

a Paper and cardboard waste recovered for reprocessing

Year	Total paper and cardboard (tonnes)
2010–11	1 212 800
2011–12	1 665 200
2012–13	1 393 600
2013–14	1 393 500
2014–15	1 530 200
2015–16	1 577 300
2016–17	1 445 300
2017–18	1 481 000
2018–19	1 249 300
2019–20	1 114 800

b Rubber recovered for reprocessing

Year	Total rubber (tonnes)
2010–11	54 500
2011–12	49 000
2012–13	64 300
2013–14	78 000
2014–15	69 300
2015–16	64 500
2016–17	41 400
2017–18	79 400
2018–19	72 000
2019–20	62 600

c Plastic waste recovered for reprocessing

Year	Total plastic waste (tonnes)
2010–11	146 200
2011–12	149 500
2012–13	152 000
2013–14	150 600
2014–15	160 500
2015–16	149 100
2016–17	130 700
2017–18	137 200
2018–19	142 500
2019–20	140 100

d Glass waste recovered for reprocessing

Year	Total glass (tonnes)
2010–11	195 500
2011–12	195 000
2012–13	167 000
2013–14	164 400
2014–15	197 000
2015–16	173 200
2016–17	137 300
2017–18	230 000
2018–19	194 700
2019–20	300 700

10 Melbourne's Eastern Treatment Plant (ETP) and Western Treatment Plant (WTP) have data on the volume of water inflowing recorded in megalitres (ML), shown in tables **i** and **ii**, respectively.

a Calculate the median, the range and the IQR for each data set.

b How do the two data sets compare?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

i

Record date	ETP Daily Influent (ML)
1/12/2019 12:59	346
2/12/2019 12:59	307
3/12/2019 12:59	264
4/12/2019 12:59	318
5/12/2019 12:59	339
6/12/2019 12:59	357
7/12/2019 12:59	311
8/12/2019 12:59	345
9/12/2019 12:59	349
10/12/2019 12:59	328
11/12/2019 12:59	336
12/12/2019 12:59	303
13/12/2019 12:59	384
14/12/2019 12:59	307
15/12/2019 12:59	288
16/12/2019 12:59	368
17/12/2019 12:59	330
18/12/2019 12:59	254
19/12/2019 12:59	332
20/12/2019 12:59	340
21/12/2019 12:59	357
22/12/2019 12:59	284
23/12/2019 12:59	280
24/12/2019 12:59	277
25/12/2019 12:59	317
26/12/2019 12:59	306
27/12/2019 12:59	177
28/12/2019 12:59	292
29/12/2019 12:59	282
30/12/2019 12:59	286

Source: Eastern Treatment Plant Melbourne

ii

Record date	WTP Daily Influent (ML)
1/12/2019 12:59	515
2/12/2019 12:59	546
3/12/2019 12:59	525
4/12/2019 12:59	526
5/12/2019 12:59	524
6/12/2019 12:59	525
7/12/2019 12:59	509
8/12/2019 12:59	487
9/12/2019 12:59	519
10/12/2019 12:59	501
11/12/2019 12:59	505
12/12/2019 12:59	504
13/12/2019 12:59	521
14/12/2019 12:59	506
15/12/2019 12:59	485
16/12/2019 12:59	508
17/12/2019 12:59	513
18/12/2019 12:59	523
19/12/2019 12:59	507
20/12/2019 12:59	517
21/12/2019 12:59	485
22/12/2019 12:59	465

Source: Western Treatment Plant Melbourne

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

11 Data for the heights of 100 national male basketball players in Australia in 2023 is shown in the following table.

Height of player (cm)	Number of players	Cumulative frequency	Cumulative percentage frequency
165–< 170	1		
170–< 175	0		
175–< 180	0		
180–< 185	4		
185–< 190	8		
190–< 195	16		
195–< 200	26		
200–< 205	24		
205–< 210	12		
210–< 215	8		
215–< 220	1		
Total	**100**		

a Construct a column graph of the data.

b Construct a cumulative percentage frequency graph.

c Using the graph, work out the:

i 25th percentile

ii median

iii 75th percentile

iv interquartile range.

d What conclusions can you draw from the data and your graphs?

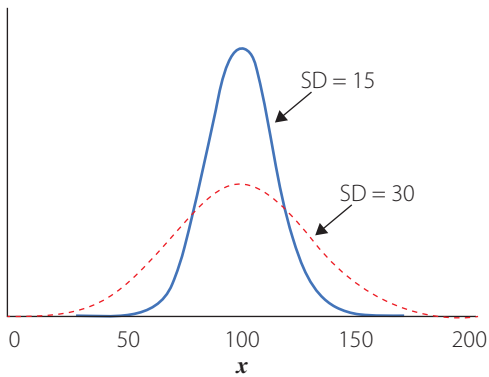
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

7F Seeing the bigger picture

Often when you take your dog or cat to the vet, the animal will be weighed. The vet will use this to see if your pet is underweight, overweight or just about the right weight.

How far your pet's weight is away from the average (mean) is an application of standard deviation.

The **standard deviation** is a commonly used measure of spread which uses all the values in its calculation. We usually use the Greek letter sigma, σ, for standard deviation, although you will also see it just written as *s* or as SD. It basically gives you a measure of the difference between the mean and each of the individual values.



On a graph, changing the standard deviation either tightens or spreads out the width of the distribution along the *x*-axis. Larger standard deviations produce wider distributions.

The graph shows two data sets with the same mean of 100 but one with a small standard deviation and the other with a larger standard deviation.

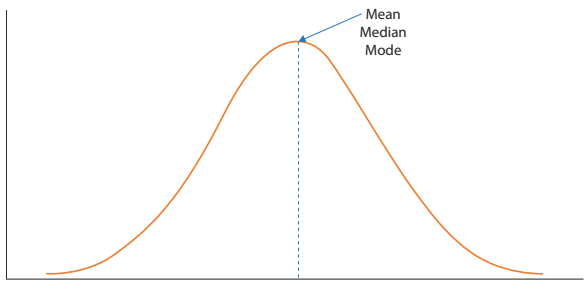
The formula for calculating the standard deviation is:

$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$$

where x is each individual value in the data set, $\bar{x}$ is the mean, and n is the total number of values in the set. Basically, the formula averages the differences between each value (x) and the mean ($\bar{x}$) as the basis for calculating this value.

The normal distribution

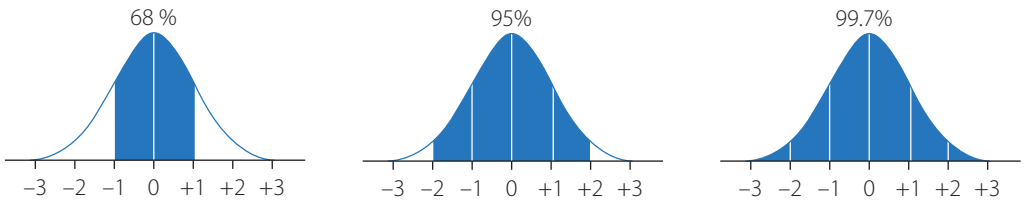
A bell curve displays a **normal distribution**, where the peak of the curve shows the mean, and the data is symmetrical with half above and half below the mean. It also has the mean, median and mode being equal.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

In a normal distribution:

- 68% of the data is within one standard deviation of the mean
- 95% of the data is within 2 standard deviations of the mean
- 99.7% of the data is within 3 standard deviations of the mean.



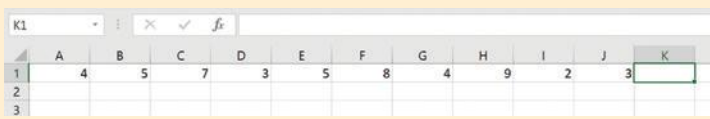
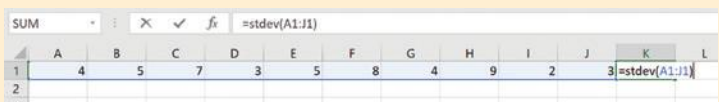
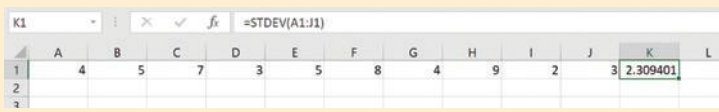
Calculating standard deviation

Calculating standard deviation by hand is cumbersome as the formula is quite complex. The opportunities for making a calculation error are real.

Fortunately, technology can be a massive time-saver for calculating the standard deviation. If using Excel, the command is =stdev(*select cells*)

Example 5 Calculating the standard deviation of a data set

Calculate the standard deviation of the data set: 4, 5, 7, 3, 5, 8, 4, 9, 2, 3.

THINKING	WORKING
STEP 1 Enter the data as a list into an Excel spreadsheet.	
STEP 2 Enter the command for calculating standard deviation and enter the range of cells for the data. In this case, **A1:J1**.	
STEP 3 Press Enter to obtain the standard deviation value in cell K1. Round to an appropriate number of decimal places.	 Standard deviation = 2.3

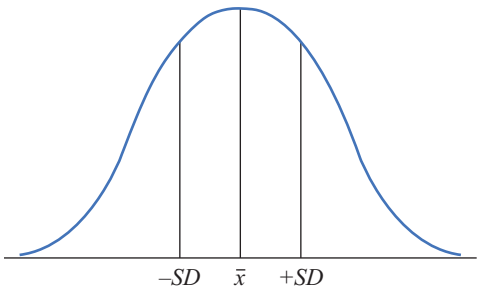
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

7F Tasks and questions

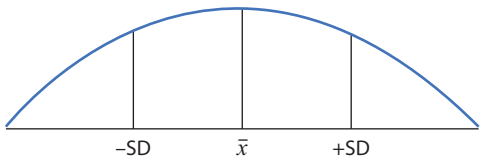
Thinking task

1 These graphs show how accurate two companies were at predicting the weather. Which company's weather forecasts would you prefer to trust and why?

Company A



Company B



Skills questions

2 For the following data sets, enter the values into an Excel spreadsheet and calculate the:

- **i** mean
- **ii** standard deviation.

a 58 23 72 41 15 67 34 87 19 50 81 29 64 38 76 12 45 83 26 55

b 12 28 44 19 33 8 41 25 9 148 122 138 114 131 17 146 117 129 6

c 192 109 231 287 229 110 136 172 200 276 155 117 299 231 284 213 248 269 116 162 250

3 The European Union collected data on life expectancy from countries within the union in 2012 and again in 2021. Answer these questions using the data in the tables that follow.

a Use technology to calculate the mean and standard deviation for each of the two data sets.

b What is the overall trend of the life expectancy data from 2012 and 2021?

c Did the standard deviation change? Can you think of reasons for this?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Country	2012	2021
Belgium	80.5	81.9
Bulgaria	74.4	71.4
Czechia	78.1	77.4
Denmark	80.2	81.4
Germany	80.7	80.9
Estonia	76.7	76.9
Greece	80.7	80.3
Spain	82.5	83.3
France	82.1	82.5
Croatia	77.3	76.8
Italy	82.4	82.9
Cyprus	81.1	81.8
Latvia	74.1	73.4
Lithuania	74.1	74.5
Luxembourg	81.5	82.8

Country	2012	2021
Hungary	75.3	74.5
Malta	80.9	82.9
Netherlands	81.2	81.5
Austria	81.1	81.3
Poland	76.9	75.6
Portugal	80.6	81.2
Romania	74.4	72.9
Slovenia	80.3	80.9
Slovakia	76.3	74.8
Finland	80.7	82.0
Sweden	81.8	83.2
Iceland	83.0	83.2
Liechtenstein	82.5	84.4
Norway	81.5	83.2
Switzerland	82.8	84.0

Source: European Union

Mixed practice

4 The following data shows how the average number of people in Australian households has changed over time.

Year	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	2010	2020
Number of people	4.5	4.4	4	3.9	3.7	3.5	3.3	3	2.9	2.7	2.7	2.5

a Use technology to graph the data.

b Use technology to calculate the average number of people in Australian households between 1910 and 2020.

c Use technology to calculate the standard deviation of people in Australian households between 1910 and 2020.

d Interpret the results of the calculations in this context.

e Explain the overall trend of the number of people in Australian households.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Application task

5 The Vegetables Galore Company (VGC P/L) is concerned that there are variations between the items produced during the night shift and those produced during the day shift. The management decides to analyse sample data for each shift to see if there are any differences between the production standards of the two shifts.

Below is the sample data of 440-g tins of corn kernels being produced by both the day shift and the night shift.

VGC P/L **SAMPLE PRODUCT CHECK SHEET**
Product: Corn kernels Shift: Day
Size: 440 g Date: 11th july

447 g	428 g	442 g	437 g	463 g
466 g	459g	448 g	455 g	453 g
438 g	449 g	443 g	445 g	432 g
450 g	446 g	469 g	444 g	453 g
447 g	465 g	450 g	457 g	458 g
440 g	463 g	435 g	456 g	441 g
458 g	453 g	461 g	487g	427 g
484 g	472 g	451 g	439 g	447 g
462 g	453 g	432 g	475 g	414 g
440 g	472 g	462 g	436 g	431 g

VGC P/L **SAMPLE PRODUCT CHECK SHEET**
Product: Corn kernels Shift: Night
Size: 440 g Date: 11th july

435 g	450 g	432 g	473 g	444 g
461 g	459 g	448 g	455 g	457 g
451 g	449 g	443 g	445 g	456 g
452 g	463 g	469 g	454 g	487 g
462 g	453 g	450 g	475 g	464 g
440 g	472 g	437 g	446 g	441 g
458 g	467 g	466 g	465 g	427 g
484 g	457 g	438 g	459 g	447 g

a By looking at these raw figures, without doing any calculations or statistical analysis, do you think there are differences between the two shifts? Why? Why not?

b Analyse the data by putting the data for each shift into a percentage frequency table in Excel using the same class intervals. Why would you use percentages in a case like this?

c Plot graphs of the figures for both shifts (as percentages) on the same graph grid, including a cumulative percentage frequency graph.

d Describe the data from the graphs. What do they tell you about the weights of the samples for each shift?

e Calculate the mean weights for each shift, correct to 1 decimal place.

f Calculate the standard deviation for each shift, correct to 1 decimal place.

g Make recommendations for the managers of each shift.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

7G Telling the story

As we have seen over the last few chapters, data is all around us – from who is using public transport and when, to what age groups are using different social media platforms and apps.

The data we interact with, and all its different manifestations and representations, including in tables, charts, graphs, infographics and more, are all trying to send us messages – to tell us a story. It might be about selling us something, or about the dangers of drink-driving or of a pandemic, or information from government or institutions, or from our employers. We need to know how to understand and interpret their stories.

Analysing and interpreting data involves looking for patterns and trends in the data, and in understanding any summary statistics, to make meaning of the data, and to answer the questions we are investigating.

We might need to do this through:

- displays of the data
- measures of centre and/or spread
- looking for patterns, trends and relationships in the data
- looking for any issues or errors with the data.

Different shaped distributions

When describing and interpreting data distributions, we look for aspects related to the shape of the data and in relation to the centre of the data set (measures of central tendency in section 7D) or the spread of the data (measures of spread in sections 7E and 7F).

As we saw in Chapter 6, there are many types of graphs used to display data, and we also looked at the language and terminology used to describe the data.

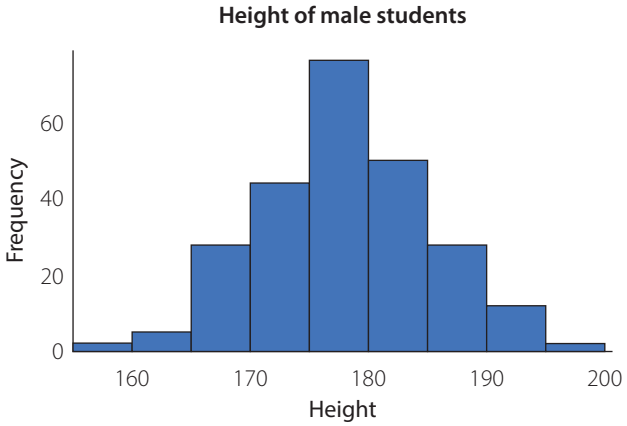
Whichever graph type is chosen; most data will tend to fall into one of the following types or shapes of distributions.

Symmetrical distributions

A symmetrical distribution means that the data is evenly spread on either side of the middle of the data. Each side of the data distribution is a nearly a mirror image of the other.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

The following histogram and stem-and-leaf plot are examples of symmetrical distributions.



Stem	Leaf
0	7
1	2 3
2	2 4 5 7 9
3	0 2 3 6 8 8
4	7 8 9 9
5	2 7 8
6	1 3

Key: 0 | 7 = 7

In symmetrical distributions, most of the data is clustered about the centre, and the mean, median and mode will all be similar values. But as we saw earlier, their spread might be quite different.

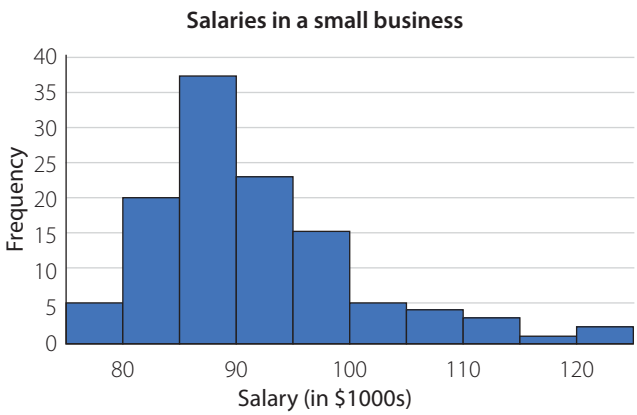
Asymmetrical or skewed distributions

Skewed distributions are not evenly distributed on either side of the centre. Data values will be clustered around higher or lower values. The type of skewness can be identified by looking at the shape of the graph.

Positively skewed distributions

Positively skewed distributions have values that are clustered at the lower end of the scale and the tail extends to the right side of the distribution. They can also be called right-skewed distributions.

The bar graph and the stem-and-leaf plot show the salaries of employees in two small businesses and are examples of positively skewed distributions.



Stem	Leaf
2	3 5 5 6 7 8 9 9
3	0 2 2 3 4 6 6 7 8 8
4	2 2 4 5 6 6 6 7 9
5	0 3 3 5 6
6	2 4
7	5 9
8	2
9	7
10	

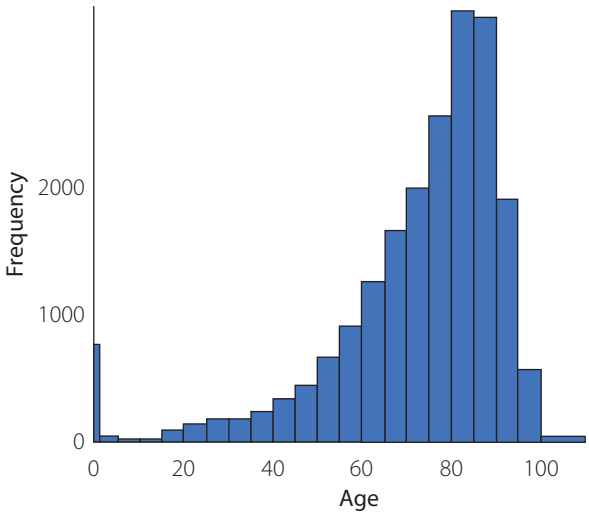
Key: 2 | 3 = $23 000

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Negatively skewed distributions

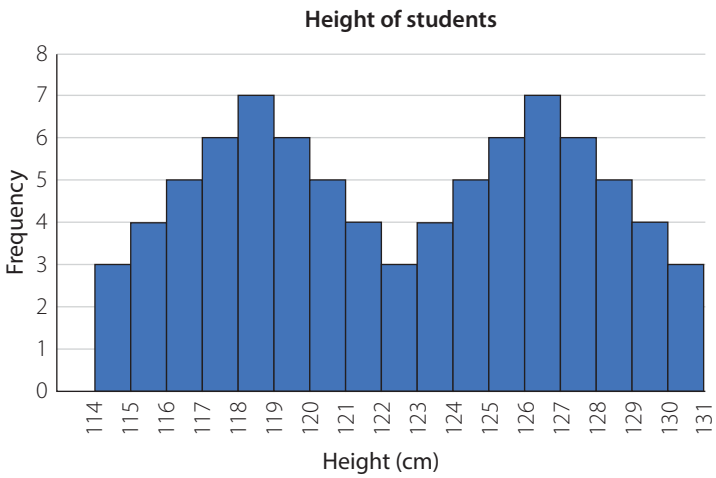
Negatively skewed distributions have values that are clustered at the higher end of the scale and the tail extends to the left side of the distribution. They can also be called left-skewed distributions.

The following graph of the age at death is an example of a negatively skewed distribution.



Bimodal

Bimodal distributions have two modes or peaks in their distributions. The following histogram and stem-and-leaf plot are examples of bimodal distributions.



Stem	Leaf
1	0 8 9
2	
3	0 3 6 6 7 8 9 9
4	1 1 8 9
5	0 1 1 2 3 6 7 7
6	0 1

Key: 1 | 8 = 18

Source: Australian Bureau of Statistics

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

7G Tasks and questions

Thinking task

1 Think about the wages of Australians and of Australian households.

a Which measure of central tendency is used for reporting average wages? Find out and explain why it is used.

b If you graphed Australian household incomes, would you expect it to be positively or negatively skewed? Why?

Mathematical literacy

2 Interestingly, much of the language of interpreting and giving meaning to data in tables, graphs and charts relates to movement or differences between various data points. Work in pairs to think about the words we use to describe data, especially about the trends and differences in a set of data, and particularly when represented in tables or graphs. Here are some examples.

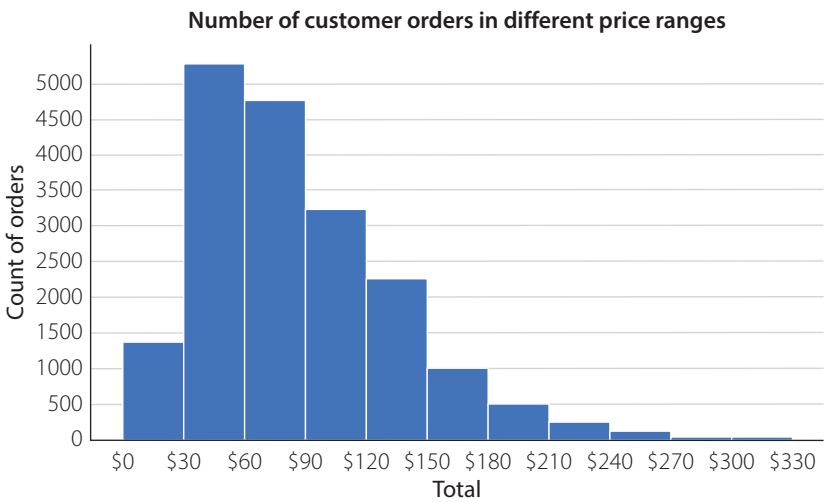
- Sales have **climbed** over the past two quarters.
- Rainfall has **declined** over the past three months.
- Profit has been **flat** over the past two years.

Think about other movement related words and terms you can use when describing information and trends in graphs and charts, or tables. Share your words and terms with other students in the class.

Skills questions

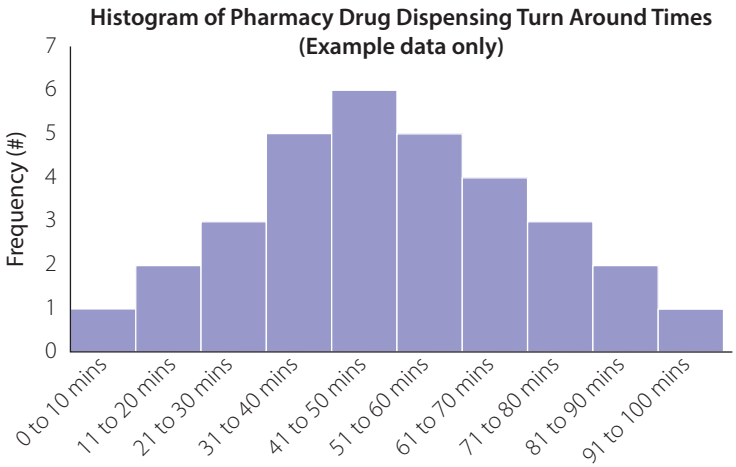
3 Describe the shape of the following data distributions, including whether they are symmetrical, positively skewed or negatively skewed.

a



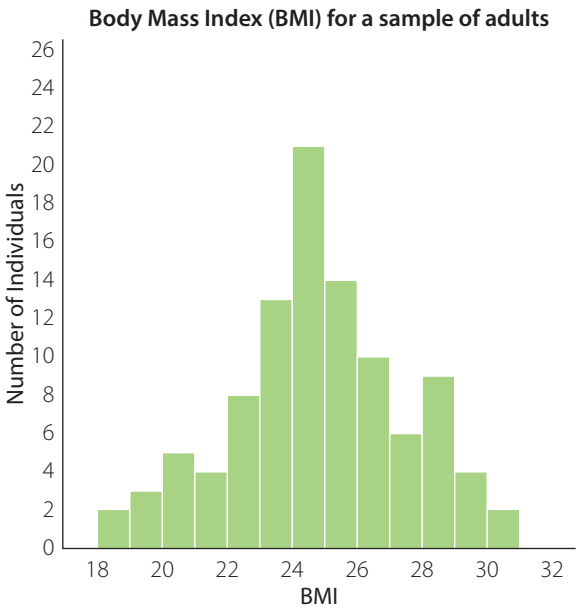
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

b

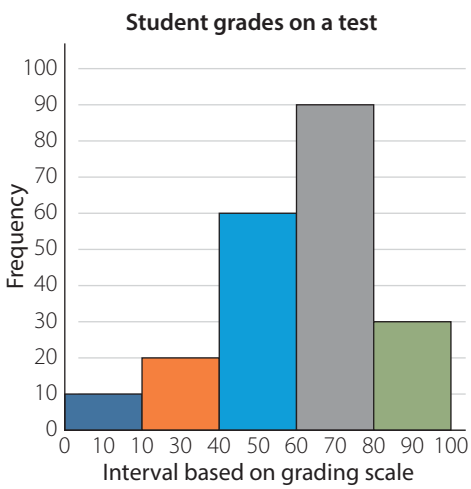


Source: Adapted with permission © NSW Clinical Excellence Commission 2024

c

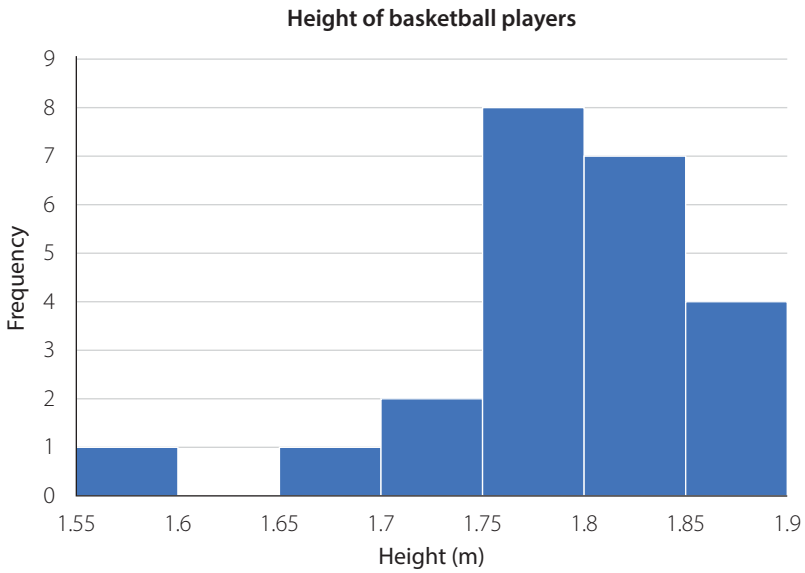


d



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4 This histogram shows the heights (in metres) of members of a basketball club.



a How many members have a height greater than 1.85 metres?

b Describe the shape of the distribution of heights as symmetrical, positively skewed, negatively skewed or bimodal.

c Does there seem to be any outliers in the data?

d What does the graph suggest about the heights of basketballers in this club?

5 The wait time for a call centre, in minutes, is shown in the table.

2.3	4.5	7.1	5.6	9.3	12.2
4.5	1.3	14.5	12.9	2.3	4.5
3.7	2.8	8.4	9.2	1.2	2.7
6.7	3.4	7.6	8.3	4.2	1.3

a Calculate the following summary statistics for the call centre wait times.

i Mean **ii** Median

iii Range **iv** Interquartile range

v Standard deviation

b Construct a graph to display the data. Use a class interval (**bin width**) of 5 minutes.

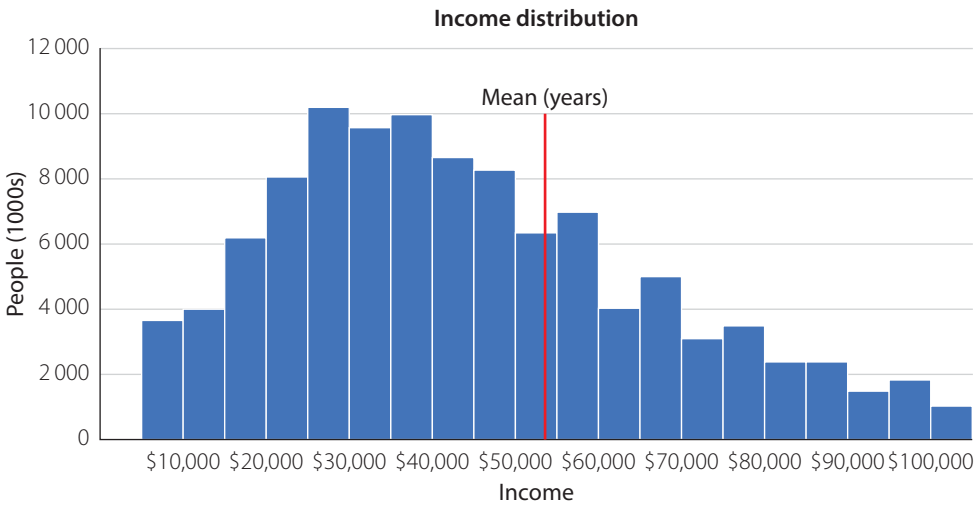
c Describe the data distribution in terms of shape and presence of outliers.

d What does the graph and summary statistics suggest about the call centre wait times?

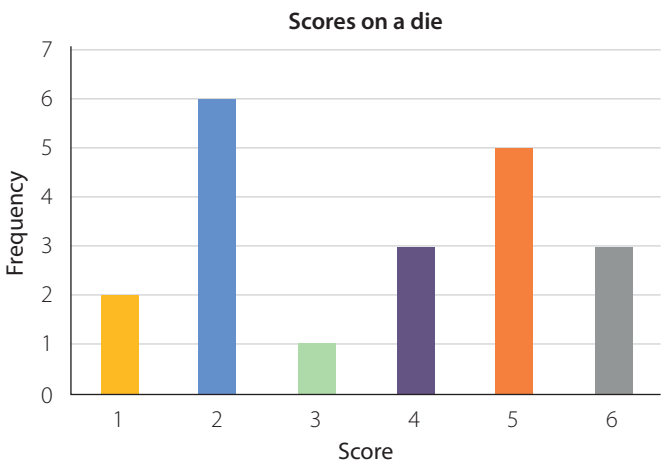
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6 Describe the shape of the distribution of each graph and identify any skewness and outliers.

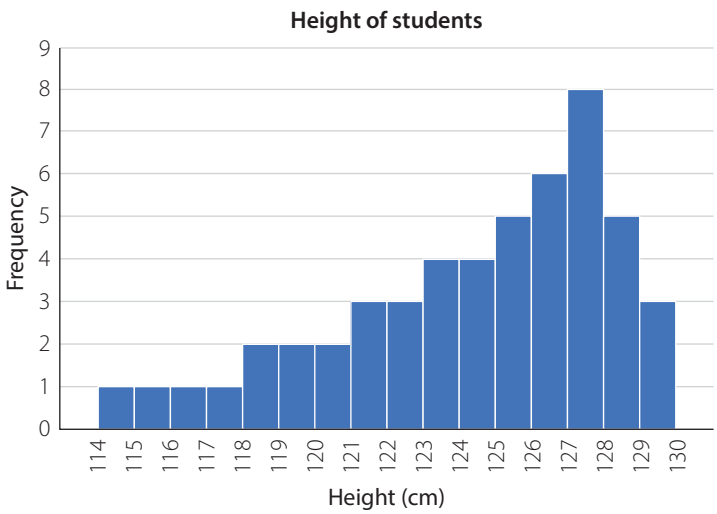
a



b



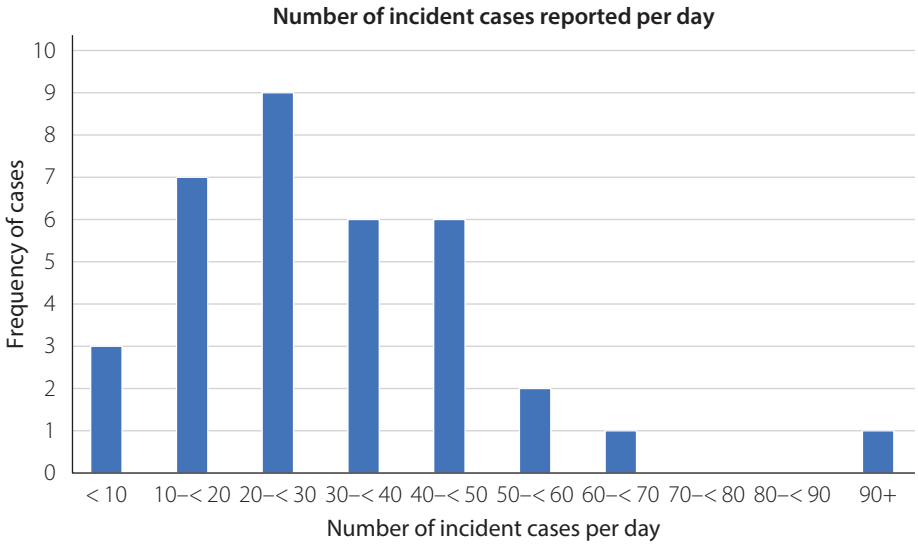
c



Source: Australian Bureau of Statistics

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

d



7 The duration, in hours, of an electrician's jobs are shown below.

1.5	3	2.5	5	4.5	4
2	6	9	2	3.5	7.5
2	1	3.5	2.5	1	4.5
6	7	5.5	8	10	8
5	4.5	2.5	1	2.5	8

a Calculate the following summary statistics for the duration of the jobs.

- **i** Mean
- **ii** Median
- **iii** Range
- **iv** Interquartile range
- **v** Standard deviation

b Construct a graph of this data.

c Describe the data distribution.

d What does the data suggest about the duration of the electrician's jobs?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Application tasks

8 Below are the numbers of students attaining Year 12 or equivalent in Victoria. All figures are in thousands.

Year	Students attaining Year 12 (1000s)
2013	2565.1
2014	2581.4
2015	2721.5
2016	2767.2
2017	2884.9
2018	3112.9
2019	3278.0
2020	3349.1
2021	3316.4
2022	3396.0

Source: Australian Bureau of Statistics

a Use a statistics tool or spreadsheet to construct a suitable chart for the data.

b Describe the shape of the data.

c Calculate appropriate summary statistics.

d What does the chart and summary statistics tell us about students' attainment of Year 12 over the period of these records? Is there other data or information you might need to consider?

9 The Bureau of Meteorology records data about the weather, which is available via their website. Use the website to access the rainfall data for the previous full month in your locality.

a Copy and paste the rainfall data into a spreadsheet.

b Calculate appropriate summary statistics for the data.

c Select an appropriate graph to present the data distribution.

d Describe the shape of the distribution.

e Explain what the distribution shows about the rainfall over the past year.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

7H Twisting the data

Have you seen claims like 'the burgers are better at …' and 'our anti-ageing face cream will …'?

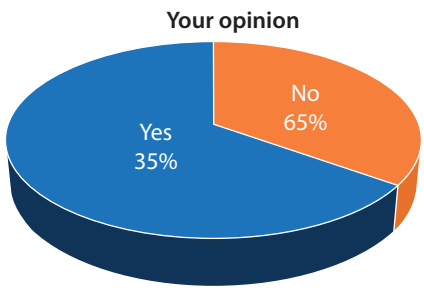
We have so much information coming to us every day, we need to be able to critically analyse the data and graphs before we simply accept the message.

We need to be able to evaluate the validity and reliability of the sources of information and data we use, and also whether the representations of data – the graphs and charts we are presented with – are not distorting or presenting biased perspectives on the data.

Misuse or misunderstanding of pie charts

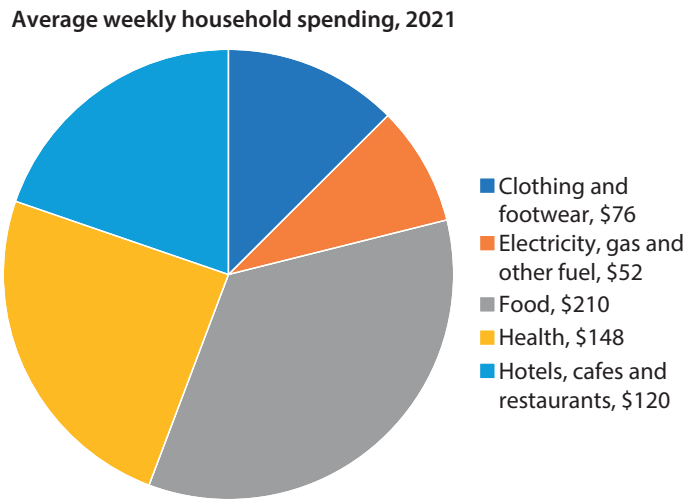
Pie charts should only be used when you are trying to compare parts of a **whole**. It is built for being able to see how each part contributes to that whole. The quantities in each category should be easy to estimate from the chart and the category labels should be clear.

Here is an example of a pie chart that has not been constructed correctly. With a partner, discuss why this pie chart is shown incorrectly.



Here is another example of the misuse of pie charts. The data is based on the ABS survey of household expenditure in 17 different categories.

By not showing all 17 categories, the graph does not accurately represent the data.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

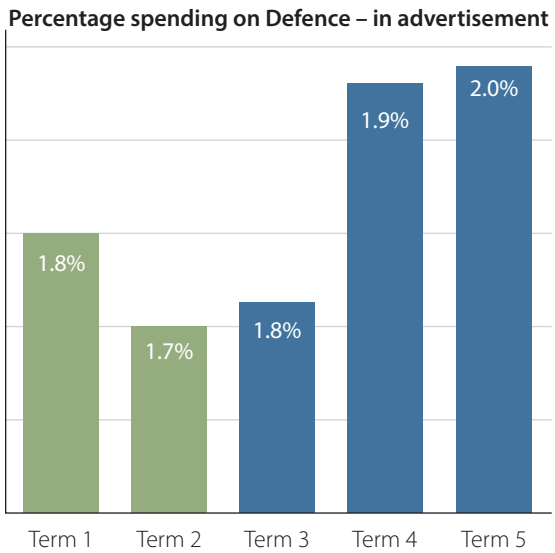
Graphs not being constructed or labelled properly

The data in this histogram is based on the percentage of federal government expenditure for Defence.

Can you identify what's wrong with this graph? What distortions have been made? What impression do you think it is trying to give?

The incorrect bar graph breaks a couple of standard conventions in creating correct graphs and charts:

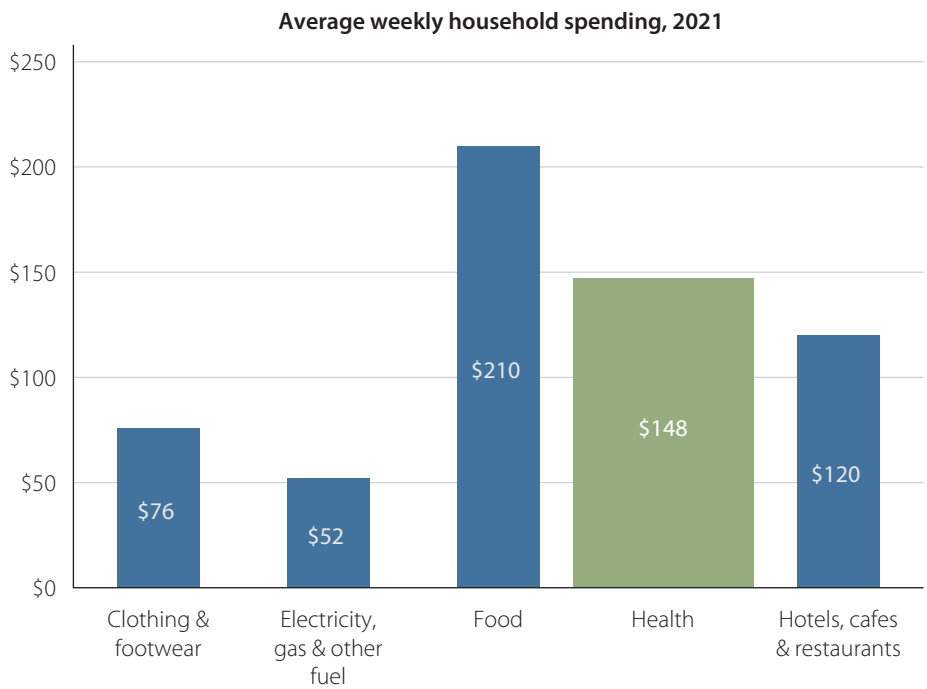
- no vertical axis with scale shown
- incorrect relative lengths of the bars, e.g. two different lengths for 1.8%.



Draw the correct graph and compare with another class member.

Misuse of the width of bars and highlighting specific aspects

Below is another bar graph of average weekly Australian spending from the household survey we saw above.

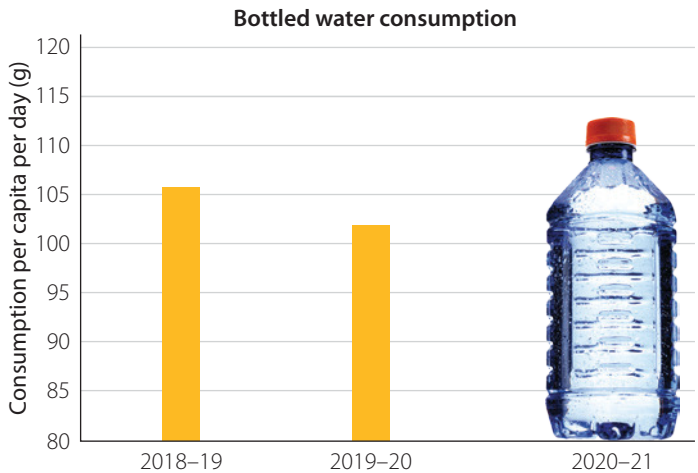


Colouring 'Health' green and making the area of the bar twice as wide gives the impression that this represents a lot more money than the other bars, and hence, those categories of expenditure.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Use of pictures or images

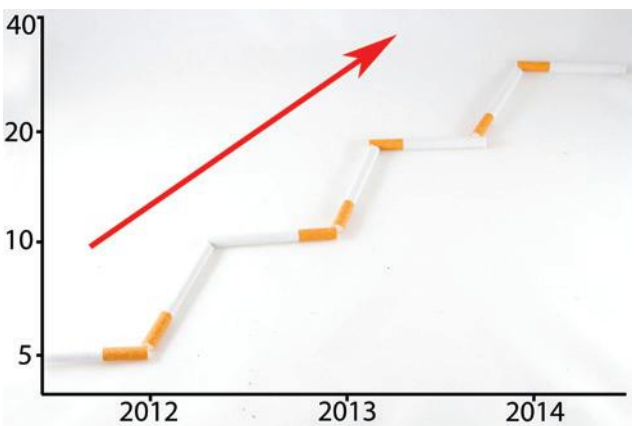
Graphs can be distorted if images or symbols are used to give a false picture. While the consumption of bottled water has actually increased a bit since 2019–20, the use of the three-dimensional container makes it look more like the consumption has increased by a considerable amount. To avoid this distortion, the size of a bar in a graph should increase in only one dimension, e.g. only the height is increased, not the width or depth.



Manipulating the vertical axis

There are several ways that people can distort a graph or chart that is related to manipulating the vertical axis. Some of the examples above have also done this.

How has the graph shown at right been distorted? Discuss with a partner.

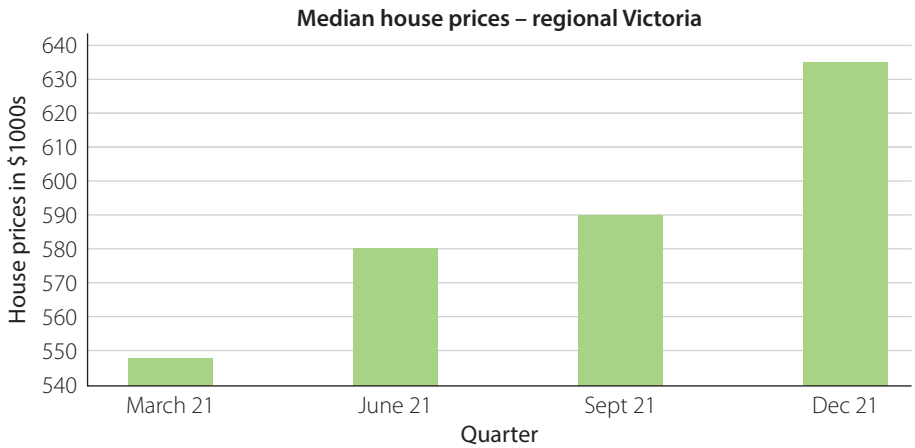


Breaking or truncating the scale

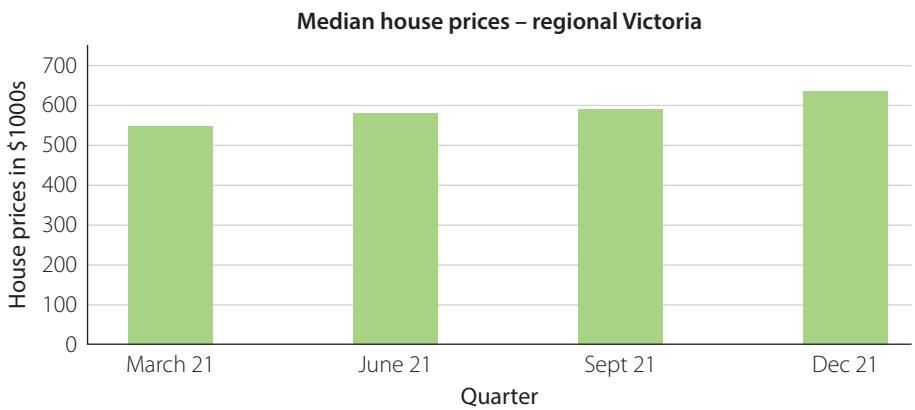
The effect of a break of scale is that it exaggerates any differences, making variations more obvious and appear more significant than they really are. It can distort the graph and its interpretation of the data – even if the data is correct. In particular, a break in the vertical scale of a bar graph can be most deceptive.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Here is a chart with the vertical axis starting at $540,000.

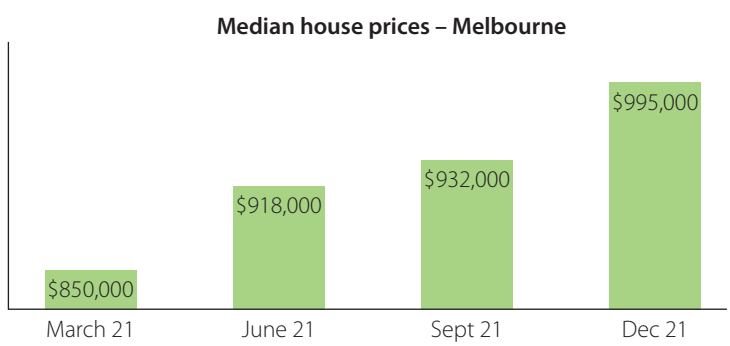


And here is the same data graphed correctly with the axis starting at 0.



The impression from the first graph is quite different from the interpretation made from the second graph.

Another misrepresentation is not including the vertical scale. Again, this is designed to exaggerate the increase, and to make it more difficult to accurately understand and interpret the data.

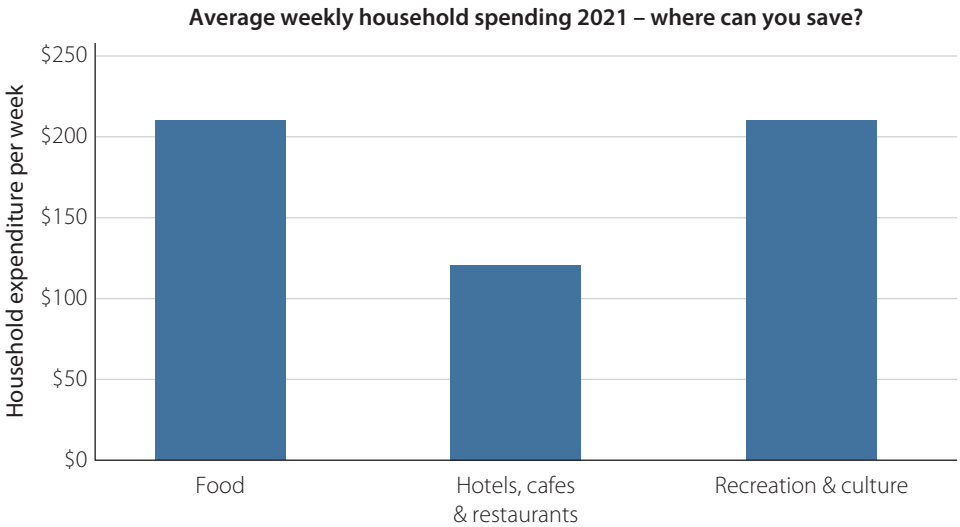


ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

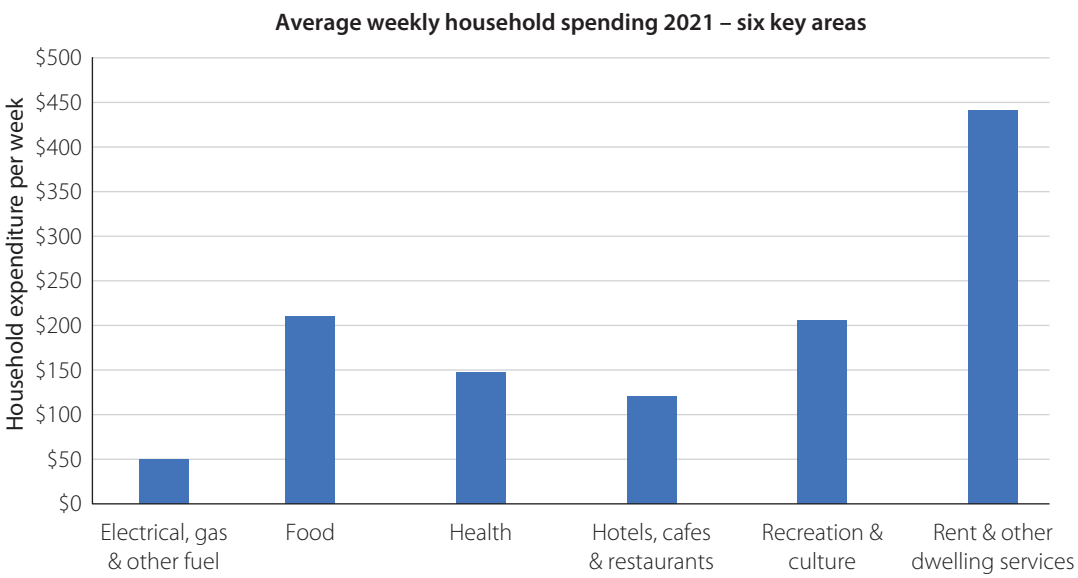
Cherry-picking the data represented

Cherry-picking data is the deliberate practice of only using the data that best support the person's own perspectives or arguments, instead of using and reporting on all the data.

This graph is an example of cherry-picking from the average weekly Australian spending from the household survey we saw earlier. The selective use of the data is to create the impression that people could save lots of money by spending less on non-essential activities.



But when all the categories of the data are represented in a graph, you see a more accurate picture of where households are spending their money.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

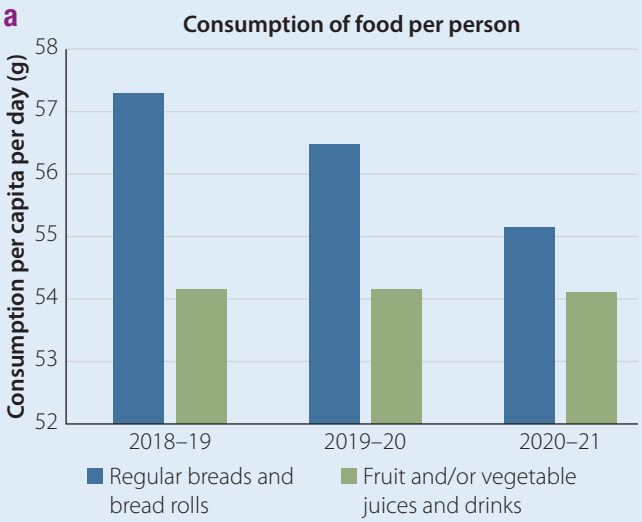
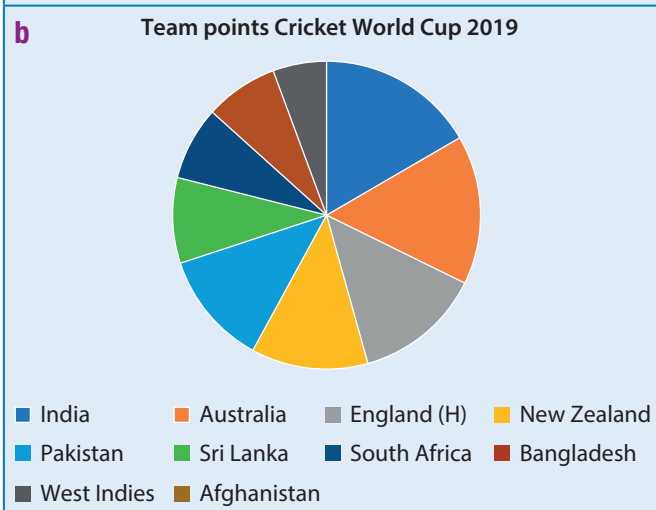
7H Tasks and questions

Thinking task

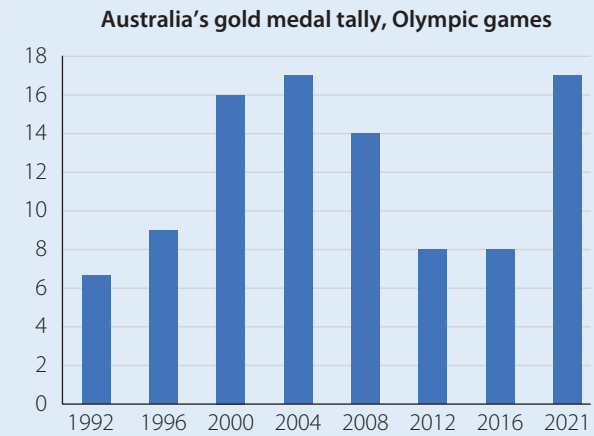
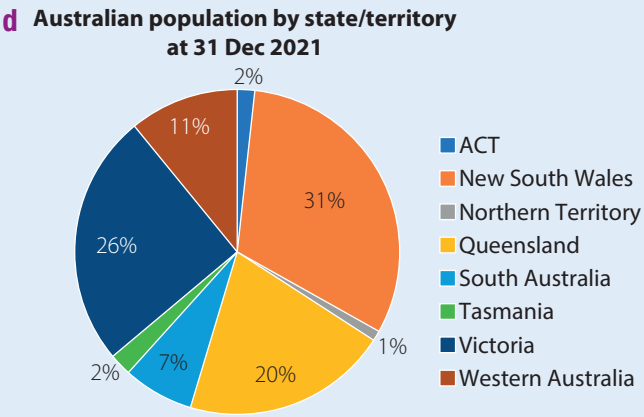
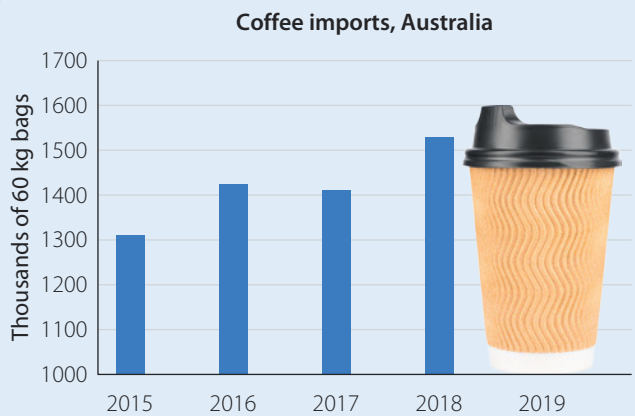
1 Why would companies make dodgy graphs? Search and find some examples. Share and compare your thinking with your classmates.

Skills question

2 Select the issue or issues with each of the graphical representations.

Chart	What is the issue with the chart or graph? It can be more than one issue.
a 	☐ Misuse or misunderstanding of pie charts ☐ Graphs not being constructed or labelled properly ☐ Misuse of the vertical axis ☐ It is correct
b 	☐ Misuse or misunderstanding of pie charts ☐ Graphs not being constructed or labelled properly ☐ Misuse of the vertical axis ☐ It is correct

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chart	What is the issue with the chart or graph? It can be more than one issue.
c 	☐ Misuse or misunderstanding of pie charts ☐ Graphs not being constructed or labelled properly ☐ Misuse of the vertical axis ☐ It is correct
d 	☐ Misuse or misunderstanding of pie charts ☐ Graphs not being constructed or labelled properly ☐ Misuse of the vertical axis ☐ It is correct
e 	☐ Misuse or misunderstanding of pie charts ☐ Graphs not being constructed or labelled properly ☐ Misuse of the vertical axis ☐ It is correct

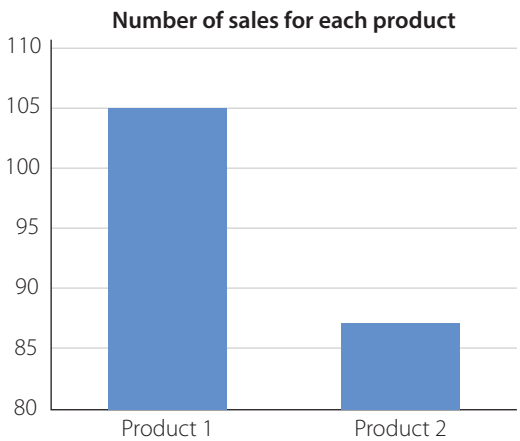
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mixed practice

3 Explain the presentation error/s in each of the following graphs.

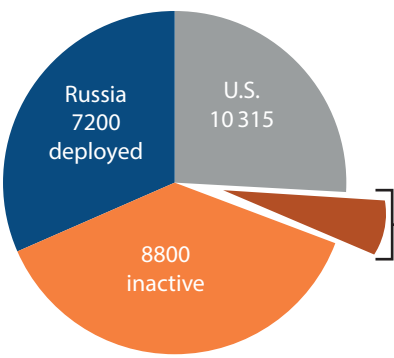
a

b



c

Estimated nuclear stockpiles, 2005



Russia has about 8800 warheads in reserve or awaiting dismantling

In addition to the known nuclear powers, North Korea says it has nuclear weapons. Iran could be next.

	Estimated warheads
China	410
France	350
Britain	200
Israel	100–170
India	75–110
Pakistan	50–110
North Korea	7–15?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Application tasks

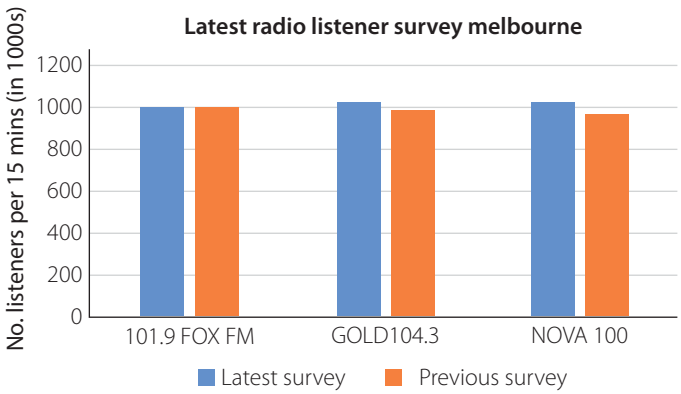
4 The following three charts are based on the results of surveys of radio listeners to the different radio stations in Melbourne. The data shows the average number of listeners tuned to a radio station per quarter hour in any given time period and is expressed in thousands (1000s) of listeners.

a Are the graphs all showing the results accurately?

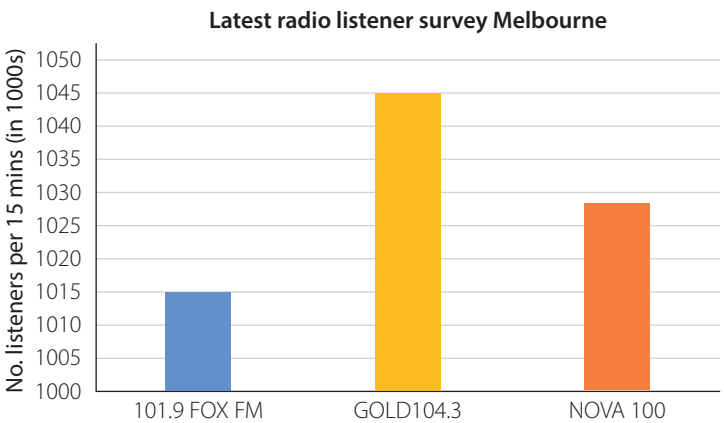
b Which graphs are not working well or are distorting the data in some way? Explain why.

c What different interpretations are possible from each graph, compared with the other two graphs in the set?

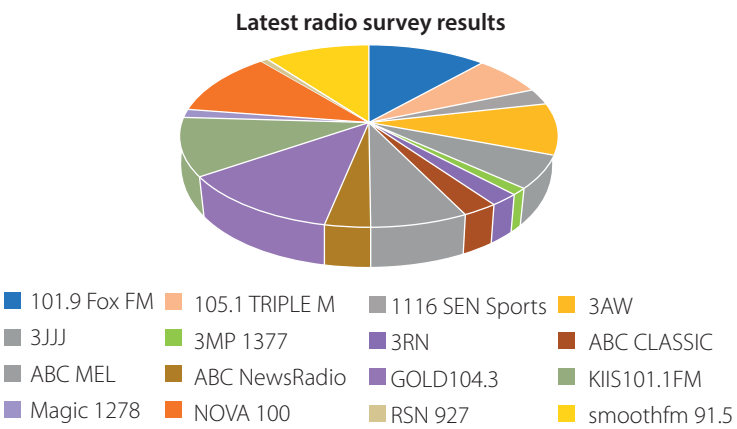
Graph A



Graph B

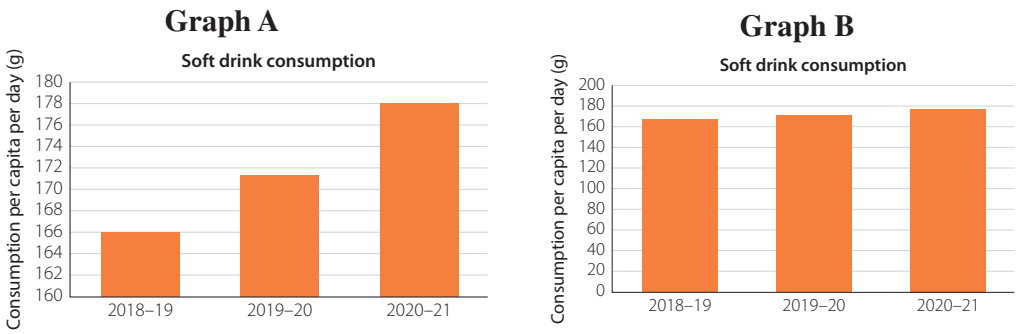


Graph C



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

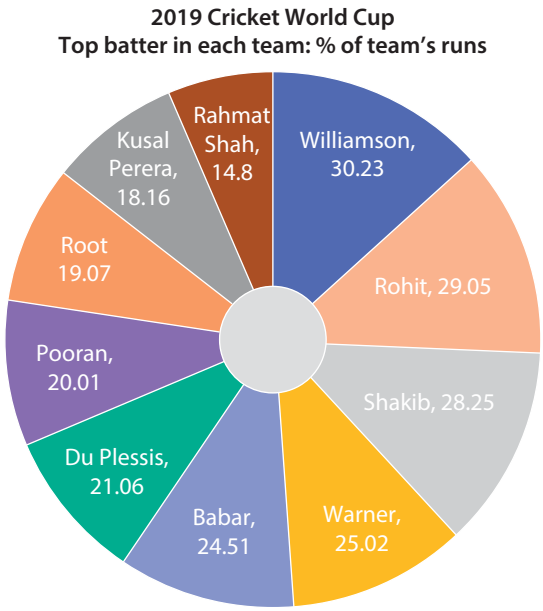
5 The following two graphs are about soft drink consumption.



a Are the graphs showing the results accurately?

b Explain how one of the graphs has misrepresented the data.

6 The pie chart below shows the top batter in each country's team in the 2019 World Cup of cricket. The values shown are each batter's percentage of the runs scored for that team.



Source: ESPN Cricinfo (2019)

a Is this the best way to represent this data? Why or why not?

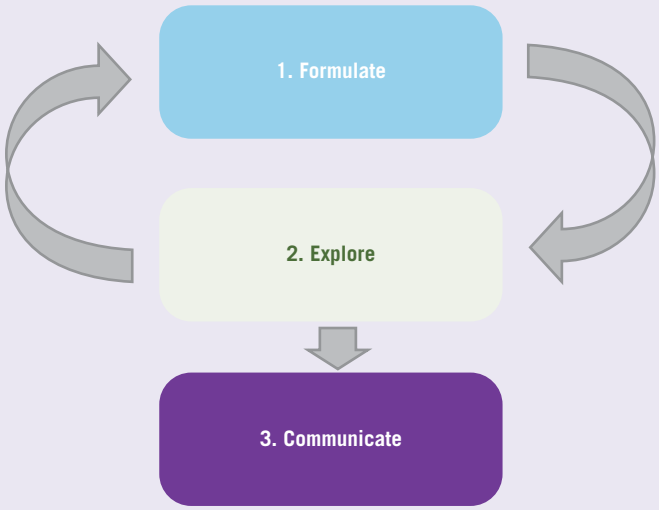
b Is there a better chart to use to display this data? Which one would you use and why?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Investigations

When undertaking your investigations, remember the problem-solving cycle steps:

- **Formulate** – Sort out and plan what you need to know and need to do to solve the problem.
- **Explore** – Use and apply the mathematics required to solve the problem.
- **Communicate** – Record and write up your results.



1 2021 Census data

Your task in this investigation is to access, analyse and report on data from the 2021 Census, including what the data shows about changes over time.

The Census, which is conducted every five years, is the most comprehensive snapshot of the country. By asking questions of every Australian, it collects data on the economic, social and cultural make up of the country. It also compares the latest data with that which was collected in earlier censuses.

You can access information about the Census, including being able to download data, from the Australian Bureau of Statistics (ABS) website.

Formulate

Work in groups of two or three.

a Decide on an area or subject that you would be interested in researching. Start by visiting the ABS Census website and familiarising yourself with what information is collected.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

b Brainstorm with the other students all the different aspects of your topic to create a mind map.

c Once the group is happy with the mind map, you each need to decide on a **single issue** from the mind map that you would like to follow up on in your investigation. You need to start formulating what questions you will ask that will form the basis of your research. Make sure it is manageable and that your data will be available from the ABS.

You will need to plan how you are going to:

- access and download a set of data about your topic that will help you answer your key question(s)
- collate the data and input into a spreadsheet or other suitable format
- represent the data in tables and graphs
- analyse the data, including comparing the data over different census dates
- use measures of central tendency and spread to summarise and compare your data
- review, reflect and discuss what the data is telling you about your topic and questions.

Explore

d During this stage, you will need to undertake the following tasks.

- Based on what you decided above, access and download the relevant data from the ABS.
- Sort the data into tables as per your research questions.
- Summarise the data appropriately.
- Review the data set and check that it all seems to be okay.
- Analyse the data, including comparing the data over your selected Census dates.
- Represent your data graphically.
- Calculate measures of central tendency and spread.
- Summarise and compare your data with that of earlier data.
- Make your interpretations and conclusions about the results and what they are telling you about your chosen issue and questions.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Once you have drawn any conclusions from your data and analysis, you should reflect on the original questions to see if the data and the results make sense. Do you need to readjust or redo any of the process and the analysis as this is part of the problem-solving cycle?

Communicate

e Write up and present the findings of your investigation of the subject area chosen. You can choose the form of your presentation.

Include the following in your presentation.

- The aspects of the census that you researched, and the earlier data you used
- The data tables and graphs that you created
- The use of statistical language in analysing the results of your research
- An explanation of the mathematics and statistics that you used in your research
- Your analysis of the findings of your research
- The technological tools that were used to research, collate and display the data in your investigation.

Reflect on your research and what you found. Were you surprised? In what ways? Why?

If you were to do this investigation again, what would you change and why?

2 Secondary data collection: 21st century issues (continued)

In Chapter 5 Investigation 2, you were required to collect secondary data about a 21st century issue of interest, collate and summarise it. This investigation involves undertaking a greater analysis of data. If you completed the Investigation in Chapter 5, you may choose to use the same set of data or collect a new set.

Formulate

In groups of two or three:

a Brainstorm topics or subjects that the group may be interested in researching. It should be something topical in the 21st century and be of broad interest. Decide on a single issue that you would like to investigate.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

b Formulate the questions that you will ask as part of your research and decide on the data that will be suitable to answer your questions. Make sure that it is manageable and that you believe the data you use will be valid and reliable.

Explore

c Conduct the research to collect and download the relevant data that will help you answer your key questions. Make sure that the data is from reliable sources such as:

- ABS (Australian Bureau of Statistics)
- Statista (if your school has an account to access the data).

d Collate and display the data in appropriate statistical representations such as tables and graphs.

e Apply mathematical and statistical processes and analyses to establish how the data you have chosen explores the questions that you have asked. This should include calculations of measures of central tendency and spread.

f What story does the data tell?

g Do your results make sense? Or do you need to adjust your investigation? If so, how will you do this?

Communicate

h Write up and present the findings of your research. You can choose the form of your presentation.

Include the following in your presentation:

- An explanation of your choice of topic and research questions. Why did you choose the data that you did?
- A summary of the mathematical and statistical language and processes that you used in this investigation, the graphs that you created and the results of your research.
- The reason why you have chosen to present the data in the way you have. Why did you choose the particular statistical methods that you did?
- The technologies that have been used to collect the data initially and the technology used to collate and analyse the data.

Reflect on the research processes you used in this investigation. Were you to do it again, what would you change, and why?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key concepts

- **Interpolation and extrapolation**
  - When we make predictions within the range of the data set that is given, this is called **interpolation.**
  - **Extrapolation** is the prediction of numbers outside of a data set. Extrapolation should be used with caution as it assumes that the trend observed within the data will continue outside the range of the data, which may not always be the case.
- **Data values**
  - These can be individual numbers (like a person's age) or grouped (ages 0–5, 6–9 etc.)
- **Measures of central tendency**
  - **Mean**: This is often called the *average*. It is calculated by adding all the values and dividing by the number of values.
  - **Median**: This is the middle value of the data when the data set is arranged in ascending order. The position of the middle value can be calculated by adding 1 to the total number of values and dividing by 2.
  - **Mode**: This is the value that happens the most.

  You have to select the most appropriate measure to use for the data.
- **Measures of spread and related statistical measures**
  - **Range**: This tells you the full extent of your data and helps you to see if your measures of central tendency are reasonable. To calculate the range, subtract the smallest value (minimum) from the largest value (maximum).
  - **Quartiles**: These are values that divide the data set into four equal-sized subgroups (when the data is arranged in ascending order). Each subgroup will contain $\frac{1}{4}$ or 25% of the values. The quartiles, or values at the end of the subgroups, are known as Q1, Q2, Q3 and Q4 where Q2 is the median.
  - **Interquartile range (IQR)**: This is when you find the difference Q3 – Q1, so it represents the range of the *middle* half of the data, and is not influenced by outliers.
  - **Percentiles**: These are values that divide the data set into 100 equal-sized subgroups (when the data is arranged in ascending order).

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- **Standard deviation (SD):** This is a measure of how far values are away from the mean.
- **Outliers:** These are values that are extremely low or high compared with the rest of the data.

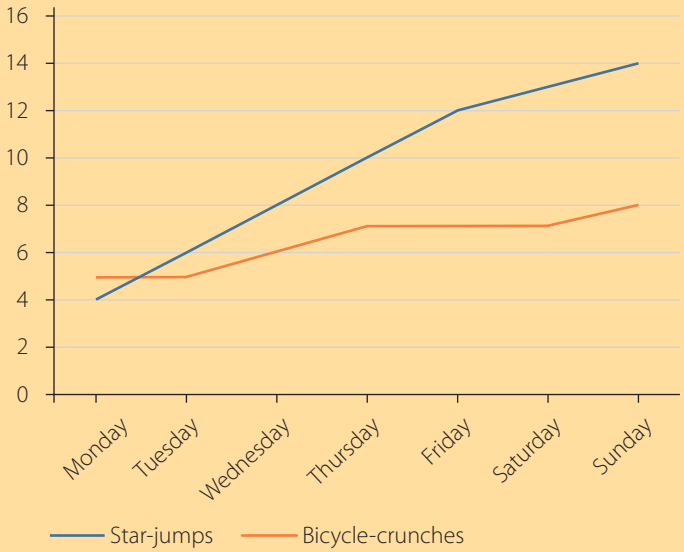
- **Read, interpret and analyse graphs**
  - A good graph has these features:
    - a title
    - an accurate vertical scale, usually starting at zero
    - clear indication of the values on the horizontal axis
    - the scale on the horizontal axis is equal (bin width)
    - is the most appropriate way to convey the message of the data.
- **Shapes of distributions**
  - A **symmetrical distribution** has data values that are evenly spread on either side of the centre. The mean, median and mode will all be similar values.
  - A **normal distribution** has data values that are uniformly spread around the middle values, forming a bell-shaped curve. In this type of distribution, 68% of the data is within one standard deviation of the mean, 95% of the data is within two standard deviations of the mean and 99.7% of the data is within three standard deviations of the mean.
  - A **skewed distribution** has data values that are not evenly distributed on either side of the centre.
  - A graph can be **positively skewed** (values are clustered at the lower end of the scale and the tail extends to the right).
  - A graph can be **negatively skewed** (values are clustered at the higher end of the scale and the tail extends to the left).
  - A **bimodal distribution** has data values that have two modes or peaks in their distribution.
- **Identify when data has been mispresented**
  - Distorted/manipulated/truncated scales
  - Too much data so that the meaning is lost
  - Relevant data purposely left out to convey a dodgy message (*cherry-picking* data)

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Success criteria and review questions

☐ I can use interpolation and extrapolation to estimate values.

1 Use the line graph to answer the following questions.



a How many star-jumps and bicycle-crunches were done on Thursday?

b Looking at the trendlines, how many star-jumps and bicycle-crunches do you think will happen on the next day?

2 Answer the following questions about the data for the average weekly earnings for employees in the United Kingdom from 2005 to 2015.

a Use software to create a line graph of this data.

b Use this graph to estimate the values for 2009 and 2020.

Year	Weekly pay (£)
2005	388.42
2006	406.75
2007	426.67
2008	441.75
2009	?
2010	451.33
2011	462.08
2012	468.33
2013	473.92
2014	479.83
2015	491.58

Source: Our World in Data
Total health expenditure per person - Australia
https://ourworldindata.org/grapher/annual-healthcare-expenditure-per-capita?tab=chart&country=~AUS

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

I can find the range, mean, median and mode of an ungrouped data set, and decide on the most appropriate measure of central tendency for this data.

3 The table shows data about the number of catches taken per match by a wicketkeeper in a season.

Number of catches	Frequency
0	1
1	2
2	6
3	3
4	2
5	0
6	1

a Calculate the range.

b Calculate the mean.

c Calculate the median.

d Calculate the mode.

e Which measure of central tendency is most appropriate for this data? Why?

I can find the mean, median and mode of grouped data, and decide on the most appropriate measure of central tendency for this data.

4 Use the grouped data below about 100 Australian national basketball players to answer the following questions.

a Calculate the mean height.

b Calculate the median height class interval.

c What is the modal class height?

d Which measure of central tendency is most appropriate for this data?

Height (cm)	Frequency
165–< 170	1
170–< 175	0
175–< 180	0
180–< 185	4
185–< 190	8
190–< 195	16
195–< 200	26
200–< 205	24
205–< 210	12
210–< 215	8
215–< 220	1
Total	**100**

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

☐ I can calculate interquartile range (IQR).

5 Answer the following for this data set: 5 8 9 15 16 16 21 24 25 28 30.

a Calculate the quartiles.

b Calculate the interquartile range.

☐ I can calculate and interpret mean and standard deviation.

6 This data gives the result scored by a group of students where 10 was the top mark on a test.

0 2 3 3 4 5 5 5 5 6 6 6 6 7 7 7 8 9 9 10

a Calculate the mean and standard deviation using technology.

b Explain whether you think that this was an 'easy' test or not.

☐ I can calculate cumulative frequency and cumulative percentage frequency.

7 Copy and complete this cumulative percentage frequency table.

Value	Frequency	Cumulative frequency	Cumulative percentage frequency
1	2		
3	3		
5	4		
7	5		
8	3		
10	2		
11	1		

☐ I can construct a cumulative frequency graph.

8 **a** Construct a cumulative frequency graph of the data in question **7**.

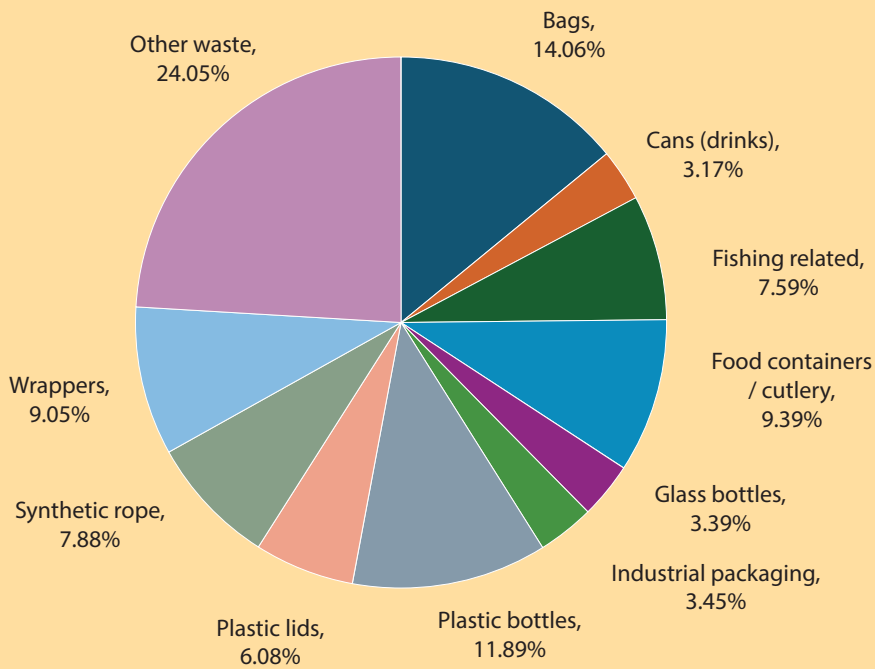
b Show the median and the quartiles on this graph.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

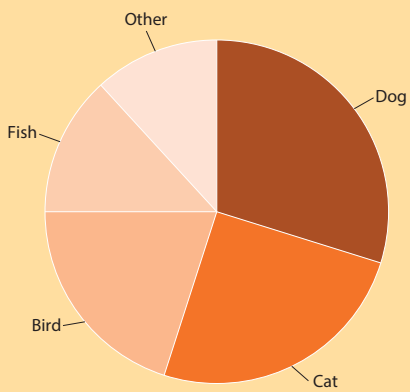
☐ I can identify good and poor graphs.

9 Looking at the graphs below, state what is done well and what is done poorly.

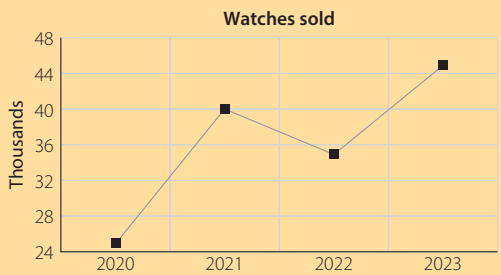
a The following chart shows the most common waste items found in rivers and oceans globally.



b This chart shows the number of pets bought at a pet store.



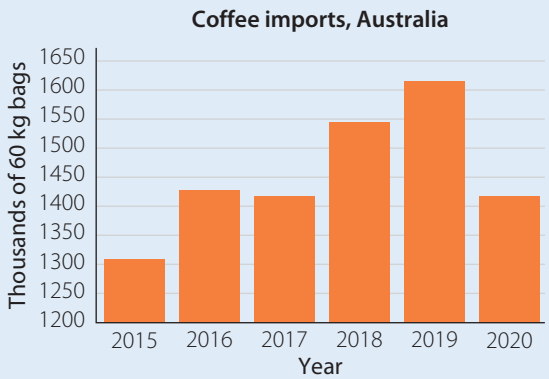
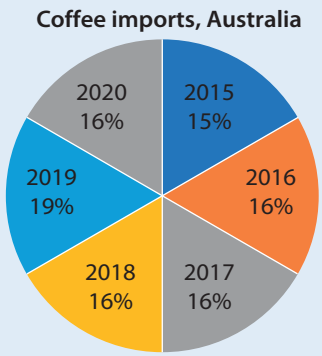
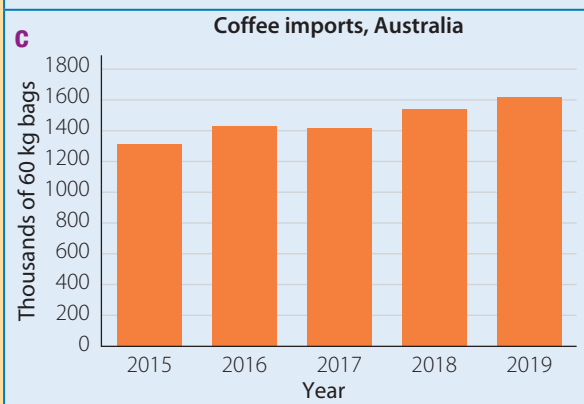
c This shows the number of watches sold over four years.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

☐ I can review graphical representations to identify if they have been distorted or manipulated.

10 For each of the charts or graphs below about coffee imports into Australia from 2015 to 2020, consider whether the representation has been manipulated or distorted in some way.

Chart	What is the issue with the chart or graph? It can be more than one issue.
a 	☐ Misuse or misunderstanding of pie charts ☐ Graphs not being constructed or labelled properly ☐ Misuse of the vertical axis ☐ It is correct
b 	☐ Misuse or misunderstanding of pie charts ☐ Graphs not being constructed or labelled properly ☐ Misuse of the vertical axis ☐ It is correct
c 	☐ Misuse or misunderstanding of pie charts ☐ Graphs not being constructed or labelled properly ☐ Misuse of the vertical axis ☐ It is correct

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mathematical toolkit

1 Reflect on the range of different calculations, technologies and tools you used throughout this chapter, and how often you used them for undertaking your work and making calculations. Indicate how often you used and worked out results and outcomes for each of these methods and tools.

Method and tools/ applications used	How often did you use this?
• Calculating and working in your head, and using algorithms	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using pen-and-paper	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using a calculator	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using a spreadsheet	Not at all: ☐ A little: ☐ Quite a bit: ☐
• Using measuring tools – name the tool, technology or application: _____ _____	Not at all: ☐ A little: ☐ Quite a bit: ☐ Not at all: ☐ A little: ☐ Quite a bit: ☐
• Using other technology or apps – name the technology or application: _____ _____	Not at all: ☐ A little: ☐ Quite a bit: ☐ Not at all: ☐ A little: ☐ Quite a bit: ☐

2 Did this chapter and the activities help you to better understand how you use different tools and technologies in using and applying mathematics in our lives and at work? In what areas and ways? Write down some examples.

3 In one sentence, explain something relating to tools and technologies that you learned in the unit. Write an example of what you learned.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key vocabulary

Here is a list of this chapter's key maths terms and their meanings.

Term	Meaning
Average	A way of finding a single value that represents all the values being measured. Commonly this is the *mean*.
Bimodal distribution	A bimodal distribution has data values that have two modes or peaks in their distribution.
Bin width	In the USA and some other countries, this is a common way of referring to *class interval*.
Central tendency	A single value that represents the centre of all the values. Usually we use the *mean*, *median* or *mode*.
Class interval	When raw data is organised into groups of values, the width of each group is called the class interval. The class intervals should have the same width for the whole data set. In the USA, this is called the *bin width*.
Cumulative frequency	This is the 'running total of frequencies' in a table, used to answer questions about how often a characteristic occurs above or below a particular value.
Data set	A collection of data – usually related to a particular subject that may be accessed individually or in combination as a whole.
Extrapolation	The prediction of numbers **outside** a data set, often using a trendline in a graph to predict values beyond those given in the data set. Extrapolation should be used with caution as it assumes that the trend observed within the data will continue outside the range of the data, which may not always be the case.
Frequency	The number of times a value occurs in a set of data, i.e. how many there are of each measurement.
Grouped data	When a large amount of raw data is organised into a smaller number of groups of values.
Interpolation	The prediction of a value **within** the data set, often using the trendline of a graph to predict a value within a data set.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Term	Meaning
Interquartile range (IQR)	The difference between the 3rd quartile and the 1st quartile in a data set. The IQR represents the middle 50% of the data.
Maximum	The highest or greatest value in a data set or on a graph.
Mean	The value calculated by adding together all the values and dividing by the number of values you have. A few very high or very low values (called *outliers*) can distort the mean value. Also called the *average*.
Median	The middle value of all the values (when they are in order from smallest to largest). There will be a half or 50% of all values less than the median value, and 50% higher than it.
Minimum	The smallest or lowest value in a data set or on a graph.
Mode	The most common or frequently occurring value.
Negatively skewed	Negatively skewed distributions have values that are clustered at the higher end of the scale and the tail extends to the left side of the distribution.
Normal distribution	Data is uniformly spread around the middle values, forming a bell-shaped curve.
Outlier	A value that is very different from others in the sample set, being unusually higher or lower than most other values.
Percentile	The cut-off values for each of 100 equal groups into which a set of data has been arranged in ascending order. For example, 60% of the data values lie at or below the 60th percentile.
Positively skewed	These distributions have values that are clustered at the lower end of the scale and the tail extends to the right side of the distribution.
Quartile	Quartiles are the four values that divide a list of data that is arranged in ascending order into four equal-sized subgroups each containing one-quarter of the data values.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Term	Meaning
Range	The difference between the *maximum* and *minimum* values in a data set.
Skewed distribution	Skewed distributions are not evenly distributed on either side of the centre. Data values will be clustered around higher or lower values.
Spread	A measure for looking at the variation amongst all the values in a data set – how spread out all the values are.
Standard deviation (SD or σ [sigma])	A measure of spread of data points relative to the mean. A larger SD indicates that the data values are more widely spread out. In business it is sometimes called 'sigma'.
Summary statistics	A way of capturing the main features of a data set. They provide a quick summary and are particularly useful for comparing one set of data with another. These are values like the *mean*, *median*, *mode*, *range*, *interquartile range* and *standard deviation*.
Symmetrical distribution	A symmetrical distribution has data values that are evenly spread on either side of the centre, and the *mean*, *median* and *mode* will all be similar values. Each side of the data distribution is nearly a mirror image of the other.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

8 Connecting chance and data

Brainstorming activity: Where's the maths?

Using this photo of an outback meteorological weather station as a stimulus, brainstorm the type of maths that would be used related to the use of this station, and its collected data and information. Think especially about any maths skills related to the content of this chapter – connecting chance and data.

Prompt questions might be:

- What activities and investigations might be related to the data collected?
- What data and information could be collected and represented?
- What types of mathematical content knowledge and skills would be relevant?
- What different tools, technologies or software might be used?

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter contents

Chapter overview and Spotlight

8A Starting activities

8B Tuning in

8C Refresher on working with probability and chance

8D Long-term data

Investigations

Chapter review

From the Study Design

In this chapter, you will learn how to:

- use long-term data and relative frequencies in practical situation to make informed interpretations and decisions about the likelihood of events or outcomes with respect to financial data, epidemics, climate data, or environmental data
(Units 3 and 4, Area of Study 2)

© Victorian Curriculum and Assessment Authority 2022

ISBN 978-1-009-11065-5 Sakurai et al.

© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter overview

Introduction

Probability and chance surround us, and we make multiple decisions each day based on probability. Did you grab a jacket or umbrella recently in case it rains? Probability – based on the weather forecast's estimated likelihood of it raining! In your after-school job, how many people are rostered on for the weekend? Probability! Had a great run driving through traffic lights? Probability again!

Data is collected and analysed to make predictions, and understanding the concepts of chance and probability is crucial in various areas of life, especially in relation to understanding risk. Some areas that use probability and estimating chance and risk include weather forecasting, politics, health and medicine, sales and marketing, insurance, staffing levels, stock levels, natural disasters, traffic management, sports, betting and investing.

In this chapter, you will develop a stronger understanding of probability and chance and how they apply to big picture issues such as the environment, health and finance. There are many calculators and apps online that you can use to help you calculate probabilities in life and in business. However, calculating probabilities is only half the story. We will examine how to read and interpret these probabilities so that you can use them in decision-making processes.

Learning intentions

By the end of this chapter, you will be able to:

- understand the key ideas behind chance, likelihood and probability
- identify the sample space
- identify types of probability
- calculate simple probabilities
- use long-term data to identify probabilities and make decisions
- use relative frequencies to identify probabilities and make decisions.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Spotlight: Judith Fronczek

An interview with a forensic pathologist

Tell us about some of the work you have done and have been doing in your job.
I work as a forensic pathologist at the Victorian Institute of Forensic Medicine. In this role, I perform post-mortem investigations on people who have died unexpectedly or have died due to unnatural causes, such as accidents and violence.

What maths do you use regularly in your job? Can you provide examples?
I use maths every day and in different aspects of my job. For example, in every decedent (a deceased person), body weight and height are measured and the body mass index (BMI) is calculated. I measure organ weights and compare them to reference values. The weight of an organ is often reflective of the health of an organ. This is especially true for the heart. There is an online tool I use in which I fill out the body weight and height of a decedent, and the tool calculates the mean and upper limit (95th percentile) of the expected heart weight based on an autopsy population. In children, it is also important to assess development. For this, different measurements are taken and I give percentiles in my report to reflect the development of the child. In research projects and post-mortem reports, I use the applicable statistical tests, especially for more complex cases when I want to explain how the medical evidence can assist in differentiating between two hypotheses or scenarios. For example, this can be between the hypothesis of the prosecution (H1: 'the deceased died of strangulation') and the hypothesis of the defence (H2: 'the deceased died of drug intoxication'). To work out the odds of either of these hypotheses being true, I often use the Theorem of Bayes which calculates the likelihood of an event (or the hypothesis) happening given the probability of other related events occurring.

What was your attitude towards maths whe you were in school? Has your attitude towards maths changed over time?
Maths was my least favourite subject at school. It is still not my favourite subject, but I acknowledge how extremely helpful it can be when probabilities are discussed in my work.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

8A Starting activities

Activity 1: The likelihood line

This is an activity for you to think about the likelihood or chance of different events happening. In maths we often refer to this as **probability**.

Work in a small group with 2 or 3 other students. Your teacher will supply you with:

- a large sheet of paper – like butcher's paper or an A3 sheet
- a few sticky notes for each of you to write on.

Work your way through the following tasks and answer the questions together in your group.

1 Talk about what the words **likelihood** and **chance** mean in maths and outside the maths class? What do you know about the likelihood or chance of events happening or not happening? The more formal word we use in maths is **probability.**

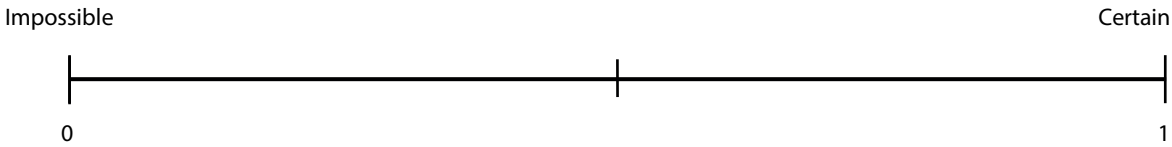
2 Thinking about likelihood and chance, what is meant by an event being called **impossible?** What are some examples of events that are impossible? What numerical value do we give to an event that we call impossible?

3 What about the opposite – what is meant by an event being called **certain?** What are some examples of events that are certain to happen? What numerical value do we give to an event that we call certain?

4 We use numbers to show the likelihood or chance or probability of something happening. If the probability of an 'impossible' event is 0 and the probability of a 'certain' event is 1, what is the range of numerical values that we could give to the probability of any event?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

5 We can show the range of numerical values for the probability of an event on a number line.



Draw this number line – we'll call it the likelihood line – across your large piece of paper.

6 What word or words about chance could you use for halfway along the likelihood line – at the halfway point? Write the words on one of your sticky notes and place it there on the line.

We can give the value to this halfway point as a fraction $\left(\frac{1}{2}\right)$, or a decimal (0.5) or as a percentage (50%). Write these numbers on your number line.

7 Now as a group, think about other words or phrases for other chance events and words we use. Where would you place words like 'unlikely' or 'highly likely' etc. on the number line? Write them on sticky notes and place the sticky notes along the line. Think about other chance words or expressions – like 'Buckley's chance' and 'Pigs might fly' and add them to your likelihood line and add numerical values against them.

8 Each group member should now write down five different events on five sticky notes – but don't put them on your number line or share them with your group. You need to make up one event that is:

a impossible to occur

b unlikely to occur

c neither unlikely nor likely to occur

d likely to occur

e certain to occur.

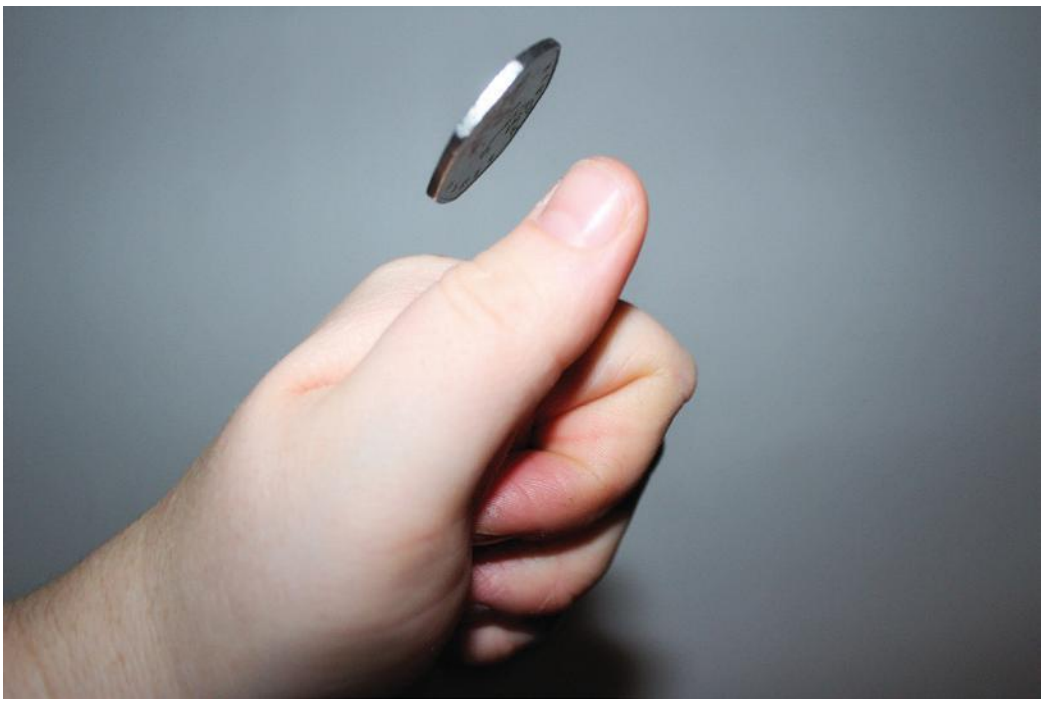
Note: These events can be examples like: 'Essendon is going to be AFL premiers this year' or 'I am going to do my maths homework tonight' or 'The chance of rolling a six on a die'.

9 Swap the sets of sticky notes with someone else in the group. Place each other's sticky notes on the likelihood line. Then discuss where you each put them and discuss any discrepancies or differences of opinion about the placement of the events on the likelihood line. Agree together on the value you would give to each of your events – express each as a fraction, a decimal and a percentage.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Activity 2: Coin flipping

You are going to do some experiments about chance by tossing a coin.



1 Work with a partner. You are going to flip a coin 20 times. How many heads and tails do you expect to get?

2 With a partner, flip a coin 20 times and record your findings in a table like the one below.

Heads	Tails
𝍸 I	III

3 How close were you to your guess of the number of heads and tails?

4 Now keep flipping your coin until you have completed 50 trials. (Each flip of the coin is a trial.) What is the story now? Are you closer to what you expected or not? Discuss why – or why not?

5 Think about and discuss what you think might happen if you kept tossing the coin? What do you think the data would look like if you plotted all the data about the tosses on a graph?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

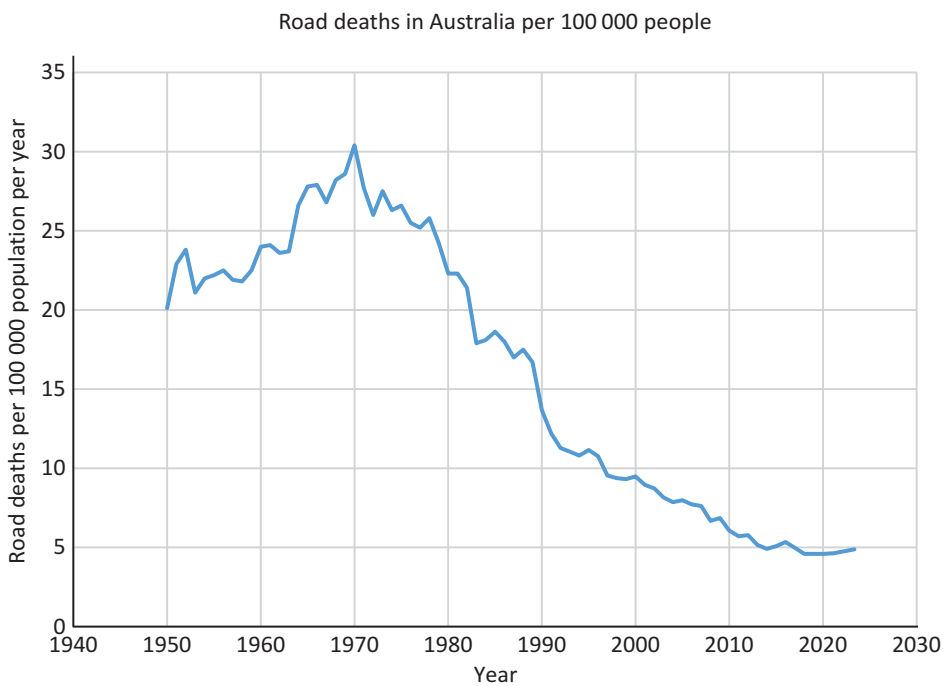
8B Tuning in

Epic Success: Seat belts save lives

Seat belts are an epic success story for Australia!

Even though seat belts were invented in 1959, it took some alarming increases in the road death toll for the government to legislate the wearing of seat belts. Seat belts became compulsory to wear in the front seat in 1969 and then for all seats in the vehicle in 1971.

The graph below provides the evidence that the death toll steadily declined with the compulsory use of seat belts and then other innovations in car safety that have followed such as antilock brakes, traction control, airbags and more.

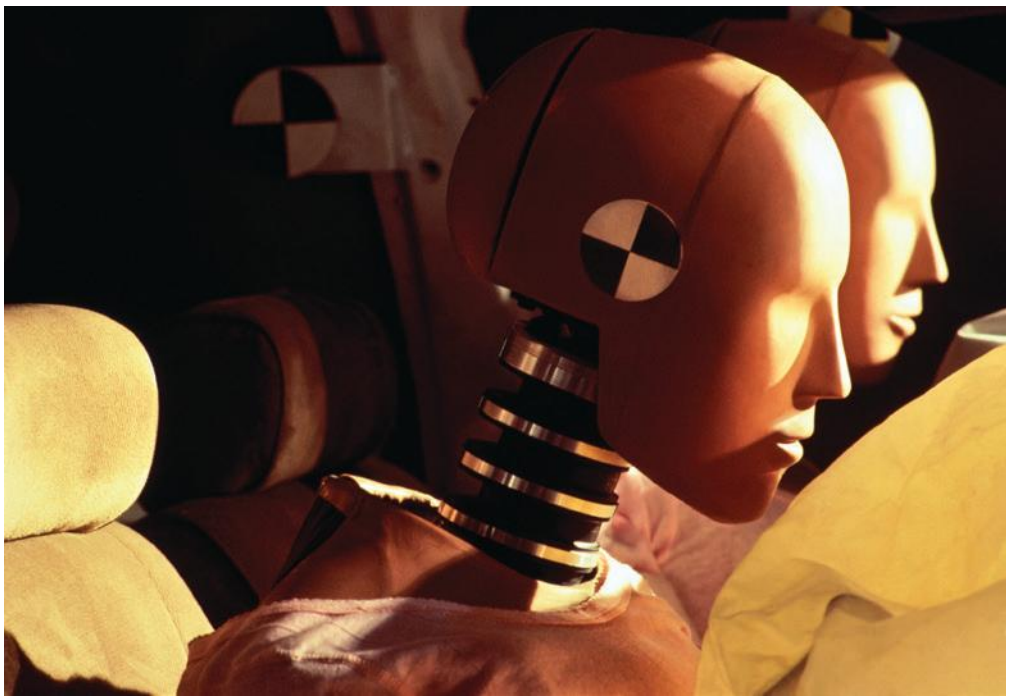


Source: Australian Transport Safety Bureau and The Department of Infrastructure, Transport, Regional Development, Communications and the Arts

... continued

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

So how did car manufacturers and governments know that seat belts could save lives in car accidents? Researchers conducted many experiments with crash test dummies.



General Motors (GM) in the USA were at the forefront of research with car crash dummies. The data they collected provided probability models that researchers could use as evidence.

Unfortunately, despite all the evidence showing how important seat belts are in saving lives, recent research has still found that:

'Failure to wear a seat belt is one of the leading causes of road crash death for crash-involved vehicle occupants.'

'Unrestrained drivers and passengers are 8 times more likely to be killed in a road crash.'

'Wearing a properly adjusted seat belt reduces the risk of fatal or serious injury by up to 50%.'

Source: Queensland University of Technology

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Discussion questions

1. Which year in Australia had the highest number of deaths per 100 000 people?
2. Compare the chances of dying in a road crash over the period from the highest value to what it is in 2022 (4.54). What was the chance of dying in a road crash in the peak years, compared to in 2022? How many times less likely is it for a person to now die in Australia from a road crash compared to the peak period?
3. Why do you think it took so many years for the statistics to drop to current levels?
4. Do you think that this statistic was affected by other factors? Share and compare these with your classmates.

Practice question

Copy and complete this table by putting a mark in the corresponding box indicating the likelihood that you will do each of the following.

	Impossible	Highly unlikely	Unlikely	Neither likely nor unlikely	Likely	Highly likely	Certain
Attend school this week							
Fly to the moon tomorrow							
Use PTV this week							
Eat dinner tonight							
Catch a cold next week							
Win Tattslotto on Saturday							
Watch a YouTube today							
Walk the dog tomorrow							
Finish all my homework							
Talk with my friends today							
Slip and fall next week							

Share and compare your responses with those of your classmates.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

8C Refresher on working with probability and chance

As stated in the introduction, an understanding of probability and chance and how they apply to issues such as the environment, health, finance and sport is critical. This is especially true in these days of **big data**. Examples about the use of probability and chance can range from predictions of the likelihood of rain, the sex of a new baby, the chance of overcoming specific diseases, the possibility of success in games and sports, to decisions about insurance and investments and announcements by business and governments.

The common terms we use include 'likelihood', 'chance' and 'probability', and it is important to think about what each term means. In general, everyday usage, we often use all three terms interchangeably, but there are some differences that are worth considering.

Wed 28 Feb		16 °C	34 °C	Late cool change. Becoming windy.
Possible rainfall: 0 mm			Chance of any rain: 10%	
Thu 29 Feb		14 °C	26 °C	Cloudy.
Possible rainfall: 0 mm			Chance of any rain: 5%	
Fri 1 Mar		11 °C	27 °C	Partly Cloudy.
Possible rainfall: 0 mm			Chance of any rain: 0%	
Sat 2 Mar		11 °C	21 °C	Cloudy.
Possible rainfall: 0 mm			Chance of any rain: 40%	
Sun 3 Mar		8 °C	21 °C	Cloudy.
Possible rainfall: 0 mm			Chance of any rain: 5%	
Mon 4 Mar		8 °C	25 °C	Sunny.
Possible rainfall: 0 mm			Chance of any rain: 5%	

Source: Bureau of Meteorology

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Likelihood is mostly used when describing whether something is likely to happen; for example, there is a higher likelihood of rain this afternoon because heavy clouds are moving in.

Chance is about the general possibility that something (called an **event** in probability) could happen. Chance refers to the likelihood of an event occurring. It encompasses the unpredictable nature of events; for example, there is a good chance that it is going to rain this afternoon.

The **probability** of an event is the numerical measure of the chance or the likelihood that the event will occur. For example, the Bureau of Meteorology might state that the probability (or chance) of rain on Saturday is 40%. This is based on their long-term data and knowledge of weather patterns for the area.

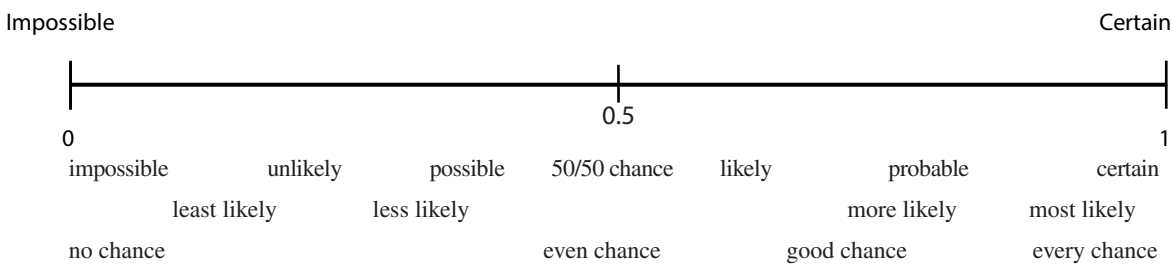
Many events can't be predicted with total certainty. The best we can say is how likely they are to happen, using the idea of probability.

From impossible to possible – the range of values of probability

In *Activity 1: The likelihood line* in section 8A, you looked at the different words and terms we use for talking about chance and probability, and gave them numerical values. This can be summarised in the following points.

- There is a continuum of probabilities from impossible to certain, with anything in between as being possible.
- There is a range of terms we use to describe this continuum of probabilities – such as 'likely', 'highly unlikely', 'equal chance' etc.
- There are numerical values given to this continuum from 0 (impossible) through to 1 (certain, absolutely sure to occur).
- These values can also be represented using percentages (from 0% to 100%), decimal fractions or common fractions.

This can be represented on a number line (we called it the likelihood line) along with where some of the common terms or phrases might be placed.



Mathematically, we say that $\mathbf{0 \leq P \leq 1}$, where P represents the probability.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

More about probabilities

In order to work out and calculate probabilities, there are more terms that we need to know and understand.

The example of rolling a six-sided die (the plural of die is dice) will be used throughout to show how these terms apply.

These terms include:

- **chance experiment** – an activity for which multiple outcomes are possible but we do not know which outcome will occur – it depends on chance. For example, an experiment could be conducted to determine the chance of throwing a 4 using a six-sided die. The range of outcomes here is the numbers 1 to 6. If the experiment is repeated, the findings may be different.

- **trial** – one instance of the task undertaken within an experiment. The experiment with the die, for example, would require the die to be rolled a number of times. Each roll of the die is a trial. For example, the die may be rolled 100 times; the number of trials in this one experiment therefore would be 100.

- **outcome** – the result of a trial. For example, when a six-sided die is rolled, the outcome could be any number from 1 to 6 (see *sample space*).

- **sample space** – an important term used in relation to chance activities. It is used to describe all the outcomes that could occur within an activity or experiment. For example, when rolling a six-sided die, the sample space includes 1, 2, 3, 4, 5 and 6 – all the numbers on the die. If the experiment is rolling two dice and **adding** the two numbers showing, the outcomes would be all the whole numbers from 2 to 12. The sample space is often written within curly brackets { }. For example, the sample space for the single die rolling would be **{**1, 2, 3, 4, 5, 6**}**.

- **event** – a selected outcome or subset of all possible outcomes. In the die experiment, the event would be the rolling of a 4. In another experiment with a die, the event might be rolling an odd number (1, 3 or 5).

- **probability** – the numerical measure of how likely an event is. For example, 'What is the probability of rolling a 4?'

Sample spaces

Because sample spaces are critical in working out probability values, it is good to know how to create them. There are a few different ways you can do this.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Lists

If you are playing in a sporting match, the outcomes could be win, lose, draw or forfeit (if a team does not show up or withdraws). This sample space could be listed as {W, L, D, F}.

Tables

When you toss two coins at the same time, the outcome can be shown in a table.

		Coin 2	
		Head	**Tail**
Coin 1	**Head**		
	Tail		

This could also be shown as:

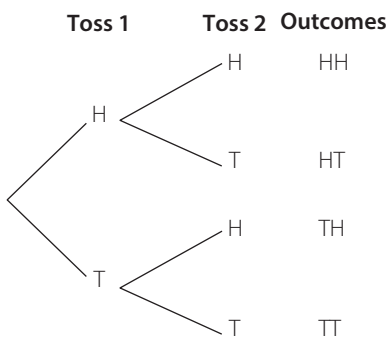
		Coin 2	
		Head	**Tail**
Coin 1	**Head**	HH	HT
	Tail	TH	TT

The sample space for this experiment is {HH, HT, TH, TT} where H represents a head and T represents a tail.

Tree diagram

When there are many possible combinations, a tree diagram can be effective to find all of the options. This can be used for the tossing of two coins as shown in this tree diagram.

The sample space for this experiment is {HH, HT, TH, TT}.

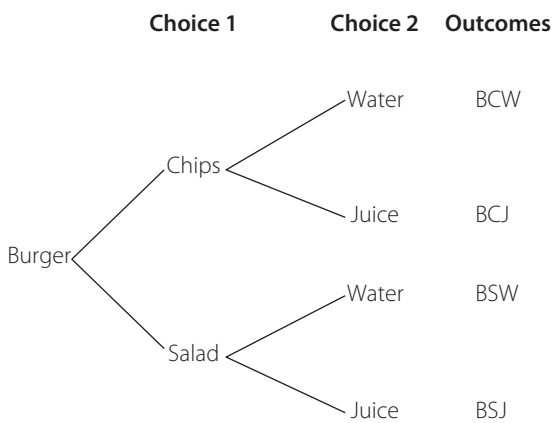


ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example: A fast-food restaurant offers a special combination of meals where you can choose different options.

Customers who purchase a burger may choose between chips or salad, and water or juice.

Representing this as a tree diagram gives us:



This tree diagram shows four meal options:

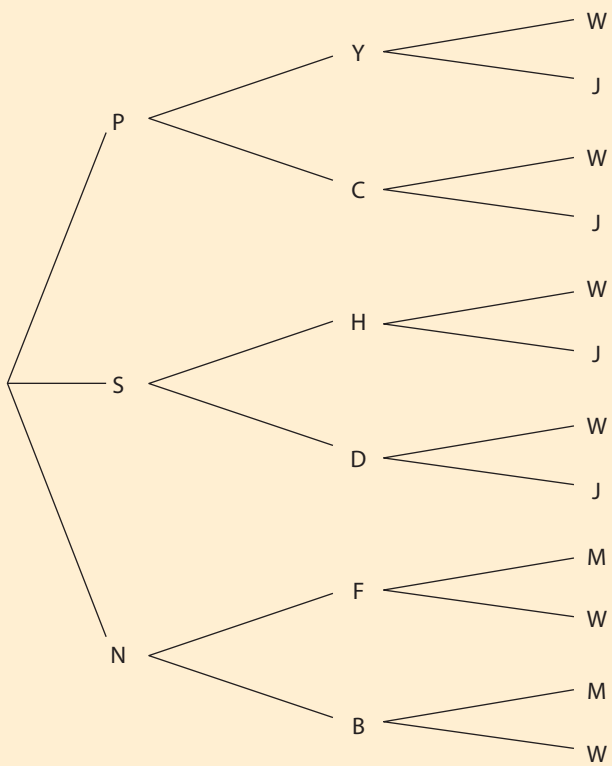
- Burger + Chips + Water
- Burger + Chips + Juice
- Burger + Salad + Water
- Burger + Salad + Juice

If we use B for Burger, C for Chips, S for Salad, W for Water and J for Juice, the sample space for this scenario is {BCW, BCJ, BSW, BSJ}.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 1 Constructing a sample space

A school canteen has the following lunch combinations for $7.50. Show the sample space for the following options.
Option A – Pita wraps with yoghurt **or** cheese dip, and water **or** juice
Option B – Sandwiches with hash brown **or** dim sums, and water **or** juice
Option C – Cup of noodles with fruit cup **or** banana bread, and milkshake **or** water

THINKING	WORKING
STEP 1	
Decide on the best way to represent your sample space.	A tree diagram is a good way to display the sample space as it can easily display the multiple events.
STEP 2	
Construct a tree diagram. Use a letter as an abbreviation for each item: P = Pita wraps S = Sandwiches N = Noodles Y = Yoghurt C = Cheese dip H = Hash browns D = Dim sum F = Fruit cup B = Banana bread W = Water J = Juice M = Milkshake	
STEP 3	
List the sample space.	Sample space is {PYW, PYJ, PCW, PCJ, SHW, SHJ, SDW, SDJ, NFM, NFW, NBM, NBW}.

The number of possible outcomes is worked out by counting the branches at the far right of your tree diagram. For this example, there are 12 possible outcomes.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Calculating probabilities

There are two ways we normally work out the value of the probability or chance of an event:

- experimental probability
- theoretical probability.

Experimental probability

The **experimental probability** is found by repeating an experiment (like tossing a coin or rolling a die) and observing the results and calculating the proportion (as a fraction, decimal or percentage) of times the event occurs. This is also called **relative frequency.**

The formula for experimental probability of an event is:

$$\Pr(\text{event}) = \frac{\text{number of times event occurs}}{\text{total number of trials}}$$

Example: A coin is tossed ten times and heads come up 6 times and tails come up 4 times.

$$\Pr(\text{head}) = \frac{6}{10} = \frac{3}{5} = 0.6 \text{ or } 60\%$$

$$\Pr(\text{tail}) = \frac{4}{10} = \frac{2}{5} = 0.4 \text{ or } 40\%$$

Theoretical probability

The **theoretical probability** of an event is what is expected based on a mathematical interpretation of the event. This equals the expected number of known ways the event can occur (favourable outcomes) divided by the number of total outcomes (as established by working out the sample space). As with experimental probability, this is calculated as a proportion (as a fraction, decimal or percentage).

Note: When calculating theoretical probabilities, it is usually assumed that there is an equal chance of success for all the outcomes of an event, e.g. when rolling a normal six-sided die, each number has the same chance of showing. This is called **equiprobable** outcomes.

The formula for theoretical probability of an event is:

$$\Pr(\text{event}) = \frac{\text{number of favourable outcomes}}{\text{total number of possible outcomes}}$$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 1: A coin is tossed. There are only two possible outcomes (a head or a tail).

$$\Pr(\text{head}) = \frac{1}{2} = 0.5 \text{ or } 50\%$$

$$\Pr(\text{tail}) = \frac{1}{2} = 0.5 \text{ or } 50\%$$

Example 2: A coin is tossed twice. As you saw above, there are now four possible, equally likely outcomes in the sample space: {HH, HT, TH, TT}. We can use this to calculate the probability of tossing two heads, which has just one favourable outcome.

$$\Pr(\text{HH}) = \frac{1}{4} = 0.25 \text{ or } 25\%$$

On the other hand, what is the probability that we get the two sides of the coin being the same? That means either a HH or a TT?

Looking at the sample space, {HH, HT, TH, TT}, we see that these are two outcomes out of the total of four outcomes. This means:

$$\Pr(\text{HH or TT}) = \frac{2}{4} = \frac{1}{2} = 0.5 \text{ or } 50\%$$

Therefore, the chance of getting the two sides of the coin being the same is 0.5 or 50%. Note that in this example where we wanted either a HH or a TT, we could have **added** together the probability for each individual outcome.

$$\Pr(\text{HH or TT}) = \frac{1}{4} + \frac{1}{4} = \frac{1}{2} \text{ or } 0.5 \text{ or } 50\%$$

Example 2 Calculating the theoretical probability

This jar has 86 lollies in total, 45 of which are red. If you drew a lolly out of this jar without looking, what is the theoretical probability of getting a red lolly?

THINKING	WORKING
STEP 1 Write the formula for theoretical probability.	$\Pr(\text{event}) = \dfrac{\text{number of favourable outcomes}}{\text{total number of possible outcomes}}$

... continued

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 2 Identify the number of favourable outcomes (number of red lollies) and the total number of possible outcomes (total number of lollies) and substitute the values into the formula.	$\Pr(\text{getting a red lolly}) = \frac{\text{number of red lollies}}{\text{total number of lollies}}$ $= \frac{45}{86}$
STEP 3 Simplify the fraction if possible. The probability can also be presented as a decimal or a percentage.	$= 0.523$ (to 3 d.p.) $= 52.3\%$

Example: Here is a table of the top five Olympic sports in which Australia has won medals.

Sport	Gold	Silver	Bronze	Total
Swimming	71	67	72	210
Athletics	21	27	28	76
Cycling	15	19	20	54
Rowing	13	15	16	44
Sailing	13	8	8	29
Total	133	136	144	413

Source: Olympian Database

It's immediately clear that Australia has won more medals in swimming events than in any others.

The experimental probability of a swimming medal is $\frac{210}{413}$, which is 0.5 when rounded to 1 decimal place. You could equally say that swimming represents 50% of Australia's top medal events.

The probability of a gold swimming medal is $\frac{71}{210}$, which is 0.3 when rounded to 1 decimal place. This is about one-third, or 33.3%.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Types of events

There are different types of events in chance and probability.

Equiprobable events

When there is an equal chance of success for all outcomes of an event, this is known as **equiprobable**.

For example, when a die is rolled, there is an equal probability or chance of rolling a 1, 2, 3, 4, 5 or 6.

Independent events

Independent events are where the outcome of one event does not influence the outcome of another event. For example, it is assumed that each time you roll a die, each roll is independent of every other roll.

Independent events can occur in the health setting. Whether you receive a flu shot or not is an independent event. Your decision to get vaccinated doesn't affect someone else's choice. Your daily exercise routine (or lack thereof) is independent of any of your family's fitness regimen.

In finance, the interest rate on one person's house mortgage or loan is independent of the rates offered to other borrowers. Whether you invest in a particular stock doesn't influence someone else's investment decisions. Each investor's choices are independent.

Dependent events

On the other hand, **dependent** events are when two or more events occur, and one event influences the outcome of another event. The language we often see with dependent events is 'if A **then** B…', or 'if A **given that** B….'.

For example, climate change is increasing the probability of extreme weather events. The **frequency** of extreme weather events is dependent on climate change. This is of particular interest to insurance providers. They have probability models upon which they base the charge to customers for insurance (known as insurance premiums). The higher the **risk** (probability), the higher the cost of buying that insurance.

Dependent events can also occur in health. For example, overeating and being overweight are dependent events. Your health risks can be influenced by your family's medical history. If your parents have a genetic condition, your likelihood of inheriting it is dependent on theirs. In finance, whether you qualify for a loan depends on various factors, such as credit score, income and existing debt. These variables are interconnected.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mutually exclusive events

Mutually exclusive events are when it is impossible for the events to occur at the same time – like it being day and night at the same time. Or, for example, getting a head and a tail in a single coin toss or rolling a 2 and a 3 on a single roll of a die.

In finance, when considering house loans, you might choose between fixed-rate and variable-rate loans. These options are mutually exclusive. In health, a person's blood type (A, B, AB or O) is mutually exclusive; they cannot have multiple blood types simultaneously. In tennis, a player wins a set or loses it – winning and losing are mutually exclusive events within a set.

In basketball, when shooting free throws, a player either makes the shot or misses it, so these outcomes are mutually exclusive.

Complementary events

Complementary events must be mutually exclusive, and the event will either happen or not happen. Complementary probabilities will add to 1.

For example, many health events are mutually exclusive. Coeliac disease has an incidence of 1%. This means 99% of people do not have the disease and 1% of people have the disease. There is no in-between. You either have the disease or you do not.

$99\% + 1\% = 100\%$

$0.99 + 0.01 = 1$

Calculating probabilities of multiple outcomes in an event or events

When you want to work out the probability of two or more specific outcomes occurring in an event or a set of events, you need to think about what it is you are asking: do you want to find out if one outcome **and** the other additional outcomes each need to happen, or whether they are outcomes where you are happy for one **or** more of them to occur across the events.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Let's look at an example to illustrate the different scenarios. If you roll a single die, and you want to know the probability of rolling a 1 **or** a 6, then you would **add** the probabilities:

- Probability of rolling a 1 is $\frac{1}{6}$.
- Probability of rolling a 6 is $\frac{1}{6}$.

So, the probability of rolling a 1 or a 6 is $\frac{1}{6}+\frac{1}{6}=\frac{2}{6}=\frac{1}{3}$.

But if you wanted to know the probability of rolling a 1 **and** then rolling a 6, then you would **multiply** the probabilities of each separate outcome:

- Probability of rolling a 1 then a 6 is $\frac{1}{6}\times\frac{1}{6}=\frac{1}{36}$.

You can see this if you think about the sample space for rolling a die twice.

1, 1	1, 2	1, 3	1, 4	1, 5	**1, 6**
2, 1	2, 2	2, 3	2, 4	2, 5	2, 6
3, 1	3, 2	3, 3	3, 4	3, 5	3, 6
4, 1	4, 2	4, 3	4, 4	4, 5	4, 6
5, 1	5, 2	5, 3	5, 4	5, 5	5, 6
6, 1	6, 2	6, 3	6, 4	6, 5	6, 6

The only option that meets rolling a 1 **and** then rolling a 6 is one outcome (highlighted in the sample space) out of 36 possible outcomes, which is a probability of $\frac{1}{36}$.

The way that you combine the individual probabilities of each outcome depends on whether you want to know the probability of **either** event (**OR**), or **both** events (**AND**).

- To work out the probability of both events (**AND**), you **multiply** the probability of one by the probability of the other.
- To work out the probability of either event (**OR**), you **add** the probability of one to the probability of the other.

Calculating probabilities using a tree diagram

We can use a **probability tree** diagram to help us calculate probabilities. To calculate probabilities of each outcome using a tree, you **multiply** the probability values along the branches.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Here is an example to illustrate how to do this. The weather forecast has said that there is a 40% chance that it will rain on each of the next two days.

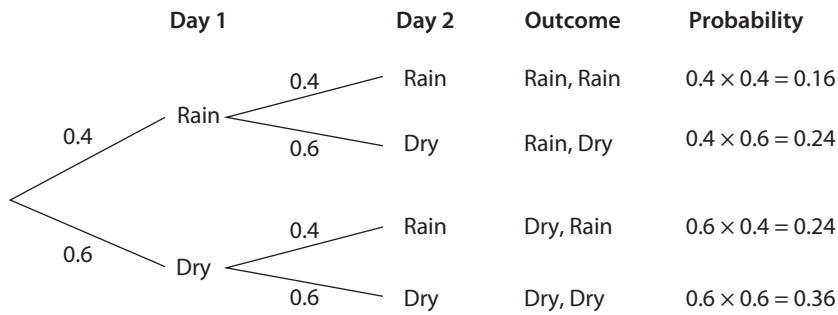
- What is the chance that it will rain on **both** of the next two days?
- What is the chance that it will rain on **only one** of the next two days?

Let's create a tree diagram and use decimals for the probability. The probability it will rain is 0.4, so the probability it will not rain (Dry) is 0.6. (These are complementary events and so their probabilities add to 1.)

Here is a tree diagram showing the options. For each outcome, you need to **multiply** the probabilities along the two branches.

For example, the probability of the first outcome is obtained by following the branch for Rain on Day 1 **and** the branch for Rain on Day 2 (Rain, Rain). That is, the probability is $0.4 \times 0.4 = 0.16$.

The probability of the second outcome is obtained by following the branch for Rain on Day 1 and the branch for Dry (no rain) on Day 2 (Rain, Dry). That is, the probability is $0.4 \times 0.6 = 0.24$, and so on.



Now we can work out the answers to our two questions.

For rain on **both** of the next two days, the favourable outcome is Rain on Day 1 AND Rain on Day 2 (or the outcome Rain, Rain) which has a probability of $0.4 \times 0.4 = 0.16$. Notice that we need to multiply the individual probabilities.

For rain on **only one** of the next two days, the favourable outcomes are Rain on Day 1 and Dry on Day 2 **OR** Dry on Day 1 and Rain on Day 2. In each of these cases, the probability of each outcome is 0.24 (that is, $0.4 \times 0.6 = 0.24$ or $0.6 \times 0.4 = 0.24$).

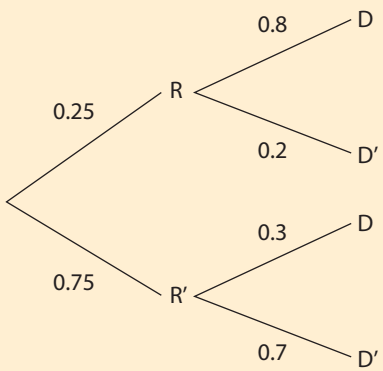
So the probability of it raining on either Day 1 **OR** Day 2 will be $0.24 + 0.24 = 0.48$. That is, we need to add those two probabilities.

Note: You can also check if you have calculated the probabilities correctly – the sum of the probabilities of all the outcomes should add up to 1 (as one of these outcomes must occur). In this case, $0.16 + 0.24 + 0.24 + 0.36 = 1.00$.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 3 Calculating the probabilities from a tree diagram

The probability that it rains on a particular day is 0.25. The probability that Jai drives to work when it rains is 0.8. The probability that Jai drives to work when it is not raining is 0.3. What is the probability that on Monday it doesn't rain and Jai drives to work?

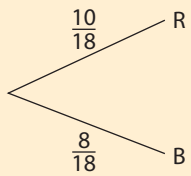
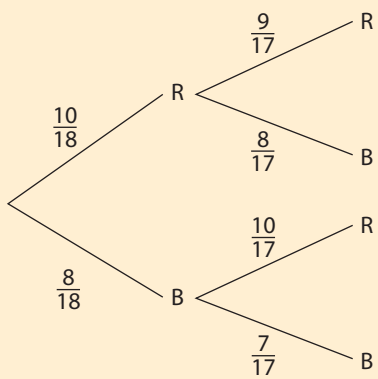
THINKING	WORKING
STEP 1	
Construct a tree diagram to represent the situation. Use the information from the question to find the appropriate probability for each branch of the tree diagram. Remember that the probabilities of complementary events (for example, rain (R) and no rain (R′)) must add to 1.	If R represents rain, then R′ represents no rain. So Pr(R) = 0.25 and Pr(R′) = 1 − 0.25 = 0.75. If D represents Jai driving to work, then D′ represents Jai not driving to work. So Pr(D given it rains) = 0.8 and Pr(D′ given it rains) = 1 − 0.8 = 0.2. Also, Pr(D given no rain) = 0.3 and Pr(D′ given no rain) = 1 − 0.3 = 0.7. 
STEP 2	
Determine the probability for the event no rain and Jai driving to work by multiplying the probabilities along the branches for R′ and D.	Pr(no rain and Jai drives to work) $= 0.75 \times 0.3$ $= 0.225$

Example 4 Calculating the probabilities of multiple outcomes from a tree diagram

A small pack of cards has 10 red cards and 8 black cards. If one card is taken from the deck and placed down on the table and then another card is taken from the remaining deck and placed on the table, what is the probability that one of the two cards is red?

... continued

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 1	
Construct the first stage of the probability tree diagram which represents selecting the first card from the pack of 18 cards. There are 10 red cards so the probability of selecting a red card is $\frac{10}{18}$. There are 8 black cards so the probability of selecting a black card is $\frac{8}{18}$.	Let R represent drawing a red card and B represent drawing a black card. **First card** 
STEP 2	
Construct the next stage of the probability tree diagram which represents selecting the second card from the deck which now only has 17 cards. If the first card was a red card, then there are 9 red cards and 8 black cards left in the deck so the probability of selecting a red card is $\frac{9}{17}$ and selecting a black card is $\frac{8}{17}$. If the first card was a black card, then there are 10 red cards and 7 black cards left in the deck so the probability of selecting a red card is $\frac{10}{17}$ and selecting a black card is $\frac{7}{17}$.	**First card** **Second card** 
STEP 3	
Identify which outcomes represent selecting one red card.	For one of the two cards to be red, the outcomes are RB and BR.
STEP 4	
Determine the probabilities for these outcomes by multiplying the probabilities along the branches for RB and then BR. Notice that RB means selecting R **and** B, so we multiply. Similarly, BR means selecting B **and** R.	$\Pr(\text{RB}) = \frac{10}{18} \times \frac{8}{17} = \frac{40}{153}$ $\Pr(\text{BR}) = \frac{8}{18} \times \frac{10}{17} = \frac{40}{153}$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 5 Calculate the probability of selecting one red card by adding the probabilities for RB and BR together. Notice that we are selecting RB **or** BR, so we add.	$\begin{aligned}\Pr(\text{one red}) &= \Pr(\text{RB or BR}) \\ &= \Pr(\text{RB}) + \Pr(\text{BR}) \\ &= \frac{40}{153} + \frac{40}{153} \\ &= \frac{80}{153}\end{aligned}$

8C Tasks and questions

Thinking tasks

Rolling a die: theoretical probability

1 Use the formula for theoretical probability to work out each of the following probabilities about rolling a six-sided die. Express your answer as a fraction, a decimal and as a percentage.

- **a** What is the probability of rolling a six?
- **b** What is the probability of rolling an odd number?

Rolling a die: experimental probability

2 Now conduct an experiment to calculate the experimental probability for the above events of rolling a six-sided die. Roll your die 50 times and record which number comes up each time in a table like the one below.

Summarise your results in a table like this:

Number on die	1	2	3	4	5	6
Total number of times the value occurred						

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Use your data in the table to answer the following questions. Express your answers as a fraction, a decimal and as a percentage.

a What is the experimental probability of rolling a six?

b What is the experimental probability of rolling an odd number?

3 Compare your experimental probability with the theoretical probability? How close are they? What do you think might happen if you did 100 rolls of the die? Or 1000 rolls of the die?

Skills questions

4 Draw up a 6×6 grid.

a Use the grid to record all the possible outcomes of the **total** when you roll two dice and add the numbers together.

b How many possible outcomes are there?

c How many of these possible outcomes are less than 7?

d How many of these possible outcomes are greater than 7?

e How many of these possible outcomes are equal to 7?

5 In a school, students have a choice of playing soccer, football or hockey in winter, and netball, baseball or athletics in summer.

a List the sample space of winter sports.

b List the sample space of summer sports.

c Use a tree diagram to list all of the sports options.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6 You are tossing a coin and then rolling a six-sided die.

- **a** Draw a tree diagram to show all of the possible outcomes.
- **b** Write the probability of each individual outcome occurring on the tree diagram.
- **c** Work out the probabilities of the final outcomes on the tree diagram.
- **d** What is the probability of getting a head with the coin and then a 6 on the die?
- **e** What is the probability of getting a tail with the coin and then an even number on the die?

7 Write the probability of each of the following events as a fraction.

- **a** I have 4 tee shirts: 1 black, 1 white, 1 blue and 1 pink. If I grab a tee shirt without looking, what is the probability that it will be the pink one?
- **b** If I roll a normal die, what is the probability that I will roll a 3?
- **c** If I randomly draw a card from a normal deck of 52 cards, what is the probability that I will draw a king?
- **d** I have a bag of 20 coloured balls where 6 are red, 4 are blue, 8 are black and 2 are yellow. If I draw one ball at random, what is the probability that I get a black ball?

8 Use the table showing the average number of rainy days in January to calculate the probability of rain for each of the capital cities of Australia.

City	Average days of rain in January	Probability of rain as a fraction	Probability of rain as a decimal	Probability of rain as a percentage
Adelaide	3			
Brisbane	8			
Darwin	20			
Melbourne	5			
Perth	1			
Sydney	8			
Hobart	6			
Canberra	6			

9 A store sells ski gloves in three colours: black, yellow and red. These are available in four sizes: small, medium, large and extra-large. All colours and sizes are equally popular.

- **a** Draw a probability tree diagram showing all the possible combinations of ski gloves that you could buy.
- **b** What is the probability that you buy black, medium ski gloves?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mixed practice

10 **a** Complete this table which shows the number of building permits issued in Victoria during February 2024.

Nature of work	Number of permits	Percentage of total permits
New building	5013	
Re-erection	46	
Extension	741	
Alteration	1304	
Change of use	46	
Demolition	737	
Removal	25	
Other	744	
Total	8656	

Source: Victorian Building Association

b Which two types of work would be mutually exclusive events?

c Which two types of work could be dependent events?

d What is the probability that the work would be an alteration?

e What is the probability that the work would be a demolition or a removal?

11 Based on their performance over the year, a netball team has an estimated probability of 0.7 of winning a match. Use a tree diagram to find the probability that the team:

a wins both of their next two matches

b wins only one of their next two matches.

12 You are rolling a 10-sided die with the digits 0 to 9 on the sides.

a What is the probability that you will roll a 3?

b What is the probability that you will roll an odd number?

c If you roll two 10-sided dice, what is the probability you will roll:

i a total of 0?

ii a total of 10?

iii two digits that are the same as each other?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

13 a Complete the table below that shows the number of new electric cars sold and the total number of new cars sold in 20 countries in 2023. Round your percentage answers to the nearest per cent and your decimal answers to 2 decimal places.

Country	Electric cars sold	Total new car sales	Percentage of new car sales that were electric cars	Probability of randomly selecting a new electric car sale from total new car sales
Australia	98 000	816 667		
Brazil	52 000	1 733 333		
Canada	171 000	1 315 385		
China	8 100 000	21 315 789		
Denmark	80 000	173 913		
Finland	48 000	88 889		
Germany	700 000	2 916 667		
Greece	17 000	121 429		
India	82 270	4 113 500		
Japan	140 000	3 888 889		
Mexico	15 200	1 169 231		
New Zealand	38 000	271 429		
Norway	110 000	118 280		
Poland	30 000	454 545		
South Africa	1 080	372 414		
South Korea	132 000	1 670 886		
Spain	122 000	1 016 667		
Sweden	171 000	285 000		
UK	450 000	1 875 000		
USA	1 390 000	14 631 579		

b Which country has the highest percentage of electric car sales?

c Which country has the lowest percentage of electric car sales?

d Which country, or countries, surprised you? Why?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

e What factors do you think would affect the percentage of electric cars sold in a country?

f If you randomly select a new car sale from the USA and Canada combined, what is the probability that this sale will be of an electric car?

g If you randomly select a new car sale from an Asian country in this list, what is the probability that this sale will be of an electric car?

Mathematical literacy

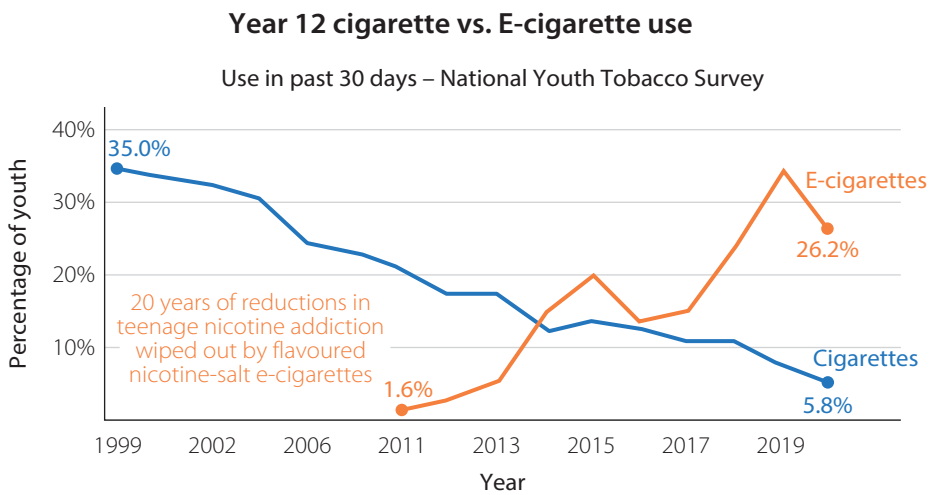
14 Complete this table using the terms:

equiprobable	mutually exclusive	complementary	independent	dependent

	Real-life situation	Type of event
a	Buying or renting when you first move out of home	
b	Blitzing your exam and kicking the winning goal in your soccer match	
c	Your friend's birthday is in March	
d	Not paying your phone bill and being denied service	
e	You are allowed to buy one pet, but it has to be a cat or a dog	

Application tasks

15 Many people would say that the increased use of e-cigarettes is related to the decrease in smoking of cigarettes. Use this graph to explore the relationship between youth cigarette smoking and vaping.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

a Does this graph support the contention that e-cigarettes are replacing cigarettes?

b In 2011, what is the probability that a teen would, in the past 30 days, have smoked:

i a cigarette? **ii** an e-cigarette?

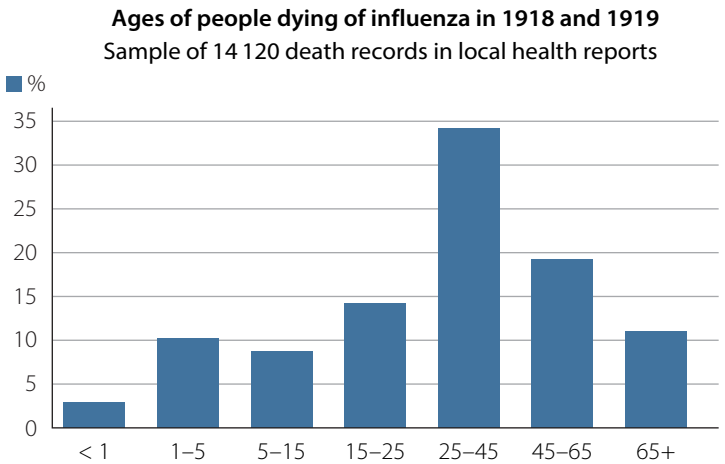
c In 2019, what is the probability that a teen would, in the past 30 days, have smoked:

i a cigarette? **ii** an e-cigarette?

d In the context of probability, explain why you would consider these to be independent, mutually exclusive, complementary or dependent events.

e What is the limitation of this data? Does this affect what you predict to be the global relationship between smoking and e-cigarettes?

16 The Spanish flu epidemic was an unprecedented epidemic. Use the chart to answer the questions below.



Source: Welcome Library

a When did the Spanish flu happen?

b What countries were affected?

c Use the graph above to find the probability that a person who died in the pandemic was:

i in the age group 25–45

ii in the age group 65+

iii less than 1 year old.

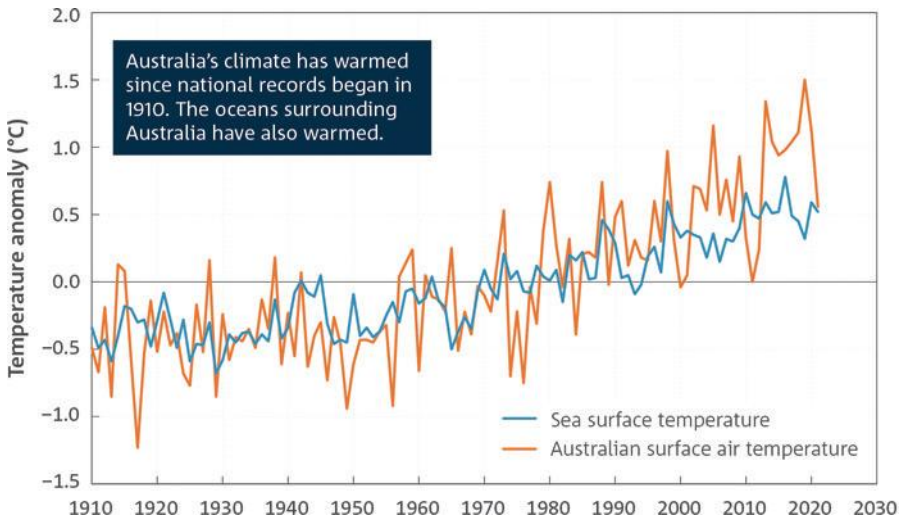
d Do a brief internet search on seasonal flu deaths. What is the most significant difference between the deaths caused by Spanish flu and today's seasonal influenza outbreaks?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

8D Long-term data

In this section, the connections between long-term data and probability will be explored. Long-term data refers to information collected over an extended period, often spanning years or decades. It provides insights into trends, patterns and variations that occur over time. The data collected provides the ability to calculate the experimental probability of the specific event occurring.

Current research and knowledge about climate change is all about long-term data and looking at the consequences and likelihood of different outcomes occurring.



Source: Bureau of Meteorology

In the past, we did not know the link between exposure to Australia's high levels of UV sunlight and the potential development of skin cancers many years later in life. It is the long-term data that has changed our habits. Similarly, in the *Epic Success* example about road safety and seat belts, this led to research about the effectiveness of seat belts in cars. You can use the data collected about road fatalities to estimate the chances of dying in a car crash if you wear, or don't wear, a seat belt.

These probability-based long-term estimates enable researchers to make risk assessments by using the historical data to identify recurring risks, assess their likelihood and estimate potential consequences. Here are two real-life examples.

- Long-term climate data helps assess the risk of extreme weather events (e.g. floods and droughts) in a region.
- Financial market data over many years informs risk models for investment decisions.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

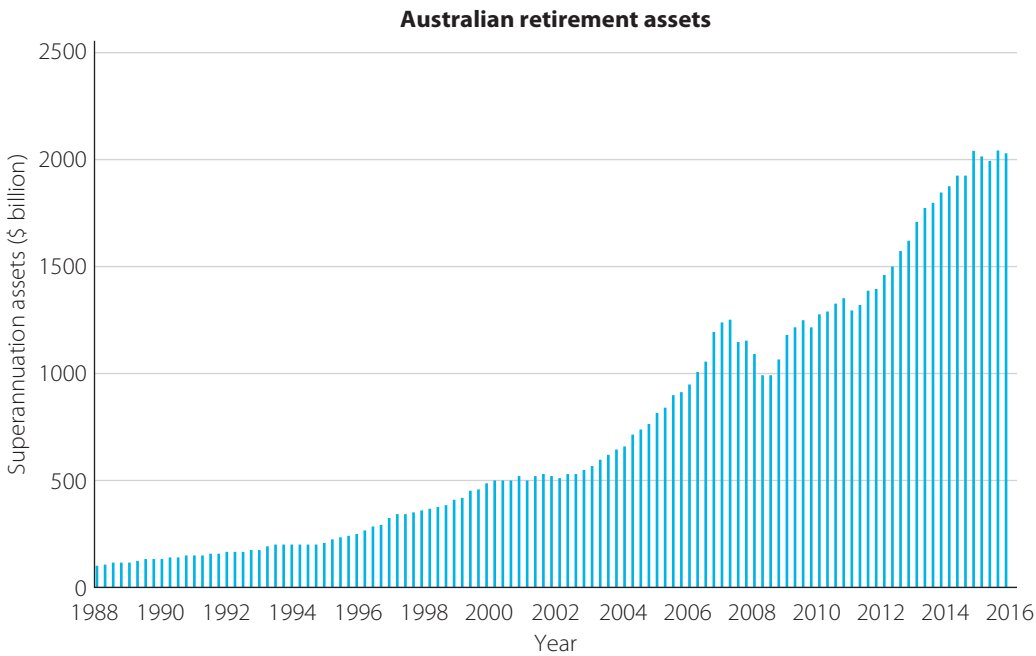
Risk represents the possibility of an adverse event occurring, and risk assessment involves evaluating the likelihood and consequences of potential incidents.

In summary, we can use **long-term data** as the foundation for understanding risk and estimating probabilities. It allows us to make informed choices.

In this section, we will examine examples related to finance, health and the environment.

Financial investments

Every working Australian should have a superannuation fund. In 1992, the Australian government made saving money for retirement through superannuation compulsory. This graph shows how the retirement assets of Australians have grown between 1988 and 2016.

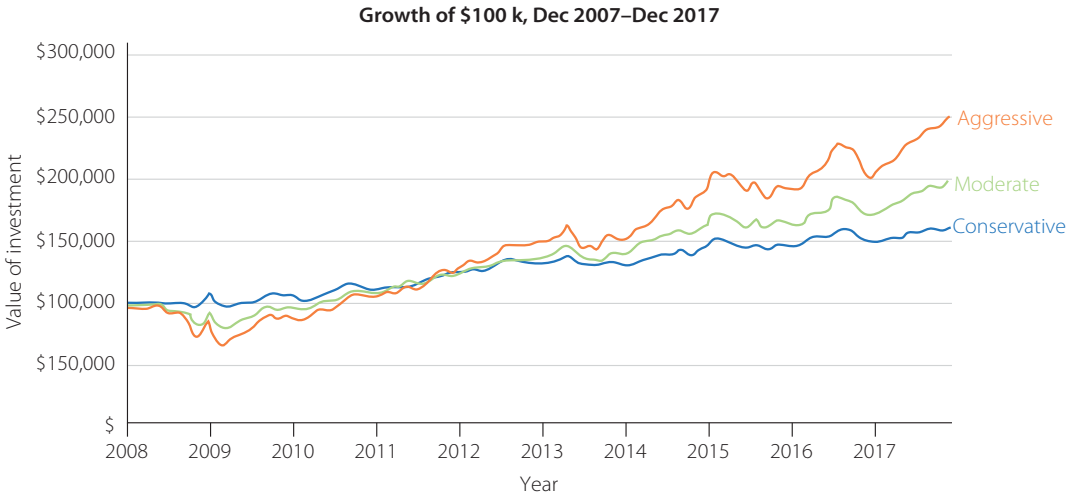


Based on this graph, is it a reasonable prediction that the superannuation value of Australians will continue to rise? This is an example of linking long-term data with probability.

Superannuation funds have at least three basic investment options: **conservative, balanced** and **aggressive.**

The following graph shows the difference between investing in conservative, moderate and aggressive options in Australian superannuation funds. Many studies have shown that in the long term (20+ years), the aggressive option outperforms moderate or conservative options.

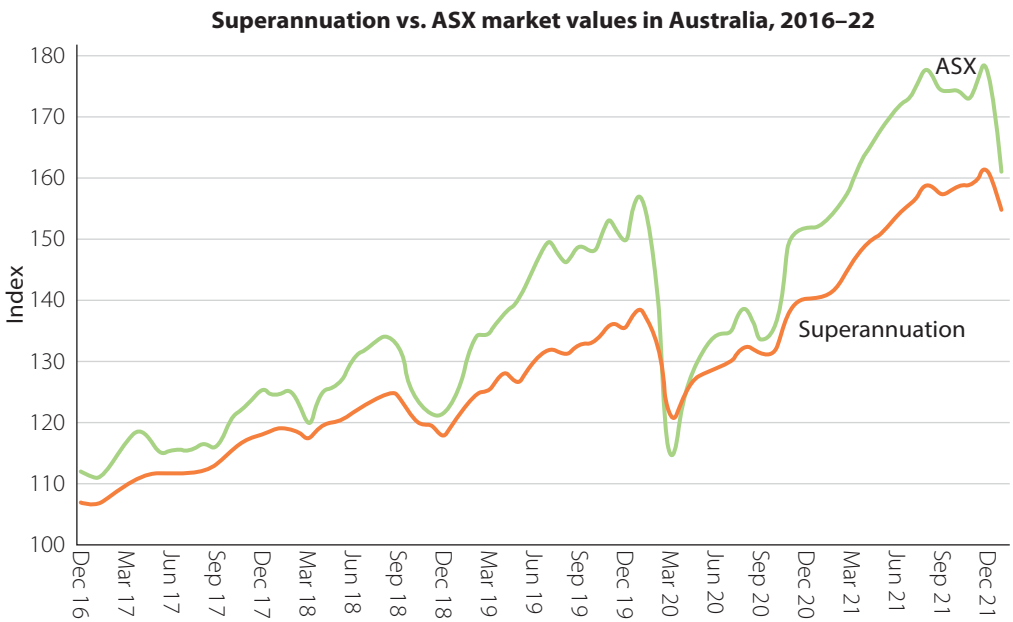
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.



Source: GFM Asset Management, 17 December 2017

This data shows that the aggressive investment option has a higher probability of generating, more income in the long term. However, this is not a certainty for any individual person's superannuation pay-out when they retire.

The following graph shows how superannuation accounts in Australia grew between December 2016 and 2021. It compares the superannuation growth against the Australian Securities Exchange (ASX) market values.



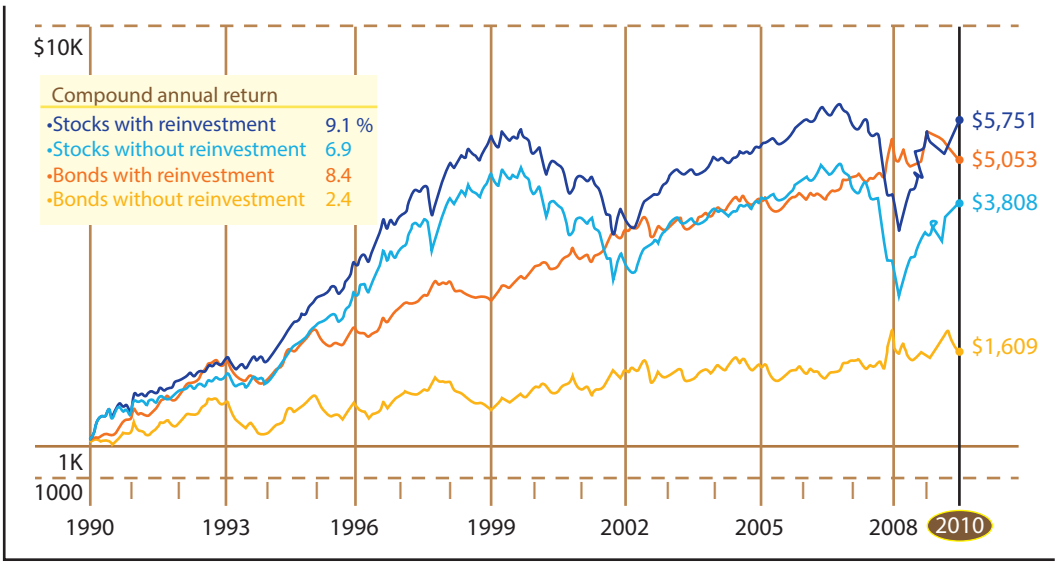
Source: Rainmaker, S&P

Why do you think there was a dip in early 2020?

Given that these two investments are rising over time, would it be probable that your investment would grow after another 20 years?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

The graph below compares the difference in the hypothetical growth of $1,000 invested in stocks and bonds from 1990 to 2010 with and without reinvestment of dividends or coupon payments.



Activity

Use the graph to answer the following questions. Discuss your answers with a partner.

1. What is the value of the $1,000 investment in stocks (without reinvestment) in 2010?
2. In 2010, which type of investment had the highest value? Calculate the percentage growth over the 20 years shown.
3. What trends can be seen in the graph? Did the investment you listed in question **2** always have the highest value over the 20 years?
4. Stocks decreased in value in 2008. Research online to discover a possible reason for this.

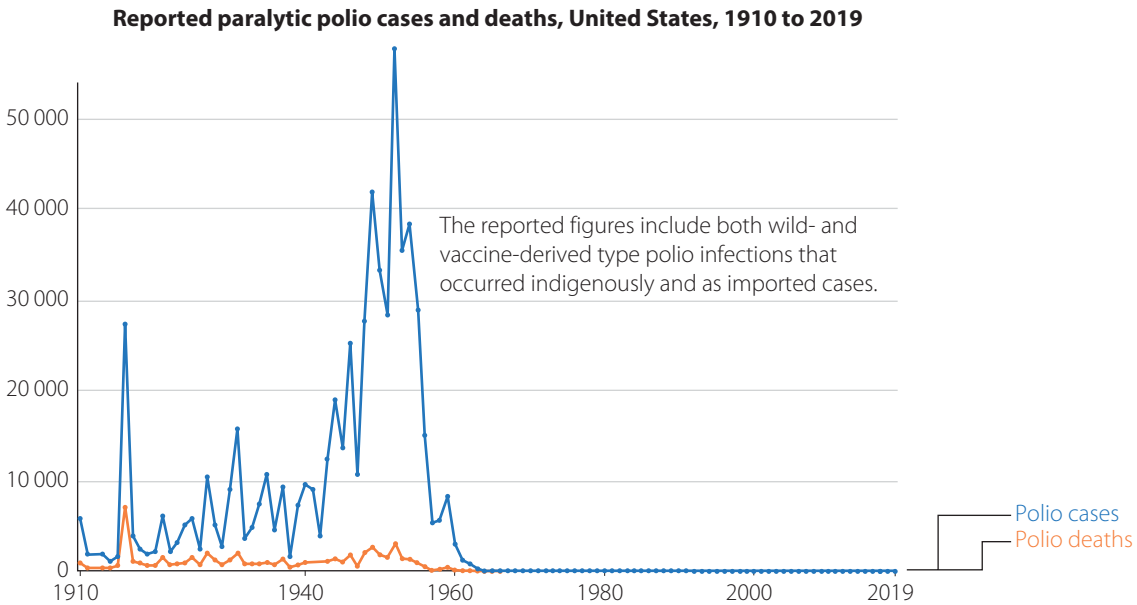
The highs and lows of investment worth are called **volatility.** An investment is considered to be more volatile if there is a greater difference between the peaks and troughs. Choosing an aggressive option for your superannuation when you are young is based on the mathematics of probability.

Health data

Polio (poliomyelitis) is a viral infection transmitted by drinking water that has been contaminated by the faeces of a person already infected with the virus. It is highly contagious, has an incubation period of 10 days and can cause permanent injury and death.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

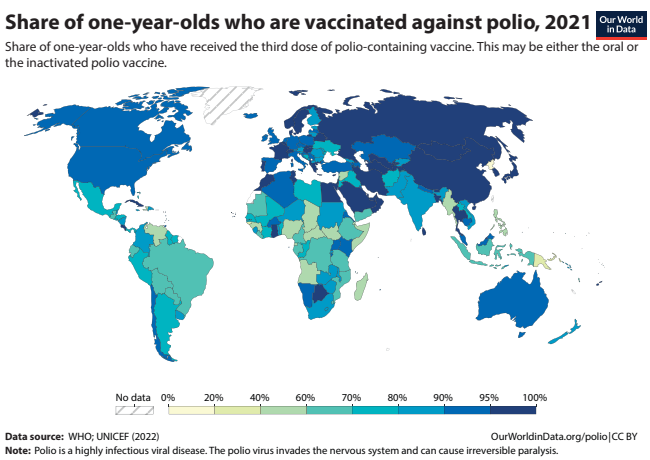
This graph shows two extreme peaks of polio cases in the United States between 1910 and 2019. It is reasonable to predict that the probability of contracting the disease during these epidemics is higher than at other times. But remember that this data refers to thousands of people – so it is not reasonable to apply this analysis to any given individual person.



Source: US Public Health Service; US Center for Disease Control; and WHO

From this graph, we can see a dramatic decrease in the number of polio cases and deaths in the 1960s. This is because a vaccine was developed and is now routinely given to one-year-old children.

The data shows that the probability of contracting polio is now much less likely due to the extensive vaccination of young children against the disease, although some countries still have low vaccination rates. Such long-term, relative frequency data allows health professionals to know where to target their vaccination campaigns, and also gauge the risks of polio outbreaks in different locations around the world.

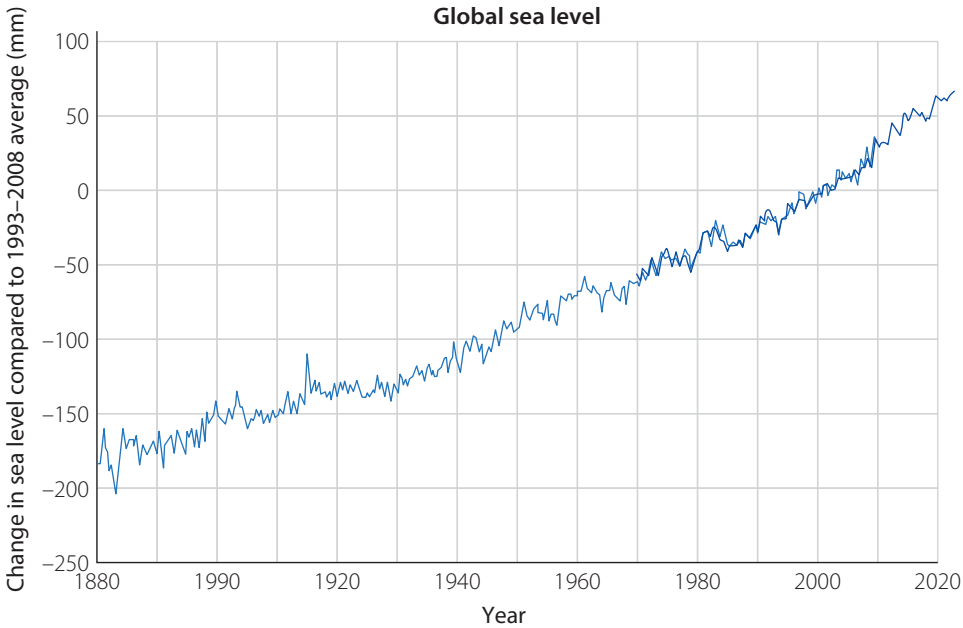


Source: World Health Organization (WHO); UNICEF

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

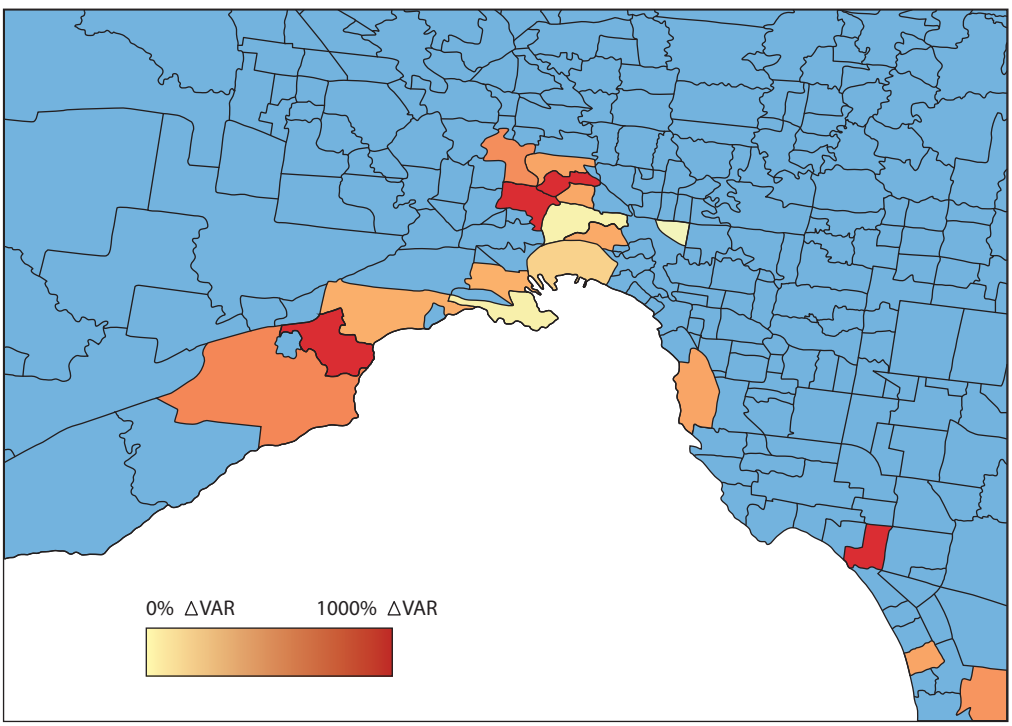
Climate change

This graph shows the global rise in sea levels from 1880 to 2020.



Source: Climate.gov

The data above supports the probability that, in the future, rising sea levels will cause flooding in these suburbs around Melbourne, as shown below.



Source: XDI Systems

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Insurance companies use long-term data and their risk calculations to establish how much they will charge for their insurances in different regions and areas. Flood insurance for homes in these and adjacent areas reflects this higher relative probability in the cost of the insurance. In other areas that are prone to bushfires for example, insurance premiums will be higher due to the greater risk of claims for fire damage.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

8D Tasks and questions

Thinking task

1 Work with a small group of fellow students to discuss climate change and long-term data. You could think about the following issues.

- **a** Explore why long-term data matters. Discuss how historical climate records help us understand trends and predict future changes.
- **b** How do scientists collect climate data and what data do they collect?
- **c** What are some key indicators of climate change?
- **d** How can we use data to advocate for climate action?
- **e** What are the impacts of climate change on our lives?
- **f** How can individuals make a difference?
- **g** What are the challenges in addressing climate change?
- **h** How do we use probability to make decisions about climate change?

Skills questions

2 The table shows population growth of some countries and regions since 1820.

Country or region	Population in 1820 (millions)	Population in 2021 (millions)	% increase or % decrease from 1820 to 2021	Projected population in 2222 (millions)
Australia	0.3	26		
Asia	750	4700		
Hong Kong	0.02	7.5		
Ireland	7	5		
USA	10	337		
Europe	225	746		
Africa	84	1400		

- **a** Copy and complete the table by calculating the percentage increase or decrease in population (to the nearest whole per cent) and then using this value, calculate the projected population in 2222 for each country (to the nearest million).
- **b** Which country is an anomaly in terms of population growth?
- **c** Research the Irish potato famine. When was it? What caused it? What happened as a result of this famine?
- **d** Do you believe the 2222 projections? Why or why not?
- **e** Give at least three factors that would affect these projections.

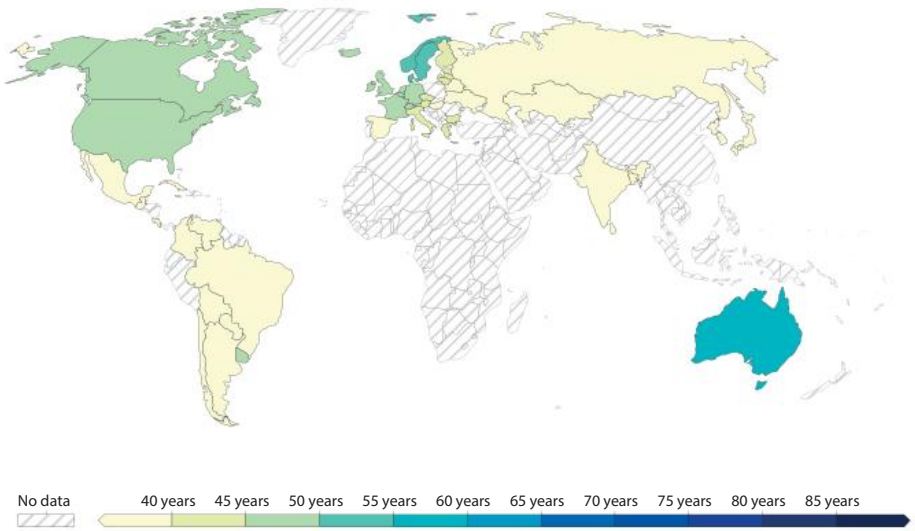
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3 Life insurance companies use data trends to calculate risk, which they then factor into the availability and cost of their products. Use these two graphics to answer the questions that follow.

Life expectancy, 1900

Our World in Data

The period life expectancy[1] at birth, in a given year.



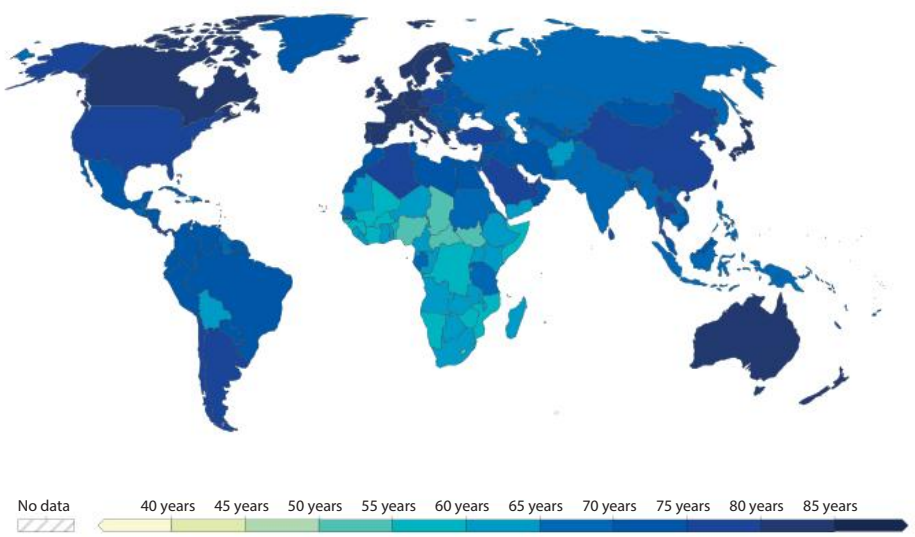
Data source: UN WPP (2022); HMD (2023); Zijdeman et al. (2015); Riley (2005) OurWorldinData.org/life-expectancy | CC BY

1. Period life expectancy: Period life expectancy is a metric that summarizes death rates across all age groups in one particular year. For a given year, it represents the average lifespan for a hypothetical group of people, if they experienced the same age-specific death rates throughout their whole lives as the age-specific death rates seen in that particular year. Learn more in our articles: "Life expectancy" – What does this actually mean? and Period versus cohort measures: what's the difference?

Life expectancy, 2021

Our World in Data

The period life expectancy[1] at birth, in a given year.



Data source: UN WPP (2022); HMD (2023); Zijdeman et al. (2015); Riley (2005) OurWorldinData.org/life-expectancy | CC BY

1. Period life expectancy: Period life expectancy is a metric that summarizes death rates across all age groups in one particular year. For a given year, it represents the average lifespan for a hypothetical group of people, if they experienced the same age-specific death rates throughout their whole lives as the age-specific death rates seen in that particular year. Learn more in our articles: "Life expectancy" – What does this actually mean? and Period versus cohort measures: what's the difference?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

a What do the two graphics show about the change in life expectancy from 1900 to 2021?

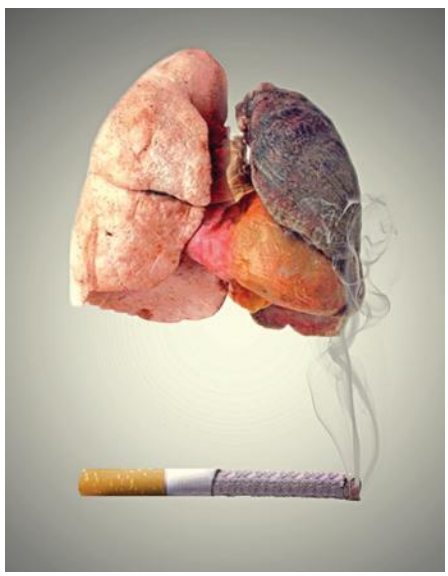
b List at least four factors that have contributed to this trend.

c What was the life expectancy of an Australian in 1900?

d What was the life expectancy of an Australian in 2021?

4 Data trends cannot accurately predict what will happen with any one person. But, with enough data, relative probability allows for reasonable predictions that can be applied to individuals. This is how life insurance works.
The table shows an example of typical life insurance premiums per month in Australia.

Age bracket	Female non-smoker	Female smoker	Male non-smoker	Male smoker
20s	$29	$50	$43	$75
30s	$32	$54	$45	$79
40s	$55	$105	$68	$135
50s	$105	$200	$140	$280
60s	$180	$340	$250	$500



a What is the overall trend in relation to age?

b What is the overall trend in relation to smoking?

c What is the overall trend in relation to the binary gender definition of female and male?

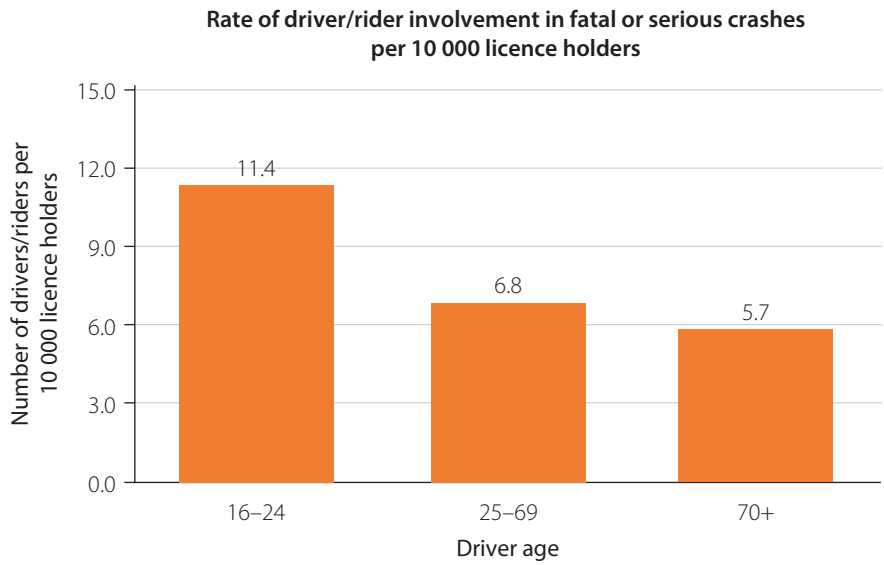
d Do you think that these premiums are fair? Why or why not?

e Explain why the people who are less than 20 years old and aged 70 or over are not considered suitable customers for life insurance.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Application tasks

5 Insurance cost is related to data – the more likely an incident, the higher the insurance premium to cover that incident. For example, if you live in an area that is prone to bushfire, that part of your house insurance will be much higher than if you live in an area where the data shows that a bushfire is unlikely. Look at this graph that shows the rate of driver/rider involvement in fatal or serious crashes.



a Which age group is more likely to be involved in a serious or fatal crash?

b What does this mean when you are insuring your first car?

c Research typical comprehensive car insurance costs. Do you think that you will be able to afford this type of insurance on your first car?

d What type of insurance do you think you could afford for your first car? How much does this level of insurance typically cost?

e What can you do if your parents have comprehensive car insurance?

6 Household air pollution is still a major cause of deaths in the world today. Consider the following to investigate the risks associated with household air pollution.

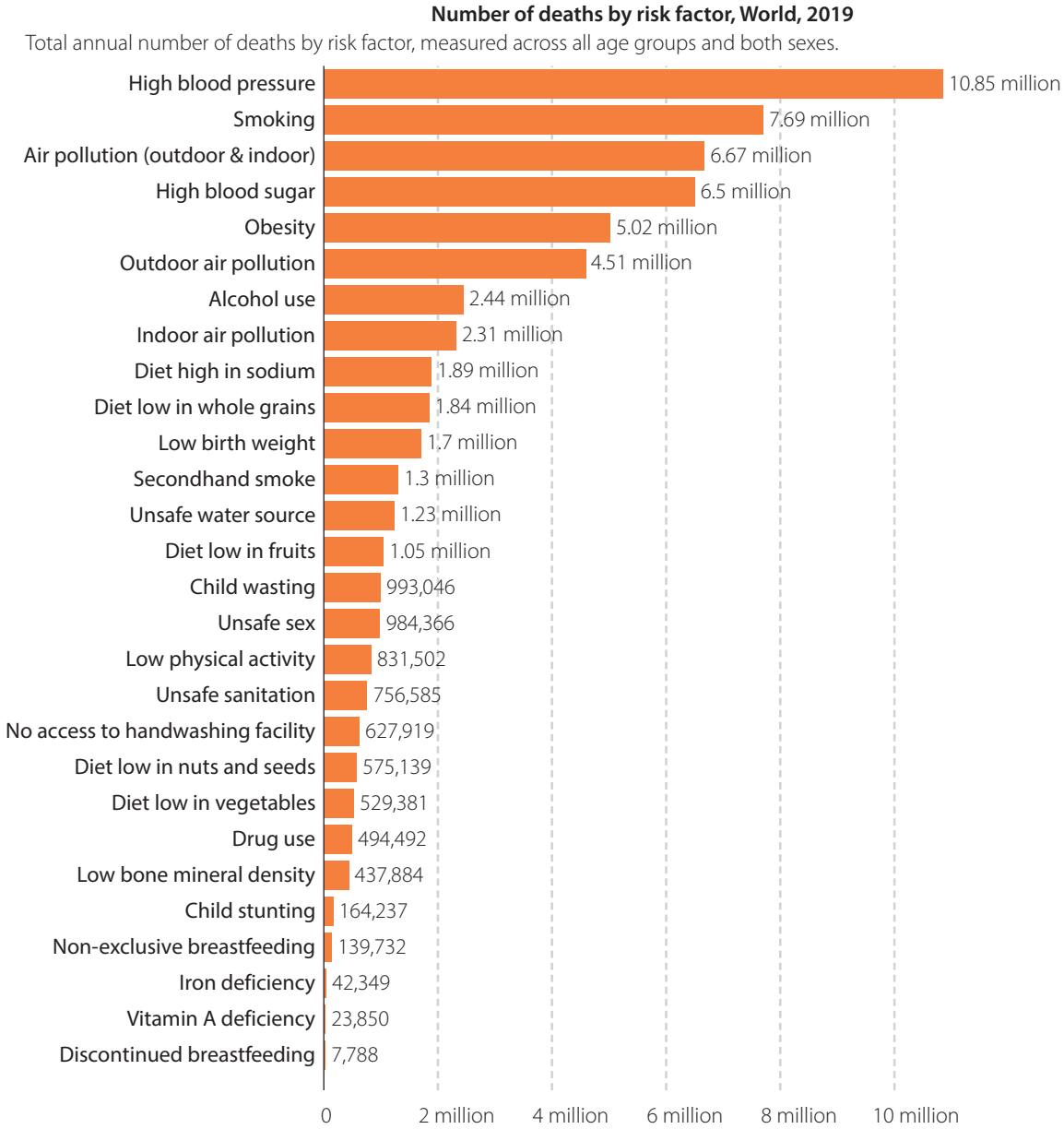
a Use the internet to investigate background information on household air pollution and health. Explore the World Health Organization website.

b Define 'household air pollution'.

c Find five interesting statistics from your research.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

7 Consider the graph below on the risk factors of dying in 2019.



Source: IHME, Global Burden of Disease (GBD)

a What was the approximate population of the world in 2019? Use this value in your calculations for parts **b-e**.

b What was the probability of dying from smoking (include secondhand smoke)?

c What was the probability of dying from low physical activity?

d What was the probability of dying from using unsafe water sources?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

e What was the probability of dying from air pollution (outdoor and indoor)?

f Would these probabilities be considered independent, dependent, mutually exclusive or complementary?

8 Now consider this table of data which shows the risk of dying from household air pollution in selected countries.

Risk of death from household air pollution from solid fuels (all ages)

Country	1990	2019
Argentina	1.6%	0.2%
Armenia	4.1%	0.3%
Australia	0.1%	0.0%
Bangladesh	16.5%	11.1%
China	17.3%	3.3%
India	13.5%	6.6%
Indonesia	10.4%	4.3%
Japan	0.1%	0.0%
Mexico	4.0%	1.4%
New Zealand	0.1%	0.0%
North Korea	20.3%	13.1%
Saudi Arabia	7.1%	0.0%
Solomon Islands	23.5%	20.7%
Spain	0.5%	0.0%
Uganda	9.7%	11.2%
USA	0.0%	0.0%
Vanuatu	18.1%	16.3%
Zambia	10.9%	8.3%

a Explain ‘risk’ in this context using ideas of probability.

b Which country had the highest risk in 1990?

c Which country had the lowest risk in 1990?

d Which country had the highest risk in 2019?

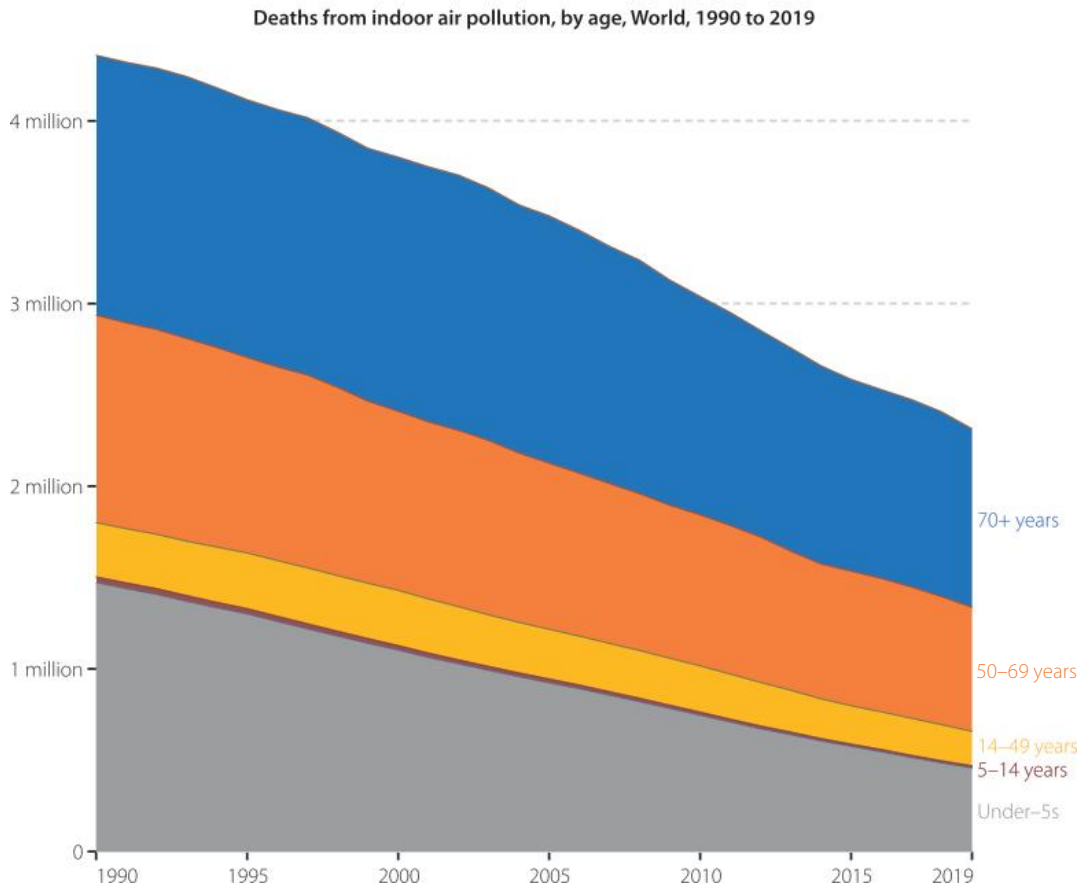
e Which countries had the lowest risk in 2019 ?

f Which country has seen the biggest difference in their risk from 1990 to 2019?

g Which country surprised you the most and why?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9 Now consider the following graph which shows deaths from indoor pollution by age from 1990 to 2019.



Source: Institute for Health Metrics and Evaluation (IHME), Global Burden of Disease (2019)

a Which age group had the highest number of deaths in 2000? Is this true for the period 1990 to 2019? Why do you think this is?

b What was the number of deaths in 2005 for the age group 14–49 years? How does this compare to 1990 and to 2019?

c What was the total number of deaths from indoor air pollution in 2019?

d What was the number of deaths in the age group 50–69 years in 2019?

e What is the probability that a person who died from indoor air pollution in 2019 was in the age group 50–69 years? Compare this to the probability for the same age group in 2005.

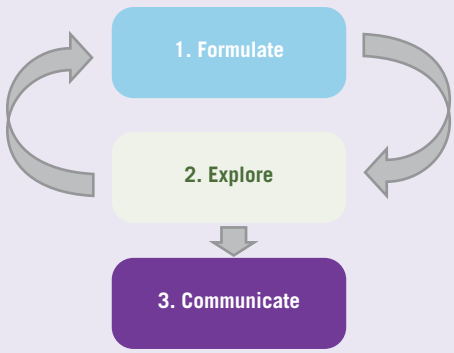
f Investigate the world's population in 2019. What is the probability of a person in the age group 14–49 years dying from indoor pollution in 2019? Compare this to the probability for the same age group in 1990.

g Determine the percentage change in the probability of a person dying from indoor air pollution in the age group 50–69 years from 1990 to 2019.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Investigations

When undertaking your investigations, remember the problem-solving cycle steps:



- **Formulate** – Sort out and plan what you need to know and need to do to solve the problem.
- **Explore** – Use and apply the mathematics required to solve the problem.
- **Communicate** – Record and write up your results.

1 Bushfires – then and now

Your task is to analyse the data about Victorian bushfires, both in the past and in more recent times. You will be identifying significant factors that influence the severity of bushfires and the impacts that the bushfires had on Victoria and its people.

Two extreme bushfire events were the 'Black Friday' bushfire in 1939 and the 'Black Saturday' bushfire in 2009. You may choose to research these bushfire events or select two others.

Formulate

a Select at least five significant bushfire factors to research. Some factors that you could investigate include:

- weather conditions before the fires
- type of country and terrain of the fires
- fuel load of the area
- area of land burned
- loss of habitat for native animals
- loss of life
- loss of houses and infrastructure
- population density
- influx of seasonal visitors to the regions of the fires
- availability of firefighting equipment and personnel.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- difficulty of road access both for firefighters and for people to evacuate
- how the bushfires affected the physical and mental health of the survivors
- how the experiences created long-term physical and mental health problems for survivors
- how the bushfires affected the government budget due to deployment of the Defence personnel to assist with the rebuilding of the communities
- changes that have been made to reduce the effects of bushfires.

b How will you research the information? How will you know that the sources you use are reliable?

c How will you record the information? What technology will you use to collect and display the data?

Explore

d Conduct your research. Select an appropriate technological tool to record the data. Be sure to include the hyperlinks to each data source.

e Construct appropriate tables and graphs that compare the historical data with the more recent data.

f We have a rating system for ranking the fire danger level. What are these four levels? For those factors that influence the severity of fires that you have selected to research, rate them using the four levels of danger rating.

Communicate

g Write up and present the findings of your investigation into significant factors affecting bushfires. You can choose the format of your presentation.
Your presentation should include:

- all data tables, graphs or infographics that you have used in your research
- a description of what the data indicates about how bushfires have changed over time. Were there similarities or differences in the factors for both events?
- an explanation of why you have rated each factor as you have
- the mathematics you used in the investigation
- the technology you used to conduct the investigation and present the results.

If you were to do this investigation again, explain what you would alter, and why.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

2 What causes people to become displaced?

A displaced person is someone who has been forced to leave where they live. Your task is to investigate the factors that may cause people to become displaced.

Formulate

a In a small group or as a class, conduct a brainstorm to identify different factors (natural/environmental/political) that might cause people to become displaced.

b From your brainstorm, identify an area that you would like to focus on.

c Develop a plan for your investigation that includes:

- where and how you will find the information you need
- how you will record your investigation and the outcomes.

Explore

d Conduct your research. Select an appropriate technological tool to record the data. Record the source of your information.

e Use downloaded data to construct tables and graphs that create a story about the factors that cause people to become displaced.

f Analyse your data to establish the top five reasons why people become displaced. Use statistical methods to conduct your analysis.

Communicate

g Write up and present the findings of your research. You can choose the form of your presentation, which should include:

- your reasoning for selecting the area for your research
- any data tables, graphs or infographics that you have used in your research
- the mathematical and statistical processes that you have used to reach your conclusion
- your reasoning for presenting the data in the way you have. Why did you choose the statistical methods that you did?
- the technologies that have been used to collect the data initially and what technology was used to collate, present and analyse the data

Reflect on the research processes you used in this investigation. Were you to do it again, what would you change, and why?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key concepts

- **Chance** is the idea of 'possibility' – that something could or might happen.
- **Likelihood** describes how 'likely' it is that an event will happen, usually in words rather than numbers.
- **Probability** is the formal numerical measure of the likelihood.
  - Probability of an event occurring $= \dfrac{\text{number of favourable outcomes}}{\text{total number of trials}}$
  - Probability is a measure in the range of 0 to 1 of how certain or uncertain an event will occur.
  - Probabilities may be written as a decimal, e.g. 0.5, a fraction, e.g. $\frac{1}{2}$, or a percentage, e.g. 50%
- **Experimental probability** – experimental probability is found by repeating an experiment and observing the results and calculating the proportion (as a fraction, decimal or percentage) of times the event occurs.
  - **Number of trials** – how many times was the experiment repeated.
  - **Outcomes** – the results of the experimental trials.
  - **Frequency** – the number of times you observe a particular outcome.
  - The formula for experimental probability of an event is:

$$\Pr(\text{event}) = \frac{\text{number of times event occurs}}{\text{total number of trials}}$$

  - **Relative frequency** – is basically the same as experimental probability. As the number of trials increases, the experimental probability or relative frequency approaches the theoretical probability.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- **Theoretical probability** – theoretical probability of an event is what is expected based on a mathematical interpretation of the event. This equals the expected number of known ways the event can occur (favourable outcomes) divided by the number of total outcomes (as established by working out the sample space). As with experimental probability, this is calculated as a proportion (as a fraction, decimal or percentage).
  - **Sample space** – all the possible outcomes of an event listed in curly brackets {}.
  - The formula for theoretical probability of an event is:

$$\Pr(\text{event}) = \frac{\text{number of times event occurs}}{\text{total number of trials}}$$

- **Event** – a selected outcome or subset of all possible outcomes, e.g. in the experiment of rolling a die, the event could be the rolling of a 4.
  - **Equiprobable events** – events that are equally likely to occur.
  - **Mutually exclusive events** – the outcome can be one or the other, but not both at the same time, e.g. a coin toss can land on a head or a tail.
  - **Complementary events** – where an event will either happen or not happen. Complementary probabilities add to 1 or 100%, e.g. if a team's probability of winning is 70%, then its probability of not winning is 30%.
  - **Independent events** – where the outcome of one trial does not influence the outcome of another trial, e.g. having spaghetti for dinner and posting on social media.
  - **Dependent events** – one event influences the outcome of another event, e.g. you can't get your Driver's licence until you have met the requirements of the Learner's permit.
- **Long-term data** can provide information to calculate probabilities such as climate, epidemics, and health and finance events.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Success criteria and review questions

I can understand the key ideas behind chance, likelihood and probability.

1 Describe chance, likelihood and probability in your own words.

2 Look at the following 7-day weather forecast.

27 JUN	28 JUN	29 JUN	30 JUN	1 JUL	2 JUL	3 JUL
Monday Possible shower	**Tuesday** Possible shower	**Wednesday** Mostly cloudy	**Thursday** Late shower	**Friday** Possible shower	**Saturday** Possible shower	**Sunday** Possible shower
17°C	17°C	19°C	18°C	17°C	18°C	18°C
8°C	8°C	8°C	9°C	9°C	9°C	10°C
80% 1-5mm	30% < 1mm	5% < 1mm	70% 5-10mm	70% 5-10mm	80% 5-10mm	90% 10-20mm

a Explain the terms ‘possible’ and ‘mostly’.

b What is the probability of rain on Wednesday?

c What is the probability of rain on Saturday?

d Explain what the percentage of rain means, e.g. Monday has ‘80% 1–5 mm’.

I can identify the sample space.

3 Use this menu to answer the questions.

a Use a tree diagram to show all the possible combinations of having three courses.

b List the sample space for this menu.

4 Your class has the opportunity to participate in an adventure excursion. These are the options available:

- You can do one activity in the morning, and one in the afternoon.
- The morning activities are: Archery, Abseiling, High ropes, Zip lines.
- The afternoon activities are: Rafting, Cave exploration, Snowboarding, Hiking, Orienteering.

a Use a tree diagram to show all the possible combinations of activities.

b List all of the possible combinations of activities as a sample space.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

I can identify types of probability and calculate simple probabilities.

5 A store sells popular runners. The options available are:

- Four colours: black, black and white, black and orange, and black and green.
- Four sizes: small, medium, large and extra large.
- All colours and sizes are equally popular.

a Draw a probability tree diagram showing all the possible combinations of runners that you could buy.

b What is the probability that you buy black, medium-sized runners?

6 The probability of developing asthma in Australia is 10.7%. What is the probability of not developing asthma?

7 If 3.6% of the population of Australia will, at some stage of their life, be diagnosed with osteoporosis, what percentage will not have this diagnosis?

8 A medical professional tells a patient that there is an 8% chance that they will have a dangerous form of the disease with which they have been diagnosed. Explain the risk and what this means.

9 Based on their performances over the season, a soccer goalkeeper has an estimated probability of 0.3 of saving a penalty goal kick.
Using a tree diagram, find the probability that if in a game where they have to face three penalty goal kicks, they save:

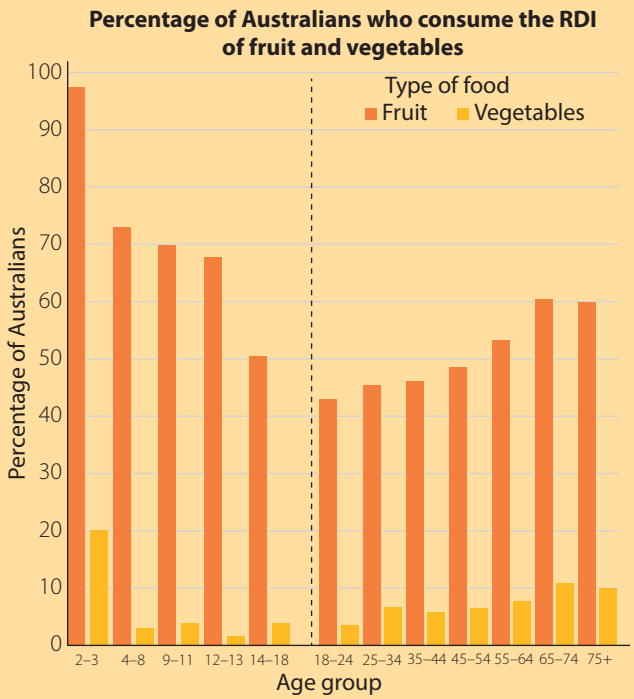
a all three goals

b two goals out of the three.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

I can use long-term data and relative frequencies to identify probabilities and make decisions.

10 The following graph shows the percentage of Australians in different age groups who consumed the recommended daily intake (RDI) of fruit and vegetables for a healthy diet in the year spanning 2014–15.

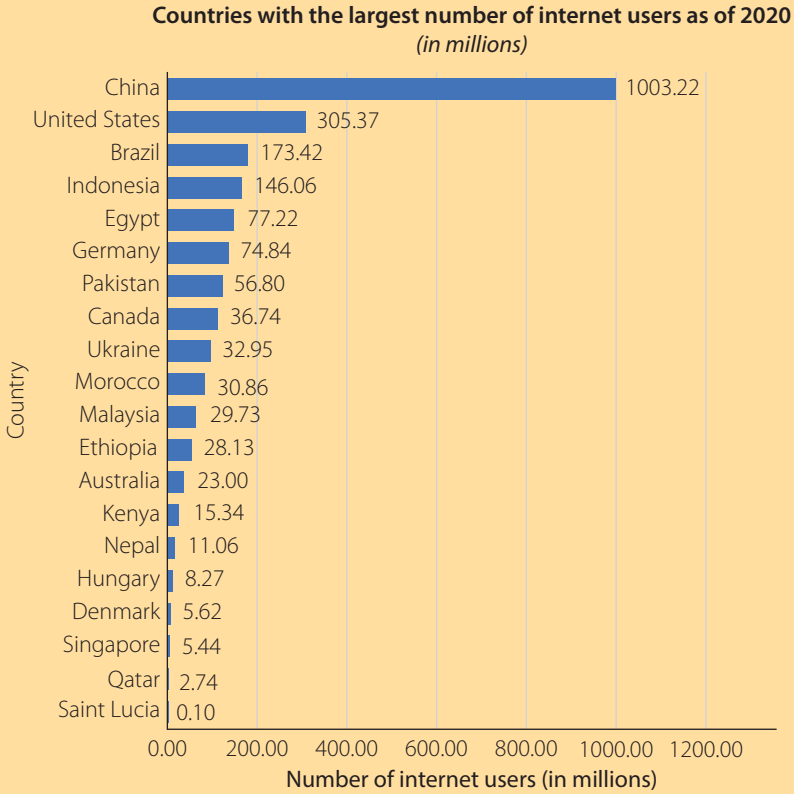


Source: Australian Bureau of Statistics (ABS)

a What is the probability that an adult aged 18–24 years eats the RDI of fruit?
b What is the probability that an adult aged 65–74 years eats the RDI of vegetables?
c What is the probability that a child aged 14–18 years eats the RDI of fruit?
d What is the probability that a child aged 14–18 years eats the RDI of vegetables?
e What is the probability that a child aged 12–13 years eats the RDI of vegetables?
f Draw conclusions from this data and make recommendations.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

11 Consider the following data on internet users by country, or research to find the latest available data.



a Create a table similar to one shown to determine the probability that a person in a country will be an internet user. Choose five countries that interest you and research to find their populations.

Name of country	Number of users	Population of country	Probability that person will be an internet user (as a decimal)	Probability that person will be an internet user (as a percentage)
USA				
China				

b Draw conclusions from your findings.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mathematical toolkit

1 Reflect on the range of different calculations, technologies and tools you used throughout this chapter, and how often you used them for undertaking your work and making calculations. Indicate how often you used and worked out results and outcomes for each of these methods and tools.

Method and tools/ applications used	**How often did you use this?**
• Calculating and working in your head, and using algorithms	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using pen-and-paper	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using a calculator	A little: ☐ Quite a bit: ☐ A lot:☐
• Using a spreadsheet	Not at all: ☐ A little: ☐ Quite a bit: ☐
• Using measuring tools – name the tool, technology or application: _____ _____	Not at all: ☐ A little: ☐ Quite a bit: ☐ Not at all: ☐ A little: ☐ Quite a bit: ☐
• Using other technology or apps – name the technology or application: _____ _____	Not at all: ☐ A little: ☐ Quite a bit: ☐ Not at all: ☐ A little: ☐ Quite a bit: ☐

2 Did this chapter and the activities help you to better understand how you use different tools and technologies in using and applying mathematics in our lives and at work? In what areas and ways? Write down some examples.

3 In one sentence, explain something relating to tools and technologies that you learned in the unit. Write an example of what you learned.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key vocabulary

Here is a list of this chapter's key maths terms and their meanings.

Term	Meaning
Big data	Collecting and analysing vast data sets that you cannot collect or analyse by hand; however, with technology it is possible to examine the data.
Certain	A probability of 1 or 100%, e.g. the Sun will rise tomorrow morning.
Chance	Chance is about the general possibility that something (called an *event* in probability) could happen; chance refers to the likelihood of an event occurring. It encompasses the unpredictable nature of events, e.g. there is a good chance that it is going to rain this afternoon.
Complementary	Complementary events must be *mutually exclusive*, and the event will either happen or not happen. Complementary probabilities add to 1.
Dependent	Where two or more events occur, and one event influences the outcome of another event. The language we often see with dependent events is 'if A **then** B…', or 'if A **given that** B…'.
Equiprobable	When there is an equal chance of success for all outcomes of an event, e.g. rolling a normal die.
Event	A selected outcome or subset of all possible outcomes.
Experimental probability	The experimental probability is found by repeating an experiment (like tossing a coin or rolling a die) and observing the results and calculating the proportion (as a fraction, decimal or percentage) of times the event occurs. The formula for experimental probability of an event is: $\Pr(\text{event}) = \frac{\text{number of times event occurs}}{\text{total number of trials}}$
Frequency	The number of times you observe a particular outcome.
Impossible	A probability of 0 or 0%, e.g. rolling a 7 on a normal six-sided die.
Independent	Where the outcome of one event does not influence the outcome of another event.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Term	Meaning
Likelihood	Likelihood is mostly used descriptively when describing whether something is likely to happen, e.g. there is a higher likelihood of rain this afternoon because heavy clouds are moving in.
Long-term data	Long-term data can be used to make informed predictions about the chance or likelihood of events occurring, e.g. about health, finance, the environment and the changing climate.
Mutually exclusive	When it is impossible for two events to occur at the same time, e.g. the result of a coin toss will be a head *or* a tail – it cannot be both simultaneously.
Outcome	The result of an experimental trial.
Probability	The precise mathematical representation, where a numerical value is in the range of 0 to 1 (or in the range of 0% to 100%) is used to express the *likelihood* of an event occurring. $$\text{Probability of an event} = \frac{\text{number of favourable outcomes}}{\text{total number of trials}}$$
Probability tree	To calculate probabilities using a tree diagram, you write the probability next to each branch then multiply the probability values along the branches.
Relative frequency	The number of times a particular outcome happens divided by the total number of *trials*.
Risk	Possible exposure to danger or loss that can be expressed as probabilities.
Sample space	All the possible theoretical outcomes of an event.
Theoretical probability	The expected probability of an event based on a mathematical interpretation of the event. This equals the expected number of known ways the event can occur (favourable outcomes) divided by the total number of outcomes (as established by working out the sample space). The formula for theoretical probability of an event is: $$\text{Pr(event)} = \frac{\text{number of favourable outcomes}}{\text{total number of possible outcomes}}$$
Trials	When an experiment is repeated a number of times.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Revision of Chapters 1–8: Exam-style questions

Areas of Study 1 and 2

- The questions are divided into two sections: Section A and Section B.
- For Section A, all multiple-choice questions are worth one mark each.
- For Section B, the marks are indicated next to the questions and individual question parts.
- A downloadable version of these questions, including space for working out in Section B, is available in the Interactive Textbook.

SECTION A – Multiple-choice questions

1 Nate is measuring his family room. The length and width are 9.3 m and 13.9 m. The calculation giving the best estimate for the room's area is

A 9×13 **B** 9×14 **C** 10×13 **D** 10×14

2 Boris is conducting a survey about company culture at his workplace. The following table shows the number of people in each department.

Department	Number of people	Percentage of all employees (%)
Finance	348	9
Sales	1504	41
Senior management	31	1
Production	1802	49

He randomly selects participants for his survey such that 9% are from Finance, 41% are from Sales, 1% are from Senior management and 49% are from Production.
Which of the following is **not** a reason why Boris' sample method could improve the reliability of his results?

A Reduces error due to the sample not reflecting the makeup of the company.

B Increases precision of conclusions about each department.

C Guarantees inclusion of smaller groups within the company, where random sampling could result in these groups being excluded.

D Accounts for individuals who belong to more than one department.

3 A peregrine falcon dives at a speed of 301.89 km/h.
This measurement, correct to 3 significant figures, is

A 301 km/h **B** 301.89 km/h

C 301.9 km/h **D** 302 km/h

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4 In a recycling centre, disposal fees for waste materials are calculated based on their weight, rounded to the nearest kilogram.
A pile of mixed recyclable materials weighs 56.85 kilograms, and the disposal fee is $3.50 per kilogram.
The disposal fee for this pile of recyclables is

A $196.00 **B** $198.98 **C** $199.15 **D** $199.50

5 A mixed fruit drink contains pineapple juice, orange juice and lemonade in the ratio 1 : 3 : 6. The mixture contains 750 mL more lemonade than pineapple juice.
The amount of orange juice in the mixture is

A 300 mL **B** 375 mL **C** 450 mL **D** 500 mL

6 The formula for converting degrees Celsius, C, to degrees Fahrenheit, F, is $F = \frac{9C}{5} + 32$.

In order to transpose this formula to make C its subject, the first step is to

A swap the letters C and F **B** subtract 32 from both sides

C divide both sides by 5 **D** multiply both sides by 9

7 It takes a group of eight workers 12 days to landscape a large backyard.
The best estimate of how long it would have taken six workers to landscape the same backyard is

A 9 days **B** 15 days **C** 16 days **D** 20 days

8 The following pie chart is created at Brentsville Secondary College to show the school community the popularity of various Year 12 areas of study.

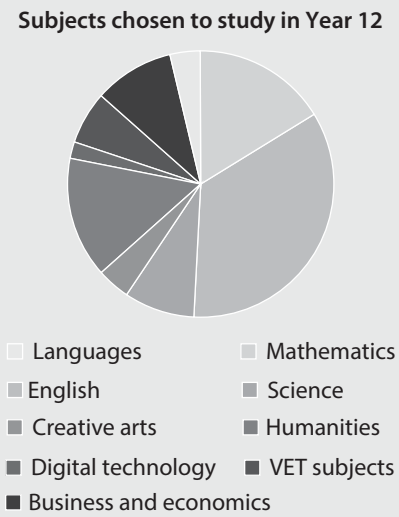
What is misleading about the chart? Choose the **most** correct answer.

A The pie chart does not include a legend, making it hard to interpret.

B Students can make multiple combinations of subject choices, so each student is being counted more than once.

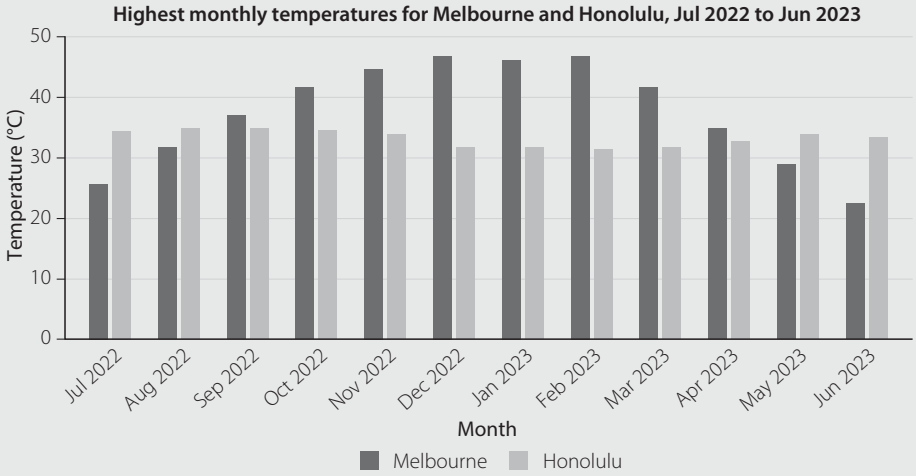
C Insufficient information was provided about the sample size for the data represented by the pie chart to be meaningful.

D This pie chart is a good representation choice for the data.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9 Camilla recently emigrated to Honolulu from Melbourne. She investigates the highest recorded monthly temperatures for both Melbourne and Honolulu and creates the following chart on a weather comparison website.



Which of the following is true about this data?

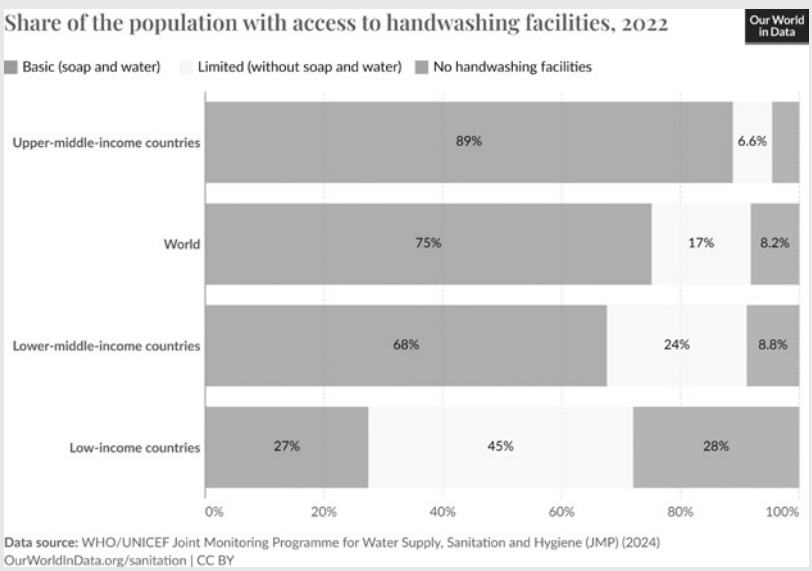
A In the majority of months, the highest recorded monthly temperature is greater for Honolulu than for Melbourne.

B The standard deviation of the highest recorded monthly temperature is greater for Melbourne than for Honolulu.

C The range of highest recorded monthly temperatures is greater for Honolulu than for Melbourne.

D It is impossible to compare the standard deviations or ranges of the highest recorded monthly temperatures for the two cities.

10 The following graph shows the share of the population that has access to handwashing facilities in 2022.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Based on the information shown, which of the following statements is **false**?

A The probability that a randomly selected person in a lower-middle-income country has limited access to handwashing facilities is more than 20%.

B The probability that a randomly selected person in an upper-middle-income country has limited or no access to handwashing facilities is 11%.

C The probability that a randomly selected person in the world has basic access to handwashing facilities is 75%.

D The probability that a randomly selected person in a low-income country has basic or no access to handwashing facilities is 45%.

SECTION B

1 Neona owns a cafe and notices that customers tend to order drinks rather than food. She decides to investigate what her customers think about the food sold at her café. Neona drafts the following two surveys to give customers who order food one Monday morning.

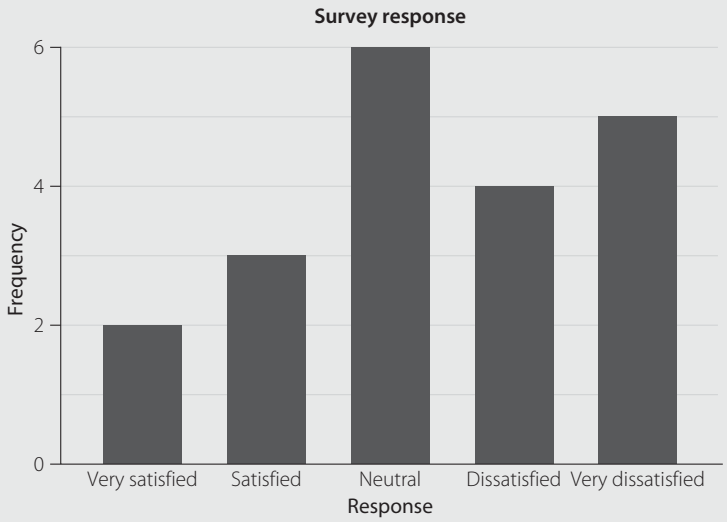
Option 1	**Option 2**
Are you satisfied with your food order? • Yes • No	Which of the following best describes your satisfaction with your food order? • Very satisfied • Satisfied • Neutral • Dissatisfied • Very dissatisfied

(5 marks)

a Identify one advantage and one disadvantage of choosing Option 1 over Option 2. 2 marks

b State whether Neona is collecting numerical or categorical data. 1 mark

Neona chooses Option 2. She produces the following graph based on the results.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

c By calculating the percentage of customers who like Neona's food, determine whether customers tend to like or dislike Neona's food. 1 mark

d Suggest an improvement for Neona's data collection method. 1 mark

2 Vutha is deciding whether he will continue with his current mobile plan from Company A, or whether he will switch to one of the competitors Company B or Company C. (5 marks)

	Company A	Company B	Company C
Cost per month	$35	$60	$85
Mobile data (gigabytes)	30	38	150

a Express the monthly cost of Company A's plan as a fraction of the monthly cost of Company B's plan. 1 mark

b Express the monthly cost of Company B's plan as a percentage of the monthly cost of Company C's plan. Round your answer to 2 decimal places. 1 mark

c Determine which of the given plans is the cheapest per gigabyte of mobile data. Use calculations to support your answer. 2 marks

d By what percentage would Company A have to increase or decrease its cost per month to have the same cost as Company C per gigabyte of mobile data? Round your percentage answer to the nearest whole number. 1 mark

3 Mitch decides to purchase a new phone. He borrows money from his parents to buy a phone at a Boxing Day sale where it is discounted by 15%. (5 marks)

a The recommended retail price of the phone is $1,400. Calculate the sale price that Mitch paid. 1 mark

Mitch earns $20 per hour at his part-time job. He decides to set aside 45% of his earnings towards paying back his parents.

b If his parents require him to pay back the borrowed amount as well as an additional one-tenth of the borrowed amount, calculate how long he needs to work to pay them back. Give your answer to the nearest hour. 2 marks

c Mitch is informed that the value of this phone ($1,400) is forecast to depreciate by a constant rate of $250 each year.
If he intends to sell the phone before its value depreciates to $1,000, calculate the number of months he can wait to sell it. Give your answer to the nearest month. 2 marks

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4 The cost to manufacture a limited-edition car is $37,000 per car, plus a fixed cost of $100,000 to be spent on advertising. The cars sell for $50,000 each. (5 marks)

a Write an equation where C, the cost of manufacturing x cars, is the subject. 1 mark

b Write an equation for the revenue, R, from the sale of x cars. 1 mark

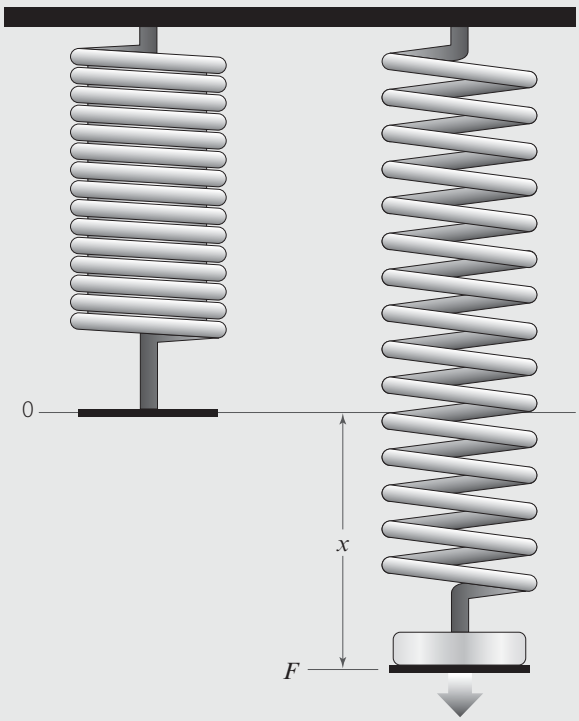
c Calculate the number of cars that need to be sold for the car manufacturer to break even and start to make a profit. 3 marks

5 Some Physics students are investigating forces in the lab.
The force due to tension, F (in newtons), applied to a spring when extended is directly proportional to the length of its extension, x (in centimetres). (10 marks)

a Given $F = 300$ newtons when $x = 12$ cm, write a formula for F in terms of x. 2 marks

b Calculate the force due to tension when the spring is extended by 5 cm. 1 mark

c Calculate the extension required for the force due to tension to be 12.5 newtons. 2 marks



The students also investigate forces involving magnets.
The amount of force, F (in newtons), that a magnet applies to a metallic object is inversely proportional to the square of the distance, x (in centimetres), between the magnet and the object.

d Given $F = 8$ newtons when $x = 5$ cm, write a formula for F in terms of x. 2 marks

e Transpose the formula so that x is the subject.
Hence, calculate the distance between the magnet and the object required to apply a force of 12.5 newtons. 2 marks

f As a general rule, what is the change in F when x is doubled? 1 mark

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9 Managing your money

Brainstorming activity: Where's the maths?

Using this photo as a stimulus, brainstorm the type of maths related to this task or activity. Think especially about any maths skills related to the content of this chapter – the financial world around us. Prompt questions might be:

- What might this person be doing in this photo?
- What activities and investigations might they be undertaking?
- What types of mathematical content, knowledge and skills would be relevant?
- What different tools, technologies or software might be used?

People use their mobile phones and devices such as laptops to make transactions and keep track of money. Think about:

- What finance-related apps do you use? What do you like about these apps? What are the risks in using them?
- For an adult, such as a family member, what finance-related apps do they use and what do they use them for?
- Are finance-related apps replacing the need to learn financial mathematics?

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter contents

Chapter overview and Spotlight

9A Starting activities
9B Tuning in
9C Interest and repayments
9D Comparing credit options
9E Student loan schemes
9F Wage growth and the cost of living
Investigations
Chapter review

From the Study Design

In this chapter, you will learn how to:

- compare, contrast and undertake routine calculations for credit options for personal financial management such as personal borrowing (a car, holiday) or for housing
  (Units 3 and 4, Area of Study 3)

© Victorian Curriculum and Assessment Authority 2022

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter overview

Introduction

This chapter explores the important role of mathematics in the financial issues that we encounter every day. More and more, financial activities and transactions take place digitally and so are not always apparent.

This chapter prepares you to understand the financial language, concepts and calculations involved in keeping track of your financial position in relation to both debt and savings so that you can make informed decisions.

In undertaking any of this financial analysis, interpretation and comparisons requires us to know about and use a range of mathematical knowledge and skills – the knowledge and skills that have been covered in the first eight chapters of this book. You will need to dip into that knowledge bank and into your mathematical toolkit throughout this chapter, and the next two as well.

Learning intentions

By the end of this chapter, you will be able to:

- calculate interest and repayments on loans
- understand credit and how to manage debt
- understand student loan schemes
- understand the concepts of risk and reward in the context of personal finances
- understand interest in the context of investment.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Spotlight: Melissa Au

An interview with a bank worker

Tell us about your job and some of the work that is involved.

I work as a lending manager at the Bank of Queensland. What I do is offer a financial service where I help people meet their financial goals. Most of the time it's for lending purposes, so, for example, someone can buy a car or a shop. I also help people meet their financial goals more broadly. I feel that the financial literacy of the average Australian is pretty low, so a lot of the time I'm here to help educate people on how they can be better with their money.

What maths do you use regularly in your work? Can you provide examples?

The maths that I use is fairly basic and involves a lot of percentages. Most of the time I'm calculating how much someone can borrow based on the type of thing they're trying to buy. One very typical calculation that I'll do is trying to work out the loan to value ratio. For example, if a person wants to buy a house for $1 million, then we lend typically 80% of that (so $800 000). I also perform loan repayment calculations to help guide people to understand what their monthly repayments are going to look like to then help them budget for that month. I use our website's loan repayment calculator for this as it has the formulas already in there so it's just a matter of punching in the figures.

What are some of the key issues that you see in terms of lack of financial literacy in customers?

There's a common misconception around how principal and interest works in loans. People often think they're saving money by making lower loan repayments over a long term such as 30 years. What they don't realise is that they are potentially paying more in interest over the life of that loan. While it depends on a person's financial goals (for example, they may choose a longer term if they are starting a business or saving for something), if their overall aim is to pay less interest, then making the minimum monthly repayments will not do this. Making repayments more frequently, such as fortnightly instead of monthly, and paying off your loan quicker will save you more money in the long run and can shave years off your loan.

What was your attitude towards maths in school? Has this attitude changed over time?

I was slightly above average at maths in school. It wasn't something I was super passionate about, but I knew it was something I had to do in order to get into the university course I wanted, which was Commerce and Economics as I always had an interest in finance. Now, my work has made me realise how important maths is, and having a good grasp of maths and understanding how certain things are worked out makes my job easier. If you can calculate basic things like percentages in your head, then you look more professional.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9A Starting activities

Activity 1: Different ways to purchase items

1 Match each way of buying what you want with the different types of payment. Note that there can be more than one possible type of payment for each type of transaction.

Types of payment: **Credit card**, **Buy now pay later**, **Debit card**, **Personal loan**.

	Type of transaction	Types of payment
a	I use money that I have earned or saved.	
b	I make or agree to a contract to buy an expensive item that I cannot pay for upfront but can afford to repay (with interest) over an extended period of time.	
c	I use the bank's money to pay for an emergency expense. I will repay this expense (with interest) as soon as possible.	
d	I make or agree to a contract agreeing to make four part-payments to a retailer.	

2 Think about the benefits and disadvantages of each type of payment.

3 Share and compare these with your classmates.

Activity 2: What are the risks?

1 Rate each of these scenarios on a scale of least financial risk (1) to maximum financial risk (5).

a Taking out a loan from a payday lender

b Using your debit card to buy items

c Using store **credit** to buy items

d Investing in the stock market

e Regularly checking your bank account activity

f Taking a **personal loan** from a bank to buy a car

g Falling behind on paying your electricity bill

h Using one credit card to pay off another credit card

i Taking out a student loan to continue with your studies

j Sending money via the internet to a person you don't know.

2 Share and compare your risk analysis with your classmates.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9B Tuning in

Epic Success: Buy now, pay later

One of the emerging industries from **fintech** is **Buy Now Pay Later (BNPL)**. Over the pandemic years, consumers made a huge shift to online purchasing. BNPL provides another option for borrowing money that seems attractive to consumers.

For the owners of BNPL services, this is the pot of gold at the end of the rainbow. BNPL companies provide the money and the software but collect fantastic returns in the form of **transaction fees** from the sellers, and interest from customers who do not make payments in time. Lots of shops offer different buy now pay later options. Buy now pay later providers in Australia include:

- Afterpay
- Humm
- LatitudePay
- Plenti
- Zip Pay
- Brighte
- Klarna
- Payright
- StepPay

In 2020, $24 billion or $24,000,000,000 worth of goods were paid for using BNPL.

In 2021, that increased to $100 billion or $100,000,000,000 worth of goods!

How much was purchased using BNPL last year?

Afterpay, an Australian BNPL start-up founded by Nick Molnar and Anthony Eisen, was sold to an American company in 2021 for $39 billion! $39,000,000,000!

Their success could be attributed to their model which charges retailers a fee between 4% and 6% for every transaction. And then, of course, there is interest charged to consumers who are unable to make repayments on time.

ASIC's (Australian Securities and Investments Commission) 2018 report into the BNPL industry found that:

- 60% of BNPL users are aged 18–34 years
- 44% of BNPL users earn under $40,000 per annum, and of these, almost 40% are students or work part-time
- most (80%) report that BNPL services allow them to buy more expensive items and spend more than they could afford to otherwise
- 65% thought that if they missed a BNPL payment it would be less risky than other payment options
- more than 15% had either incurred late fees or borrowed more money because of a BNPL debt.

... continued

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Discussion questions

Search the internet to find some examples of BNPL firms, their charges and some examples of their **Terms and Conditions** related to BNPL. Simply search for 'How much does it cost you to use BNPL in Australia' or 'BNPL Terms and Conditions' and you will find a lot of information – use Australian sites.

- How do the BNPL providers make their money from you? How can they say you can pay the amount borrowed back in interest free instalments?
- Do you think that missing a BNPL payment is less, the same, or more risky than other credit options? Give reasons for your answer.
- Retailers have to pay for offering BNPL services. What are the possible benefits to retailers in offering this service?
- What happens if you miss a BNPL payment?
- What happens if you default (cannot repay) a BNPL debt?

Percentages

Studying and understanding financial mathematics requires a strong foundation in working with percentages.

Often in the retail industry, shop assistants are required to calculate percentages for sales, but also on customer returns. Tradespeople add a **percentage mark-up** on products that they purchase for customer installation, and contractors must add 10% GST to all their invoices. Wages and costs of goods and services are often increased by a percentage rate, often based on the Consumer Price Index (CPI) that is a percentage rate.

If you need a refresher on percentages you may want to look back at Chapter 3 sections 3F, 3G and 3H.

Remember the key types of percentage calculations:

Unknown percentage: To calculate a *percentage* given the amount and the total, we use:

$$\text{Percentage} = \frac{\text{amount}}{\text{total}} \times 100$$

Unknown amount: To find the *amount* if we know the percentage and the total, we use:

$$\text{Amount} = \frac{\text{percentage}}{100} \times \text{total}$$

Unknown total: To find the *total* if we know the percentage and the matching amount, we use:

$$\text{Total} = \frac{\text{amount}}{\text{percentage}} \times 100$$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Practice questions

1 Answer the following questions about BNPL.

- **a** How is BNPL different from using a credit card?
- **b** Can you have more than one BNPL arrangement at once?
- **c** What happens if you can't make a payment?
- **d** Does BNPL affect your credit rating?

2 For each of these products, find the cost of such an item and then calculate the 10% GST that has been incorporated into the cost that you would pay.

a

b

c

d

3 Use the internet to find and estimate the following percentage proportions.

- **a** Percentage of teenagers out of Australia's total population
- **b** Percentage of McDonalds stores versus all fast-food franchise stores in Australia
- **c** Percentage of Melbourne's population versus the total population of Victoria
- **d** Percentage of today's daylight hours versus 24 hours

4 Calculate the following amounts.

- **a** The amount saved on a new bike with a retail price of $1,098.00 which has a 15% discount
- **b** The amount paid for a pair of jeans advertised at $79.95 with a 25% sale discount
- **c** The extra charge for paying for a meal costing $125.50 when the business charges an extra 0.5% for paying by card
- **d** The annual salary if a current salary of $75,250 had a wage increase of 3.1% applied

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9C Interest and repayments

You need to know about interest relates to be able to look after your money. Interest rates and how they apply to saving or borrowing money is critical. It is important to know about the difference between simple interest and compound interest and how these are applied.

Interest calculations apply when you are saving money and making investments. They also sit behind the amounts of money you need to repay when you purchase items and need to use credit cards or borrow money via a loan. Learning about simple interest and compound interest equips you with essential life skills and financial awareness.

In Australia, there are a number of different types of financial institutions that you could deal with for savings, credit and loans. Banks are licensed to provide loan products and accept deposits. Credit unions and building societies offer deposit, personal/housing loans and payment services to members. Whereas non-banking financial institutions focus on other more specialised services such as insurance, wealth management and investments. There are also finance companies who provide loans to households and small- to medium-sized businesses.

Savings and investments

Australia offers a variety of savings and investment options to help you grow your money. In terms of saving some of your hard-earned cash, the simplest and most common ways is to use savings accounts with a bank or building society. These provide stable, low-risk income through regular interest payments, but their returns are usually quite low. The average returns over the last 10 years have been around 3% per year.

For higher return, you can choose term deposits. These are fixed-term investments that offer stable and predictable interest payments over different time durations. They are suitable for short-term goals (up to two years) and offer higher interest rates. To benefit from the compounding effect on interest as we saw above, having them reinvest the interest regularly (e.g. every month or quarter, rather than annually) means you can benefit more. The only negative is that it's more difficult to get your money before the term deposit has reached its time.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Another way of investing your money is through fixed interest bonds, which can be issued by governments or by companies. You can also purchase shares in companies, where you become a shareholder. If the company's shares grow in value, your investment appreciates. However, share prices can be volatile and move in the opposite direction – so there is a significant amount of risk. Australian shares have averaged a return of about 6.5% per year over the last decade.

Putting your money in the bank or building society is safe, but the interest rates are often less than you could get if you put your money into stocks and shares.
BUT: investing in the stock market has risk. What if you put your money into shares in a business and it goes broke?

Investing in stocks and shares really should be a long-term venture so that you can ride out the volatility of the market.

It's your money, so it's your choice about how you balance risk and reward. Remember to research each option thoroughly and consider your goals, risk tolerance and investment time frame before making decisions. Whichever way you go, you should always discuss your financial plans with someone who is reliable and independent.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Getting into debt

You may be familiar with the 'Buy now, pay later' option that is widely available. This allows customers to receive a product or service straight away but pay for it in four regular instalments. But beware: there can be significant fees and charges if you miss or are late with a repayment.

When you are buying an expensive item – like a car – you will sign a loan document that sets out your obligations and what will happen if you don't meet them.

Both scenarios are common forms of debt. Before you sign up for any debt, you should make a personal budget to ensure that you can comfortably afford to make the repayments.

Properly managed, you will not only get to keep the item, but you will also be establishing a good credit rating. This will be important to you when you want to rent or buy a house.

Simple interest and compound interest

In Chapter 8 in the Units 1 and 2 textbook, both simple interest and compound interest were introduced. **Simple interest** is calculated based solely on the initial principal amount of an investment (or loan), while with **compound interest**, the amount accumulates interest on top of interest. Simple interest tends to work in your favour when you're a borrower because it keeps the overall amount that you pay lower than it would be with compound interest. However, it can work against you when you're an investor because you'll want your returns to compound as much as possible to get the most from your investment.

Let's look at interest in relation to investing money first. Interest is usually expressed as a percentage per year or **per annum** (abbreviated to % p.a.).

The initial sum of money invested (or borrowed) is called the **principal.**

There are two types of interest: **simple interest** and **compound interest.**

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Simple interest (I)

Principal, P = the amount of money borrowed or invested

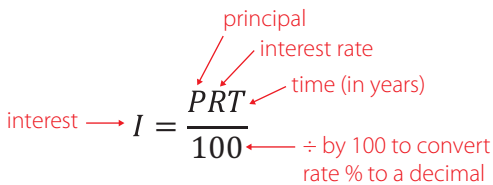
Term, T = the time period for which the principal is borrowed or invested

Rate of interest, $R\%$ = the percentage of the principal that is charged for borrowing the money, or paid to you for investing the money

Simple interest can be calculated using the formula:

$$I = \frac{PRT}{100}$$

That is:



Compound interest (I)

Principal, P = the amount of money borrowed or invested

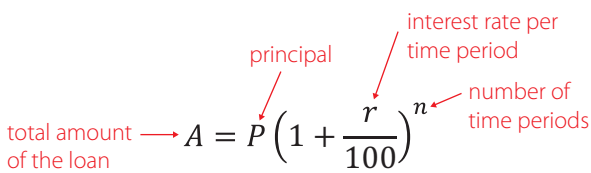
Term, n = the number of time periods for which the principal is borrowed or invested

Rate of interest, $r\%$ = the percentage of the principal that is charged for borrowing the money, or paid to you for investing the money, per the time period

The total amount (or **accumulated value**), A, can be calculated using the compound interest formula:

$$A = P\left(1 + \frac{r}{100}\right)^n$$

That is:



To find the compound interest, (I), we would subtract the principal (P) from the total amount (A); that is, $I = A - P$.

The compound interest formula is exponential (to the power of n), compared to simple interest, which is linear.

Let's now look at a comparison of investments based on simple interest and compound interest.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 1 Comparing the value of an investment earning interest using a spreadsheet

$10,000 is invested for 10 years at an interest rate of 5.2% p.a. Calculate the value of the investment if the interest is:

a simple interest
b compound interest accumulated or reinvested annually
c compound interest accumulated or reinvested quarterly.

THINKING	WORKING
STEP 1	
Identify P, R and T of the simple interest investment.	For simple interest: Principal (P) = $10,000 Annual interest rate (R) = 5.2% Term in years (T) = 10
STEP 2	
Identify P and calculate n and r of each compound interest investment.	For compound interest, reinvested annually (1 per year): Principal (P) = $10,000 Number of time periods (n) = 10 × 1 = 10 Interest rate per time period (r) = 5.2 ÷ 1 = 5.2% For compound interest, reinvested quarterly (4 per year): Principal (P) = $10,000 Number of time periods (n) = 10 × 4 = 40 Interest rate per time period (r) = 5.2 ÷ 4 = 1.3%
STEP 3	
Set up a spreadsheet with the investment information.	

	A	B	C	D	E	F	G	H	I	J	K	L
1	**Calculating Simple interest and Compound interest**											
2												
3	**Simple interest**				**Compound interest**				**Compound interest**			
4					**Compounded annually**				**Compounded quarterly**			
5	Principal (P)	10000			Principal (P)	10000			Principal (P)	10000		
6	Interest rate (R)	5.2			Interest rate per time period (r)	5.2			Interest rate per time period (r)	1.3		
7	Term (T)	10			Number of time periods (n)	10			Number of time periods (n)	40		

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING **WORKING**

STEP 4

Enter the time periods for each scenario in a column, starting from 0.

	Simple interest		Compound interest Compounded annually		Compound interest Compounded quarterly	
	Time periods	Investment value	Time periods	Investment value	Time periods	Investment value
	0		0		0	
	1		1		4	
	2		2		8	
	3		3		12	
	4		4		16	
	5		5		20	
	6		6		24	
	7		7		28	
	8		8		32	
	9		9		36	
	10		10		40	

Note: For compound interest reinvesting quarterly (compounded quarterly), the time periods will go up in 4s to represent each year.

STEP 5

The initial value of the investment (principal) goes into the first cell next to time period 0. For simple interest, type **=B5** in the appropriate cell (B11).

3	**Simple interest**	
4		
5	Principal (P)	10000
6	Interest rate (R)	5.2
7	Term (T)	10
8	**Simple interest**	
9		
10	Time periods	Investment value
11	0	=B5
12	1	

STEP 6

Calculate the simple interest investment after each time period (A) using

$A = P + I$ or

$$A = P + \frac{PRT}{100}$$

Enter the formula into cell B12 next to the first time period.

	A	B	C	D
1	**Calculating Simple interest and Compound interest**			
2				
3	**Simple interest**			
4				
5	Principal (P)	10000		
6	Interest rate (R)	5.2		
7	Term (T)	10		
8	**Simple interest**			
9				
10	Time periods	Investment value		
11	0	10000		
12	1	=$B$5+($B$5*$B$6*A12)/100		
13	2			

Note: You can use the $ symbol to lock in the cells for the principal and interest rate. The time period will be updated when you copy the formula down the column.

... continued

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING

STEP 7

Copy or fill down the formula to the remaining cells by dragging the cursor from the bottom-right corner of the first cell (B12) to the last cell (B21).

8	**Simple interest**	
9		
10	Time periods	Investment value
11	0	10000
12	1	10520
13	2	11040
14	3	11560
15	4	12080
16	5	12600
17	6	13120
18	7	13640
19	8	14160
20	9	14680
21	10	15200

STEP 8

Repeat Step 6 for the compound interest investment (compounded annually) using the formula $A = P\left(1 + \frac{r}{100}\right)^n$.

First type **=F5** into cell F11 and then type the formula into cell F12.

	E	F	G	H
	Compound interest			
	Compounded annually			
	Principal (P)	10000		
	Interest rate per time period (r)	5.2		
	Number of time periods (n)	10		
	Compound interest			
	Compounded annually			
	Time periods	Investment value		
	0	10000		
	1	=$F$5*(1+$F$6/100)^E12		
	2			
	3			

STEP 9

Copy or fill down the formula to the remaining cells by dragging the cursor from the bottom-right corner of the first cell (F12) to the last cell (F21).

Compound interest	
Compounded annually	
Time periods	Investment value
0	10000
1	10520
2	11067.04
3	11642.52608
4	12247.93744
5	12884.83018
6	13554.84135
7	14259.6931
8	15001.19714
9	15781.2594
10	16601.88488

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING

STEP 10

Repeat Step 9 for the compound interest investment (compounded quarterly) using the formula $A = P\left(1 + \frac{r}{100}\right)^n$.

First type **=J5** into cell J11 and then type the formula into cell J12.

	I	J	K
	Compound interest		
	Compounded quarterly		
	Principal (P)	10000	
	Interest rate per time period (r)	1.3	
	Number of time periods (n)	40	
	Compound interest		
	Compounded quarterly		
	Time periods	Investment value	
	0	10000	
	4	=$J$5*(1+$J$6/100)^I12	

STEP 11

Copy or fill down the formula to the remaining cells by dragging the cursor from the bottom-right corner of the first cell (J12) to the last cell (J21).

Compound interest	
Compounded quarterly	
Time periods	Investment value
0	10000
4	10530.22817
8	11088.57052
12	11676.51776
16	12295.63962
20	12947.58907
24	13634.10671
28	14357.02545
32	15118.27537

STEP 12

Compare the values of the investments after 10 years by reading the last value in each column.
Round your answers to the nearest cent.

	Simple interest		Compound interest Compounded annually		Compound interest Compounded quarterly	
10	Time periods	Investment value	Time periods	Investment value	Time periods	Investment value
11	0	10000	0	10000	0	10000
12	1	10520	1	10520	4	10530.22817
13	2	11040	2	11067.04	8	11088.57052
14	3	11560	3	11642.52608	12	11676.51776
15	4	12080	4	12247.93744	16	12295.63962
16	5	12600	5	12884.83018	20	12947.58907
17	6	13120	6	13554.84135	24	13634.10671
18	7	13640	7	14259.6931	28	14357.02545
19	8	14160	8	15001.19714	32	15118.27537
20	9	14680	9	15781.2594	36	15919.88891
21	10	15200	10	16601.88488	40	16764.00626

Value of the investment (to the nearest cent)

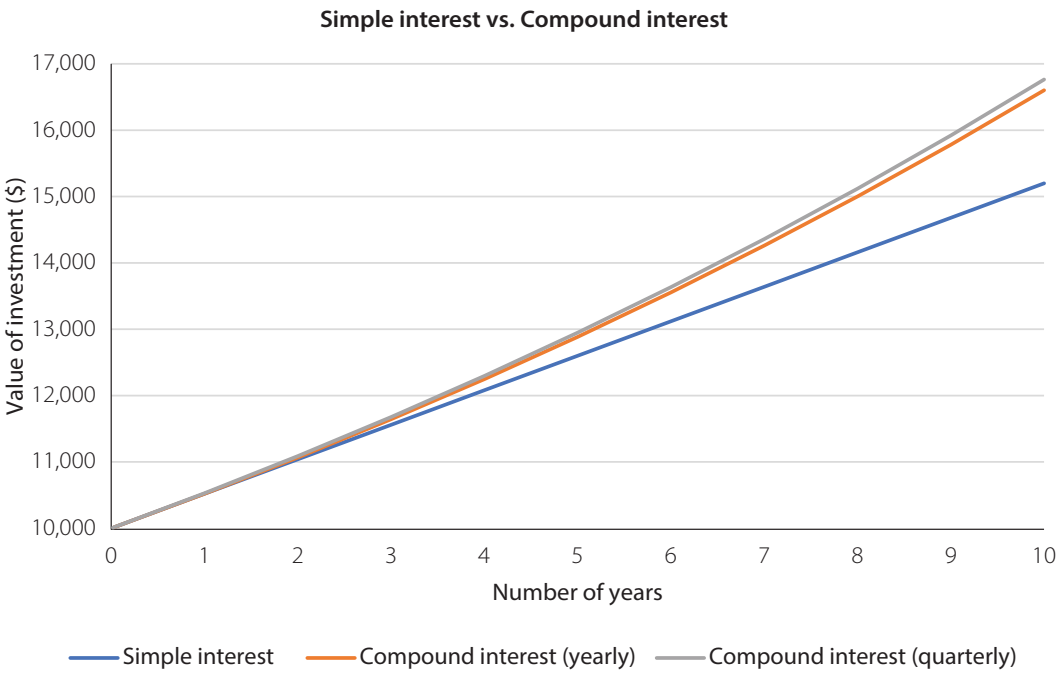
a Simple interest: $15,200.00

b Compound interest (yearly): $16,601.88

c Compound interest (quarterly): $16,764.01

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

We can visually compare how the amount of an investment increases for the simple interest (linear) and compound interest (exponential) scenarios in the previous example using a graph. This shows the compounding effect and how the increased interest continues to increase (or *compound*) as the **term** of the investment (or loan) increases.

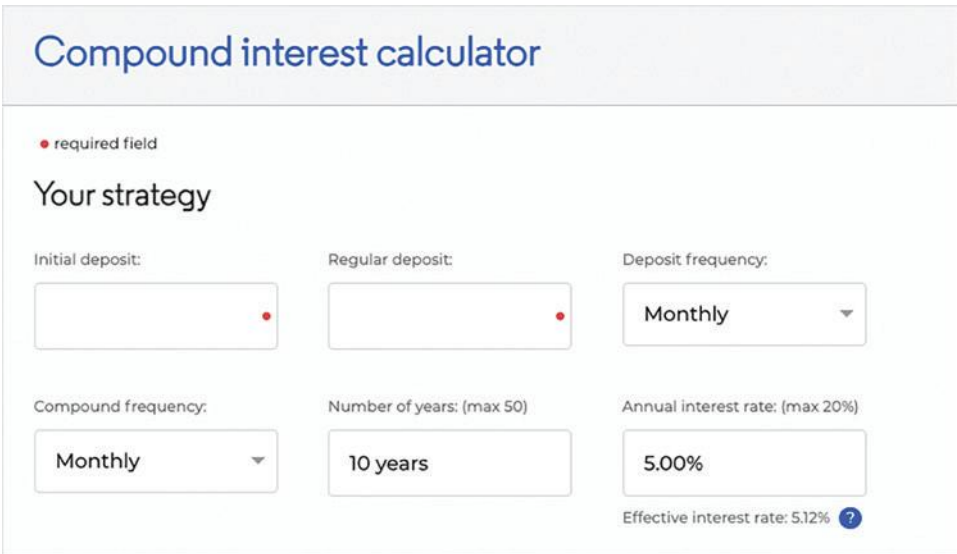


We can see from the graph that after the first year the accumulated amount including the interest earned is much higher for compound interest than simple interest, and for the two compound interest scenarios, the one with the more frequent re-investment of the interest (quarterly versus annually) also earns more money because of the compounding effect.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Online interest calculators

Fortunately, there are many online calculators that make calculating interest easy. For example, search for the compound interest calculator in the budgeting section of the Moneysmart website.



Paying off interest and fees when borrowing money

When you borrow money, you pay for the use of that money from the lending institution – the bank or building societies, credit unions and member-owned banks. There are several costs and charges associated with the loan you might take out. The cost of borrowing includes all the fees and charges that have to be paid when you borrow money.

There are basically two charges.

- The **interest rate** is the primary cost of borrowing. It represents the percentage of the loan amount that you'll pay as interest over a specific period (usually annually). The interest rate can be fixed or variable.
- The **annual percentage rate (APR)** or **comparison rate** includes not only the above interest rate (nominal rate), but also other fees and charges associated with the loan such as any set-up fees, processing fees, closing costs and more. It provides a more comprehensive view of the total cost of borrowing. The APR reflects the true cost of borrowing by considering both the interest rate and these extra charges and is the best rate to use when comparing loans.

The cost of borrowing money is expressed as a percentage of the amount borrowed (the principal). Interest rates are expressed as a percentage and calculated against the loan amount.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Simple interest loans

Example 2 Calculating simple interest and repayments on a loan

For a loan of $11,000 borrowed at a rate of 12.5% p.a. simple interest and paid back over five years, calculate the:

a total interest owed

b total debt for the five years of this loan

c monthly repayments for the five years to pay back this loan.

THINKING	WORKING
STEP 1	
Identify the values for principal (P), interest rate (R), and term or time period (T) of the simple interest investment.	$P = \$11{,}000$ $R = 12.5\%$ $T = 5$ years
STEP 2	
Substitute the known values for P, R and T into the formula $I = \frac{PRT}{100}$ to calculate I, the interest.	**a** $I = \frac{PRT}{100}$ $I = \frac{11{,}000 \times 12.5 \times 5}{100}$ $I = \$6{,}875$
Write your answer.	The total interest owed is $6,875.
STEP 3	
Use the formula $A = P + I$ to calculate A, the total amount (or total debt). Write your answer.	**b** $A = P + I$ $A = 11{,}000 + 6{,}875$ $A = \$17{,}875$ The total debt on the loan is $17,875.
STEP 4	
There are 60 months in 5 years, so divide the total debt by 60. Write your answer.	**c** 5 years = 5 × 12 = 60 months 17,875 ÷ 60 = $297.92 Monthly repayments of $297.92 are needed to pay off this loan in 5 years.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

The simple interest formula can be rearranged to change the *subject* and make it easier to calculate the principal, interest rate or time.

$I = \frac{PRT}{100}$	$P = \frac{100I}{RT}$	$R = \frac{100I}{PT}$	$T = \frac{100I}{PR}$

Example 3 Calculating the rate of interest

$5,400 is invested for six years. What simple interest rate per annum would be required to earn a total amount of interest of $712.80?

THINKING	WORKING
STEP 1	
Identify the values for P, T and I.	$P = \$5{,}400$ $T = 6$ years $I = \$712.80$
STEP 2	
Substitute the known values for P, T and I into the formula $R = \frac{100I}{PT}$ to calculate R, the interest rate.	$R = \frac{100I}{PT}$ $R = \frac{100 \times 712.80}{5400 \times 6}$ $R = 2.2$
STEP 3	
Write your answer.	The interest rate will be 2.2% p.a.

Compound interest loans

Banks and other lenders use compound interest when calculating interest charged on loans.

Compound interest is calculated on the accumulated value of the amount borrowed. The effect is that the lender charges you 'interest on the interest' as well as on the principal. The total debt is much higher than that of simple interest, but only if there are *no repayments made*. If you make repayments regularly, then the amount owing reduces and the amount of the debt decreases along with the amount of interest being charged. This will only happen if you pay off more than the extra interest amount each payment term.

In some cases, people can start off their housing loan with what is called an **interest-only loan** where you only pay back the interest amount for an initial period of the loan (for example, five years). It is a way of deferring paying off the full amount

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

of the loan (but then you need to pay the loan, and further interest, after that initial period until you have paid off the full amount). It means that, in those initial years, the repayments are lower.

And remember, as we saw previously, when you invest money, the amount you earn is much higher when it is based on compounding interest – when the money is reinvested and added on to your savings.

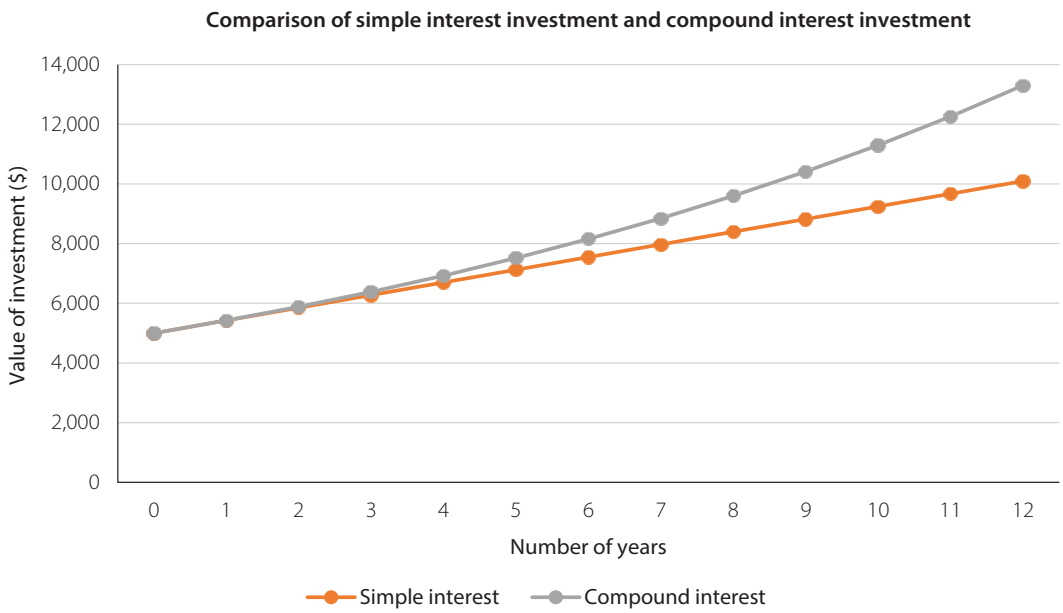
As above, the compound interest formula is exponential (to the power of n), although people mostly use online calculators these days.

$$A = P\left(1 + \frac{r}{100}\right)^n$$

We can visually compare how the amount of interest earned increases for the simple interest (linear) and compound interest (exponential) scenarios using a graph. This shows the compounding effect and how the increased interest continues to increase (or *compound*) as the term of the investment increases.

Here is an example of interest accrued on two investments of $5,000 with an interest rate of 8.5% p.a. for 12 years. One is a simple interest investment, and the other is a compound interest investment compounding yearly.

Note: Comparing loans using simple interest and compound interest would be similar if no repayments were made. However, this is not normal practice with loans, as repayments reduce the amount owing.



We can see from the graph that after the first year the accumulated amount, including the interest, is higher for compound interest than simple interest so the value of the investment increases.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Online loan calculators

It is much more efficient to use existing online interest or loan calculators. They are also available for calculating personal loans or mortgages (housing loans).

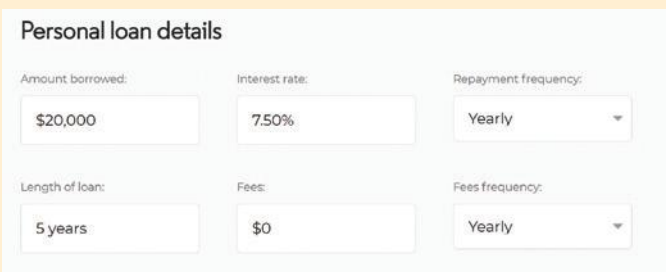
For example, there is a free one that is accessible and easy to use from the Moneysmart website. Often the interest on a loan is calculated monthly over the term of the loan.

Example 4 Calculating compound interest using an online calculator

$20,000 is borrowed for five years at an interest rate of 7.5% p.a. Use an online calculator to calculate the interest paid if the interest is:

a compounded yearly

b compounded monthly.

THINKING	WORKING
STEP 1 Identify the amount borrowed, the annual interest rate and the length of the loan from the given information.	Amount borrowed = $20,000 Interest rate (p.a.) = 7.5% Length of loan = 5 years
STEP 2 Use an online calculator such as the Moneysmart personal loan calculator to calculate the total repayments if the interest is compounded yearly. Enter the known information into the fields.	**a Interest is compounded yearly** Using the personal loan calculator on the Moneysmart website: 

Note: It is assumed that the repayment frequency (how regularly the payments are made) will be the same as the compounding period. In this case, the repayment frequency is yearly.

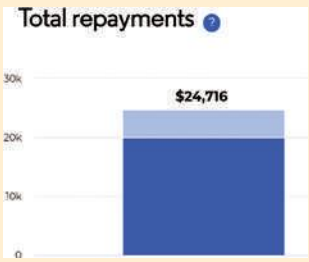
... *continued*

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING

STEP 3

Read the value for the total repayments from the graph shown below the personal loan details and then calculate the interest.

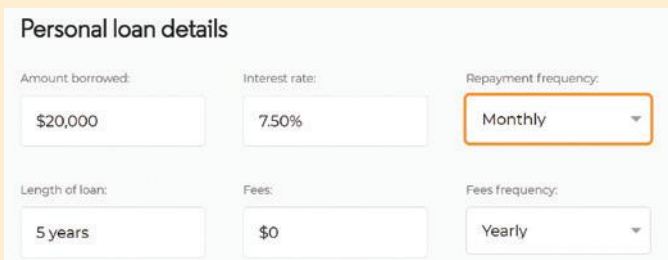


Total repayments = $24,716
Interest = total repayments – principal
= $24,716 – $20,000
= $4,716
The interest paid if the interest is compounded yearly is $4,716.

STEP 4

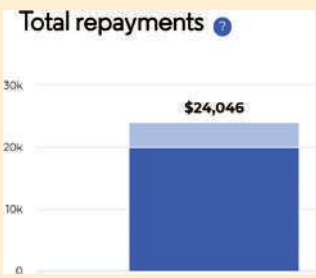
Repeat step 2 to calculate the total repayment if the interest is compounded monthly. Enter the known information into the fields. In this case, the repayment frequency is monthly.

b **Interest is compounded monthly**
Using the personal loan calculator on the Moneysmart website:



STEP 5

Read the value for the total repayments from the graph shown below the personal loan details and then calculate the interest.



Total repayments = $24,046
Interest = total repayments – principal
= $24,046 – $20,000
= $4,046
The interest paid if the interest is compounded monthly is $4,046.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Repayments

When you borrow money (take out a loan) you will usually have to start repaying that loan immediately. Loan **repayments** are calculated so that you pay off the total amount borrowed plus fees and interest in equal regular payments over the loan period.

For a simple interest loan, the repayments are calculated as follows:

$$\text{Amount of each repayment} = \frac{\text{accumulated value}}{\text{number of repayments}}$$

Example 5 Calculating repayments for a simple interest loan

A simple interest loan of $12,300 is borrowed at an interest rate of 13.2% p.a. The loan is to be paid off completely in five years.
Calculate the monthly repayments to be made.

THINKING	WORKING
STEP 1	
Identify the principal (P), the interest rate (R) and the term of the loan in years (T).	$P = \$12{,}300$ $R = 13.2\%$ $T = 5$
STEP 2	
Use the simple interest formula to calculate I, the interest.	$I = \frac{PRT}{100}$ $I = \frac{12{,}300 \times 13.2 \times 5}{100}$ $I = \$8118$
STEP 3	
Use the formula $A = P + I$ to calculate A, the accumulated value (total debt or total amount).	$A = P + I$ $A = 12{,}300 + 8118$ $A = \$20{,}418$
STEP 4	
For monthly repayments, calculate the number of months in 5 years.	5 years = 5 × 12 months = 60 months
STEP 5	
Calculate the monthly repayment by dividing the total debt by 60.	Monthly repayment = $\$20{,}418 \div 60$ $= \$340.30$ To pay off this loan in 5 years, $340.30 needs to be paid each month.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Repaying compound interest and house mortgages

Calculating the repayments for a compound interest loan is more complex. This is because the interest is calculated on the changing **balance** of the loan. This type of loan is called a **reducing balance loan**. This is complex, both because the interest for each term needs to be calculated each and every time on the balance owing (which has to take into account how much you have paid off the loan during that term), as well as adding on any monthly or quarterly fees that the bank charges you.

These cases are beyond the scope of our course to work out manually or by using a spreadsheet (although it can be done), but you can find calculators online that will do this for you. For example, search for the mortgage calculator in the home loan section of the Moneysmart website.

9C Tasks and questions

Thinking task

1 If you had some surplus money to use for longer term investment, would you invest in stocks and shares? Why or why not? What would you invest in and why?

Skills questions

2 Use an online calculator to calculate the compound interest earned for the following investments.

- **a** $4,500 invested at 3.9% p.a. for three years compounded annually
- **b** $12,400 invested at 4.5% p.a. for 10 years compounded annually
- **c** $10,000 invested at 4.8% p.a. compounded quarterly for 10 years

3 $25,000 is invested for five years at an interest rate of 5.25% p.a. Use a spreadsheet to calculate the value of the investment if the interest is:

- **a** simple interest
- **b** compound interest reinvested annually
- **c** compound interest reinvested quarterly.

4 Calculate the term of a loan where the principal is $5,000, the simple interest rate is 12.5% p.a. and the amount of interest charged is $3,125.

5 Calculate the principal of a loan when the simple interest rate is 11.95% p.a., the interest charged is $2,151 and the term of the loan is three years.

6 Calculate the simple interest rate on a loan of $3,500 with a term of three years and the interest charged is $1,281.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

7 You are thinking of borrowing $8,000 to buy a car and are confident that you can pay off the debt in four years.

- **a** If the simple interest rate is 13.5% p.a., how much interest will be charged?
- **b** What will be your total debt?
- **c** Calculate your monthly repayment.

Mixed practice

8 Lee has invested $3,000 in 'Blue Chip' shares, which are paying an annual interest rate (called *dividend rate*) return of 8.99% p.a. (compounded annually) Use an online compound interest calculator to answer these questions.

- **a** How much could these shares be worth in five years?
- **b** How much profit could Lee make through this investment?

9 Having done some research, you calculate that to completely replace your gaming rig you will need to borrow $3,500. Your bank is offering you a 2-year loan at the simple interest rate of 12.75% p.a.

- **a** Use a spreadsheet to calculate the amount of interest you will be charged.
- **b** What will be your total debt?
- **c** Calculate your monthly repayment.

10 Steph wants to invest her $10,000 inheritance for five years.

- **a** How much interest will she be paid if the compound interest rate is 4.75% p.a., compounded quarterly?
- **b** What is the value of her investment at the end of the five years?

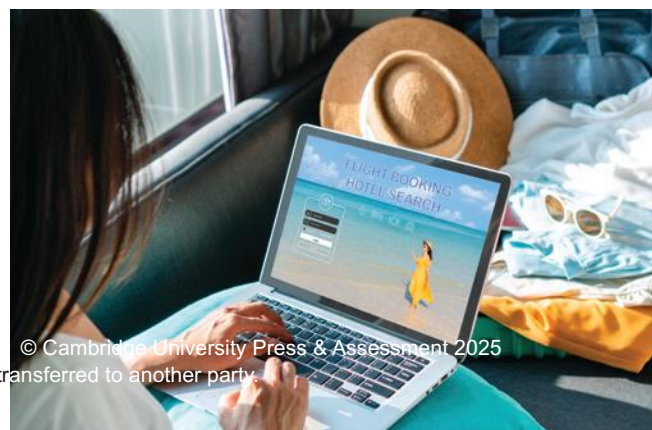
11 Dan has invested $11,000 in shares, which are paying an annual dividend rate of 11.89% p.a. Use an online compound interest calculator to answer these questions.

- **a** How much should these shares be worth in three years?
- **b** How much profit will Dan make?

12 You are offered the following loans to pay for a holiday. The total amount that you intend to borrow is $12,000. Which is the better deal? Why?

Option A: A simple interest loan at 13.2% p.a. paid off over three years.

Option B: A simple interest loan at 14.8% p.a. paid off over two years.



ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mathematical literacy

13 Use the words in the box to complete the sentences below.

comparison	repayments	interest	fees	years
borrowed	divide	principal	nominal	

a The _____ is the amount of money that you have _____.

b The _____ rate is the percentage per annum.

c The number of _____ is the period of the loan.

d The _____ rate of the loan is the _____ interest rate plus any _____ and charges applied by the lender.

e To calculate the monthly _____ that you will have to make, you _____ the total loan amount by the number of months.

Application tasks

14 Hillary deposits her birthday money of $8,350 into a term deposit bank account earning a compound interest rate of 4.25% p.a., compounding yearly.

a How much interest will the account earn in four years?

b How much money will have accumulated after four years?

c What would be the difference in the amount of interest if the interest was accumulated quarterly?

15 You want to buy a house for $750,000 and have $25,000 in savings.

- Super Bank is offering you a loan at 8.6% p.a. over 30 years.
- Whole Homes Bank is offering you a loan at 9.5% p.a. over 25 years.

Assume that both banks also charge a $10 monthly fee and that you will make monthly repayments. Put both loans through an online mortgage calculator, or use a spreadsheet, to analyse and compare these two loans, and answer the following questions. Give your answers to the bearest dollar.

a What will be the monthly repayments on the Super Bank home loan?

b What will be the monthly repayments on the Whole Homes Bank loan?

c What is the total in interest and fees charged by Super Bank?

d What is the total in interest and fees charged by Whole Homes Bank?

e Based on monthly repayments and total interest charged, which loan would you choose?

f What other information should you investigate before choosing a home loan?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9D Comparing credit options

When you use any form of credit you are placing yourself into debt. This is not necessarily a bad thing, but you do need to know the risks – one of which is that the interest rate on your loan or **credit card** can increase and if it does, you have no option but to accept this higher cost of borrowing.

Inflation, setting interest rates and more

To understand how interest rates on credit and loans affect you, we need to understand the difference between real interest rates, nominal interest rates and inflation. Inflation is the increase in the price of goods and services. It can be measured as a rate of the change in costs.

The **Consumer Price Index (CPI)** is a measure that examines the average change in prices paid by consumers for goods and services over time. It is a commonly used indicator for **inflation** and is essential for assessing changes in the cost of living for households. The CPI is calculated by comparing the current prices of a representative basket of goods and services to the prices of the same items in a base year.

When inflation goes up, the cost of goods and services go up.

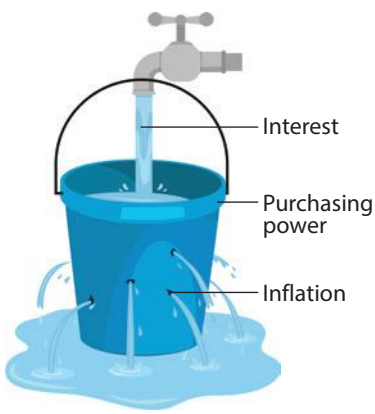
When prices increase, your purchasing power (ability to buy) decreases.

If your income does not rise in line with inflation, you can be a lot worse off!

The opposite of inflation is **deflation.** This is the situation where the price of goods and services falls over time.

The bucket represents your purchasing power, which is what your money can buy you.

- If the volume of water filling the bucket (interest) is greater than the volume of leaking water (inflation) then the bucket will have more and more purchasing power.
- If the volume of water filling the bucket (interest) is less than the volume of leaking water (inflation) then your bucket will have less and less purchasing power.
- If the volume of water filling the bucket (interest) and the volume of leaking water (inflation) are about the same, then the bucket will retain the same purchasing power.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

The **nominal interest rate** is the official rate that is advertised, and the rate that you hear about in the media. However, if we take the bucket into account and consider inflation as part of the equation, then we have the **real interest rate**.

Real interest rate = nominal interest rate – inflation rate

For example, if you have saved a deposit of $8,000 and there is a nominal interest rate of 4.5% p.a. and an inflation rate of 7.5% p.a., then:

Real interest rate = nominal interest rate – inflation rate

Real interest rate = 4.5% – 7.5%

Real interest rate = –3% p.a.

That is, your purchasing power is **less** for the same amount of money.

Conversely, if you have saved a deposit of $8,000 and there is a nominal interest rate of 8.5% p.a. and an inflation rate of 7.2% p.a., then:

Real interest rate = nominal interest rate – inflation rate

Real interest rate = 8.5% – 7.2%

Real interest rate = +1.3% p.a.

That is, your purchasing power is **greater** for the same amount of money.

Now imagine that instead of having saved that money, you are borrowing instead.

If you **borrow** $8,000 and there is a nominal interest rate of 12.5% p.a. and an inflation rate of 7.9% p.a., then:

Real interest rate = nominal interest rate – inflation rate

Real interest rate = 12.5% – 7.9%

Real interest rate = 4.6% p.a.

The **Reserve Bank of Australia (RBA)** sets the official cash rate (OCR). The OCR is the interest rate at which the RBA lends money to commercial banks. It serves as a benchmark for other interest rates in the economy. When the RBA adjusts the OCR, it influences borrowing costs for households, businesses and financial institutions.

Lending institutions such as banks always offer an interest rate which is higher than this as they factor in a margin to make a profit.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Credit cards

Credit cards are part of everyday life. The most common ones are Visa and Mastercard. They let you carry less cash, pay for things with a tap or a swipe, and shop online. But they can be expensive if used unwisely, as their interest charges and fees can be very high. The trick is to use your credit card wisely and pay it back on time.

Have you looked closely at the information a credit card statement provides you about how much you might need to pay in relation to interest charges?

Look at the credit card statement shown and work with another one or two students to discuss and answer the following questions.

- How much was still owing at the end of the month?
- How much is the minimum payment due?
- If you only keep paying the minimum amount each month, (and do not purchase any more goods or services), how long would it take to pay off this amount?
- How much are the total interest charges if this is the case?
- Are you surprised by the interest charges and how much extra you pay? What is this as a percentage of the initial amount owing on the credit card?
- Is this simple or compound interest?

Account	Opening Balance	Total Debits	Total Credits	Closing Balance
Credit Card	1,855.56	8,350.88	5,900.00-	4,306.44

Payment Summary	
Overdue Amount - Pay Now	NIL
Minimum Payment Due	$107.66
Minimum Payment Due Date	24 March 24

Minimum Repayment Warning: If you make only the minimum payment each month, you will pay more interest and it will take you longer to pay off your balance.

For example:

If you make no additional charges using this card and each month you pay >	You will pay off the Closing Balance shown on this statement in about >	And you will end up paying estimated total interest charges of >
Only the minimum payment >	5 years 2 months >	$2,344.48
$214.84	2 years	$849.32, a saving of $1,495.16

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Hints for sensible use of credit cards

- Can you pay the full balance each month? If you think you can, consider a credit card with more interest-free days. This means you won't pay interest as long as you pay the balance within a set number of days (for example, 55 days). These cards may have a higher interest rate and an **annual fee**, but that could be worth it.
- Is it unlikely you can pay the full balance each month? If this is the case, look for a no-frills card with a low or no-interest rate and a low annual or flat monthly fee.

When you do an internet search on credit cards that are available, you can be overwhelmed by the sheer variety and the number of options.

Here are some questions to help you decide which card is best for you.

- What are the annual fees charged for the use of the card?
- Does the card have an interest-free period? How long is it?
- What is the charge for a missed or late payment?
- What is the charge for a cash withdrawal?
- What is the interest rate on things you buy (purchases)?
- Does the card have add-ons like fly-buy points?

Moneysmart, a government website, is a current and reliable resource to help Australians make informed decisions about credit cards and debt. (Search for 'credit cards' on the Moneysmart website.)

Making decisions

Home loans may have a **fixed interest rate** or a **variable interest rate**. Fixed rates are generally higher than variable rates. There is less risk to the borrower with a fixed rate as the amount of interest the borrower will pay is set for a period of time.

You should check the following.

- What is the interest rate?
- How long will you have this interest rate? Is it fixed or variable?
- What is the length of the loan?
- Is there an early exit fee?

In Australia, home loan lenders must display a comparison rate. This is the interest rate which is meant to reflect the true cost by including the interest rate AND all the fees and charges. This can also be called the annual percentage rate (APR).

The Moneysmart website also has lots of useful information including online calculators, as you saw in the previous section.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9D Tasks and questions

Thinking tasks

1 Are credit cards structured to keep you in debt? How do the interest rate charges on credit cards compare with other ways of borrowing money? Share and compare your thinking with your classmates.

Skills questions

2 **a** Calculate the real interest rate you would be charged in the following situations.

i Nominal interest rate of 6% p.a., inflation rate 2.5% p.a.

ii Nominal interest rate of 7.8% p.a., inflation rate 1.3% p.a.

iii Nominal interest rate of 2.5% p.a., inflation rate 3.5% p.a.

b Which of the above situations is unrealistic? Why?

Use the Moneysmart personal loan calculator to answer questions **3** and **4**.

3 Jax and Jill are thinking about redecorating their bedroom using a credit card because they are confident that they can pay it off in a year.

a What will it cost for Jax and Jill to buy a $1,250 bedroom suite if the interest rate on their credit card is 19.74% p.a. compounded monthly, and the annual fee is $60? Assume that they do not purchase anything else.

b How much extra have Jax and Jill paid because they used a credit card?

4 Liem wants to kit out the electronics in the living room and has planned to clear this debt in two years.

a Calculate the minimum monthly repayment if Liem buys goods totalling $3,700 on a credit card with an interest rate of 20.24% p.a. and an annual fee of $75. Assume that they do not purchase anything else.

b How much extra has Liem paid because they used a credit card?

Mathematical literacy

5 There are lots of different words and terms related to credit cards, loans and repayment options. Some of these include: interest rates, fixed rates, variable rates, term, repayments.

Work with some classmates to brainstorm all the terms you can find and what they mean. Create a word cloud using an app like *mentimeter*, *Wordart*, *WordClouds*, or *WordIt Out*. These could be keywords, concepts, or specific terms. Share your word cloud with the rest of the class.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Application tasks

6 What are two benefits of making fortnightly (rather than monthly) repayments on a personal loan?

7 Consider the need to borrow $6,000 for three years. Research the loan conditions of two banks and two non-bank financial providers. Use an online personal loan calculator to find the total cost of each loan from the different providers.

	Bank 1	Bank 2	Lender 3	Lender 4
Application cost				
Interest rate				
Loan fees and charges				
Total cost of the loan				

8 Use the information you can find on the internet to complete the following table.

Type of credit	Sources (URL)	Typical amount you can borrow	Typical time period for the loan	Typical interest rate charged	Advantages of this type of credit	Disadvantages of this type of credit
Payday lender						
Store credit						
Credit card						
Personal loan						
Mortgage loan						

9 Payday lenders have slick websites and apps that promise you quick and simple loans. Consider the situation where Alba needs to pay $1,000 for some unexpected medical expenses and wants to use a Payday lender.

- **a** Use the internet to find at least two Payday lenders.
- **b** What is the maximum that you can borrow from each Payday lender?
- **c** What is the establishment fee for each?
- **d** What is the monthly fee for each?
- **e** Are the Payday lender companies the actual holders of the debt?
- **f** Explain the risks, costs and benefits of Alba using a Payday lender.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9E Student loan schemes

If you continue studying after you have finished secondary school, there are a number of options available to you such as TAFE or university. Often these courses can be quite expensive. The Australian Government offers loans to eligible students to make it easier for Australians to participate in higher education.

There are several different loans available depending on your personal circumstances and the type of further education that you have chosen. These include:

- Higher Education Loan Program (HELP)
- VET Student Loans (VSL) program.

There are also Youth and Study Allowances available. Students of a certain age have access to special government allowances. This is designed to support students and allow them to focus on their studies and goals rather than having to also find work. So, if you're studying, training or doing an Australian Apprenticeship, you may be able to apply for one of these payments:

- **Youth Allowance** for students and apprentices is financial help if you're a student or apprentice aged 24 or younger. Anyone who reaches the minimum school leaver age in their state/territory may apply. You must be either studying full-time or doing a full-time Australian apprenticeship.
- **Austudy** is financial help if you're 25 or older and studying or completing an Australian Apprenticeship.
- **ABSTUDY** is a group of payments for Aboriginal and Torres Strait Islander students or apprentices.

For official information about study allowances, you can visit the education section of the Services Australia website.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Higher Education Loan Program (HELP)

The higher education loan program is available to eligible students to assist with the costs of studying. The Government pays a **proportion** of your fees, and when you finish your course, start working and are earning above a set wage (called a **threshold**), you pay the money back at a percentage rate of your income. This payment automatically comes out of your wage via the taxation system.

More details can be found by searching online for the higher education loan program. This will lead you to the Australian Government Department of Education website.

VET Student Loans (VSL) program

Similar to the HELP scheme, the VET Student Loans (VSL) program assists eligible students pay tuition fees for approved higher-level (diploma and above) vocational education and training (VET) courses, when studying at VET Student Loans approved course providers. The program is designed to provide financial support to students undertaking higher level training in courses that address workplace and industry needs, creating better opportunities for employment.

More details can be found by searching online for VET student loan. This will lead you to the Australian Government Department of Employment and Workplace Relations website.

Trade Support Loans (TSL)

Trade Support Loans are available to eligible apprentices to cover the cost of living while completing their apprenticeship. In 2024, you could borrow up to $24,492 over the duration of your apprenticeship. There is also a 20% discount if you complete your apprenticeship. Loans are paid back through the tax system in the same way as HELP debts. If you earn above a certain wage (threshold), your repayments will be charged as a percentage (rate) of your income.

More details can be found by searching online for Australian apprenticeship support loans. This will lead you to the Australian Government Department of Employment and Workplace Relations website.

How do the loans work?

These student loans are quite different to loans that you might get from a lending institution.

- There is a cap on the amount of money the government will lend to pay for fees.
- No interest is charged on a student loan. However, the loan debt is indexed up on 1 June every year to keep up with inflation.
- You are only required to repay the loan when you are earning above a certain amount.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

When you start working after finishing your course, you are required to notify your employer that you have a student loan debt so that the employer withholds the correct amount of your gross income to be paid to the tax office.

The threshold (minimum amount you have to earn before paying your student loan debt back) and rates (the percentage of your wage to be paid) for the 2024–25 financial year from the **Australian Tax Office (ATO)** are shown below. (The most current threshold and rates can be found on the ATO website.)

Repayment income thresholds and rates 2024–25	
Repayment income (RI)	**Repayment rate**
Below $54,435	Nil
$54,435 – $62,850	1.0%
$62,851 – $66,620	2.0%
$66,621 – $70,618	2.5%
$70,619 – $74,855	3.0%
$74,856 – $79,346	3.5%
$79,347 – $84,107	4.0%
$84,108 – $89,154	4.5%
$89,155 – $94,503	5.0%
$94,504 – $100,174	5.5%
$100,175 – $106,185	6.0%
$106,186 – $112,556	6.5%
$112,557 – $119,309	7.0%
$119,310 – $126,467	7.5%
$126,468 – $134,056	8.0%
$134,057 – $142,100	8.5%
$142,101 – $150,626	9.0%
$150,627 – $159,663	9.5%
$159,664 and above	10%

Source: Australian Tax Office (ATO)

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

The repayment thresholds and rates are updated annually for the compulsory repayment of:

- Higher Education Loan Program (HELP)
- VET Student Loan (VSL)
- Student Financial Supplement Scheme (SFSS)
- Student Start-up Loan (SSL)
- ABSTUDY Student Start-up Loan (ABSTUDY SSL)
- Trade Support Loan (TSL).

Note: The following examples are based around the HELP scheme, but they apply in exactly the same way to the VSL and TSL schemes.

Example 6 Calculating the amount of a HELP loan to be repaid in a tax year

Fadumo completed an engineering degree at Deakin University with a HELP loan to pay for her fees. In her first year as an engineer her taxable income for the financial year 2024–25 was $80,650.
Will she be required to pay any of her HELP debt back? If so, how much?

THINKING	WORKING
STEP 1	
Use the ATO table to check the repayment income threshold and rate.	Repayment income threshold: $79,347 – $84,107 Repayment rate: 4.0% p.a.
STEP 2	
Use the rate to calculate the repayment percentage of Fadumo's income.	Repayment = 4.0% of $80,650 = 0.04 × $80,650 = $3,226
STEP 3	
Write your answer.	Fadumo will need to pay $3,226 of her HELP debt back via the income tax system in the 2024–25 financial year.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 7 Determining if HELP debt is to be paid in a financial year

Nick studied for three years and took a HELP debt to pay for his fees. He then took a summer job to save up money to travel around Australia. He earned $42,890 during the time he worked over the summer of 2024–25 and his employer withheld his HELP debt from his wage during this time.
Will Nick be required to pay his HELP debt for the financial year 2024–25, and if so, how much will his repayment be?

THINKING	WORKING
STEP 1	
Use the ATO table to check the repayment income threshold.	The amount Nick earned ($42,890) was below the payment threshold for the 2024–25 financial year ($54,435).
STEP 2	
Write your answer.	Nick is not required to pay his HELP debt during the 2024–25 financial year and he will have the tax he has paid returned in his 2024–25 tax return.

Indexation

HELP loans do not accrue interest like a loan you might get from the bank, but they are indexed each year based on the Consumer Price Index (CPI). Any debt that is yet to be paid which is more than 11 months old on 1 June is increased by the **indexation** rate. The table below shows the indexation rates for years 2013 to 2024. (The most current rates can be obtained from the study and training indexation rates section of the ATO website.)

Indexation rate table

Year	Indexation rate
2024	4.7%
2023	7.1%
2022	3.9%
2021	0.6%
2020	1.8%
2019	1.8%

Year	Indexation rate
2018	1.9%
2017	1.5%
2016	1.5%
2015	2.1%
2014	2.6%
2013	2.0%

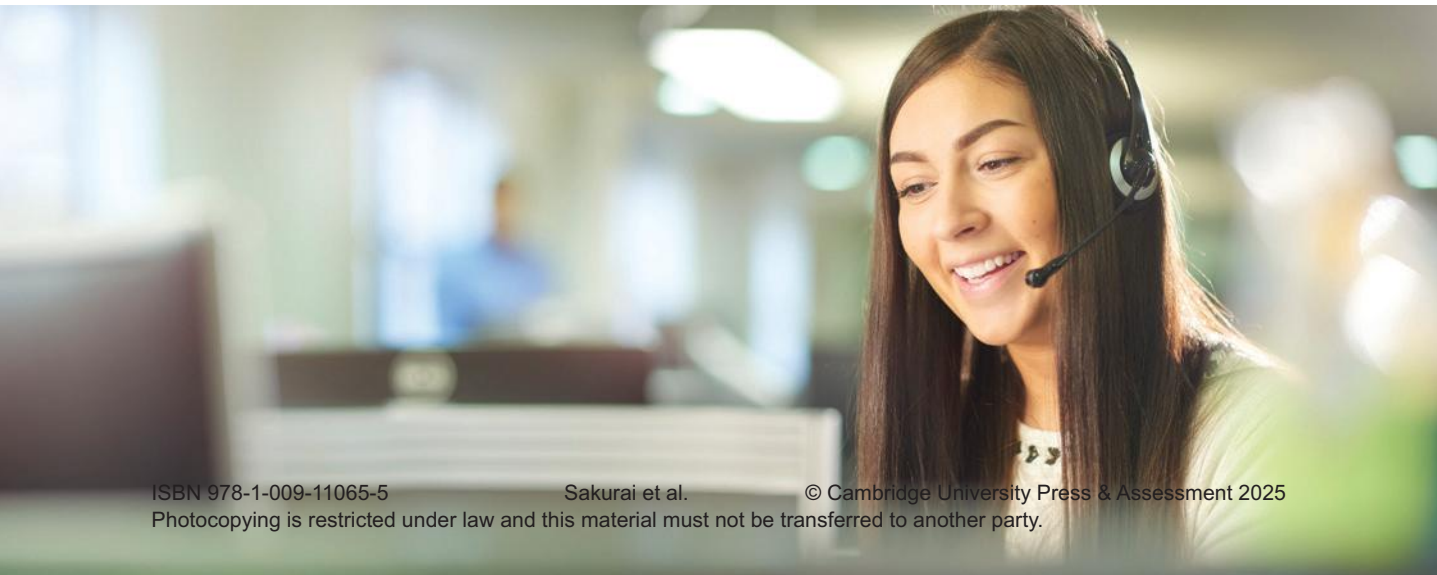
Source: Australian Tax Office (ATO)

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 8 Calculating indexing on HELP debt

Malika finished studying at the end of semester 1 in 2023 and at that time her HELP debt balance was $23,980. During the following year she worked part-time and did not earn above the threshold for repaying her HELP debt.
On 1 June 2024, will Malika's HELP debt be indexed? If so, by how much?

THINKING	WORKING
STEP 1	
Check whether Malika's debt is more than 11 months old. Consider the time from the end of semester 1 in 2023 to 1 June 2024.	Malika's debt is more than 11 months old, so it will be indexed.
STEP 2	
Check the 2024 indexation rate.	Indexation rate is 4.7% p.a.
STEP 3	
Apply the indexation rate to Malika's HELP debt. Round the answer to the nearest dollar.	Increase to debt = 4.7% × $23,980 = 0.047 × $23,980 = $1,127.06 ≈ $1,127
STEP 4	
Add the indexation amount to the original debt balance.	New debt balance = $23,980 + $1,127 = $25,107
STEP 5	
Write your answer.	Malika's new HELP debt will be $25,107.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9E Tasks and questions

Thinking task

1 Would it be better to pay off your student debt as quickly as possible, or use the money to fund lifestyle scenarios like buying a better car or putting a deposit on a house? Share and compare your thoughts with your classmates.

Skills questions

2 Emily completed a Bachelor of Computer Science degree at the end of 2023 and earned $85,250 gross in the 2024–25 financial year.

- **a** Use the ATO table to see if she is required to pay any of her HELP debt back.
- **b** What is the repayment percentage rate for her?
- **c** Calculate the amount that her employer must withhold to meet her HELP debt requirements.

3 Jing completed his apprenticeship in carpentry in April 2023, accruing a VET student loan of $10,800. In his first year of working, he earned $43,966 gross in the 2024–25 financial year.

- **a** Use the ATO table to find if he must start paying this loan back.
- **b** Would the indexation rate apply to Jing on 1 June 2024?
- **c** If Jing has not made any voluntary repayments, how much is his student loan debt on 1 June 2024?

4 Akito finished his Masters of Education degree in December 2022, accumulating a HELP debt of $58,000. He took time off to travel before starting work. In the 2024–25 tax year, he earned $78,500 across the year.

- **a** Use the ATO table to see if he must start paying back this loan.
- **b** What is the repayment percentage rate for his HELP debt in the 2024–25 tax year?
- **c** Based on the value in part **b**, calculate the amount that his employer should withhold to pay back this debt.
- **d** Is Akito's debt older than 11 months at 1 June 2024? If so, what indexation rate would apply to his HELP debt?
- **e** Apply the indexation rate to calculate Akito's increased HELP debt on 1 June 2024.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

5 Jo finished her plumbing apprenticeship in February 2022, accruing a VET student loan debt of $15,250. She is now in her fourth year of working, earning $59,000 gross per annum.

a Use the ATO table to find the repayment percentage rate for her student loan debt in the 2024–25 financial year.

b Based on your answer to part **a**, calculate the amount that should be withheld in the 2024–25 financial year to pay back some of this debt.

c Since finishing her apprenticeship, in which of the years 2022, 2023 and 2024 would her debt have been indexed on 1 June? List the rate for each of the years that indexation would have been applied to her student loan debt.

Application tasks

6 Fatima finished her apprenticeship in painting and decorating in June 2024, accruing a VET student loan of $9,500. In her first year of working, her gross income was $68,500. When she submitted her tax return to the ATO for the financial year 2024–25, she found that her employer had withheld $1,900 towards her VET debt.

a Is this amount correct?

b If it is not, what would you advise Fatima to do?

7 Joe, who is 20 years old, is working as a labourer for a landscaping company. He is being paid $29.50 per hour for a 40-hour week. His boss wants him to do an apprenticeship.

a What would be the short-term advantages for Joe if he does an apprenticeship?

b What would be the short-term disadvantages for Joe if he does an apprenticeship?

c What would be the long-term advantages for Joe if he does an apprenticeship?

d What would be the long-term disadvantages for Joe if he does an apprenticeship?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9F Wage growth and the cost of living

When inflation goes up, workers expect that their wages will also rise to keep up with changes in the cost of living.

An 'award' is a legal document that outlines the minimum terms and conditions of employment for a specific industry or occupation. Awards establish the baseline standards for wages, working hours, leave entitlements and other employment conditions.

Wage indexation

Wage indexation refers to the automatic adjustment of wages or salaries in response to changes in a specific economic indicator, often the Consumer Price Index (CPI). The purpose of wage indexation is to help protect workers' purchasing power, so they can continue to afford essentials like housing, utilities and health care.

This is why most awards specify an annual percentage increase in wages.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 9 Calculating an award annual percentage increase

Ben works in construction, earning $69,000 gross per annum. The award stipulates a 1.6% increase each year for the next three years.
Work out his gross wage for each of the next three years.

THINKING	WORKING
STEP 1	
List Ben's starting gross wage.	Starting gross wage = $69,000
STEP 2	
Calculate 1.6% of this wage to work out the increase to Ben's gross wage.	Increase for first year = 1.6% of $69,000 = 0.016 × $69,000 = $1,104
STEP 3	
Add the increase to get his wage in the first year of the award.	Gross wage in first year = $69,000 + $1,104 = $70,104
Note: On a smartphone, you can combine steps 2 and 3 as: 69 000 + 1.6%.	
STEP 4	
Calculate 1.6% of the first year's gross wage to work out the increase for the second year.	Increase for second year = 1.6% of $70,104 = 0.016 × $70,104 = $1,121.66 (rounded to the nearest cent)
STEP 5	
Add the increase to get his wage in the second year of the award.	Gross wage in second year = $70,104 + $1,121.66 = $71,225.66
STEP 6	
Calculate 1.6% of the second year's gross wage to work out the increase for the third year.	Increase for third year = 1.6% of $71,225.66 = 0.016 × $71,225.66 = $1,139.61 (rounded to the nearest cent)
STEP 7	
Add the increase to get his wage in the third year of the award.	Gross wage in third year = $71,225.66 + $1,139.61 = $72,365.27
STEP 8	
Write your answer.	Over the three years of the award, Ben receives annual gross wages of $70,104, $71,225.66 and $72,365.27.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Note that this means Ben's salary is growing based on compounding percentage growth – so it is just like compound interest.

Consumer Price Index (CPI)

Similarly, inflation means that the prices of goods and services can increase, and this is also based on an annual percentage-based rate.

The annual Consumer Price Index (CPI) inflation rate in Australia is calculated based on changes in the cost of a representative basket of goods and services over time. These items include everyday expenses like food, housing, transportation and health care. The annual CPI inflation rate was 3.6% in the March 2024 quarter.

The CPI is often used in setting planned increases, such as in the case of wage rises. Other areas where this can be applied are:

- pensions and allowances
- utility companies like gas and electricity where they may apply a percentage increase
- government or business contracts where price index clauses can be included.

Often these allowances or contracts tie prices to specific indices (e.g. CPI) and adjust them periodically.

They also may rise by different percentage rates per time period, so if this is the case you cannot use the standard compound interest formula for this scenario but should calculate and add on the change for each time period.

Example 10 Applying an annual percentage increase to goods or services

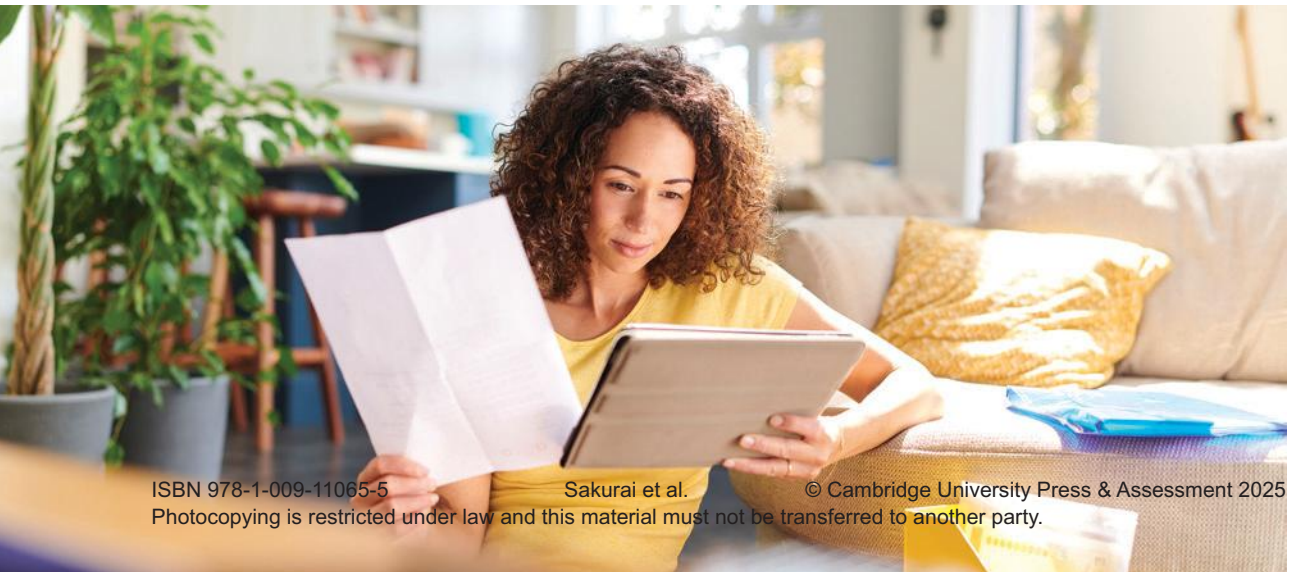
Daria is working on her budget and wants to estimate her ongoing costs over the next two years.
Her utility supplier for both gas and electricity has said that their prices will increase by the current CPI rate each year. In the coming year, it will increase by 3.6%, and Daria assumes that the CPI rate will be slightly less the following year and estimates it to be an increase of 3.2%.
Daria works out that her current annual expenditure for this company is $1,250. What will be her estimated annual utility costs after the two years of CPI-based increases?

THINKING	WORKING
STEP 1	
List Daria's current annual expenditure (cost) for her utilities (gas and electricity).	Current annual utility cost = $1,250

... continued

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 2	
Calculate 3.6% of this expenditure to work out the CPI-based increase for the coming year (first year).	Increase for first year = 3.6% of $1,250 = 0.036 × $1,250 = $45
STEP 3	
Add the increase to get the annual expenditure in the first year.	Annual utility cost in first year = $1,250 + $45 = $1,295
Note: On a smartphone, you can combine steps 2 and 3 as: 1250 + 3.6%.	
STEP 4	
Calculate 3.2% of the first year's annual cost to work out the CPI-based increase for the second year.	Increase for second year = 3.2% of $1,295 = 0.032 × $1,295 = $41.44
STEP 5	
Add the increase to get the estimated annual expenditure in the second year.	Annual utility cost in second year = $1,295 + $41.44 = $1,336.44
Note: On a smartphone, you can combine steps 4 and 5 as: 1 295 + 3.2%.	
STEP 6	
Write your answer.	Daria's estimated annual utility costs after the two years of CPI-based increases will be $1,336.44.



ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9F Tasks and questions

Thinking task

1 What do you know about the CPI? Do you know what the 'representative basket of goods and services' includes? Research about the calculation of the CPI and find out what is included in the 'basket of goods and services'. Are you surprised by what is included? Do you think it is representative? What goods and services have changed the most over recent years? Have any prices reduced? Does the CPI always go up and have a positive value? Share your findings with other students.

Skills questions

2 Ravi earns an annual gross wage of $75,500. His award has a built-in annual increase of 1.4% for four years.

a Calculate Ravi's gross wage in:

i the first year

ii the second year

iii the third year

iv the fourth year.

b Calculate the increase in Ravi's gross wage over the four years.

3 Laila is currently paid an hourly rate of $26.50. Her award states that this will increase by 2.1% for each of the next three years.

a What will be Laila's rate of pay after the third year?

b What is the increase in her rate of pay over the four years?

4 A business contract has a clause that states that the annual fee for the service will increase by 3.1% in the first year, followed by annual increases of 2.5% in the following two years. The current annual service fee is $25,750.

a Calculate the annual service fee for each of the following three years.

b What is the increase in the annual service fee over the period?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

5 An award has a built-in annual increase of 2.1% for the first two years, followed by an annual increase of 1.5% for the following two years. The current salary is $95,745 gross p.a.

a What will be the gross salary in the second year of the award?

b What will be the gross salary in the fourth year of the award?

c Calculate the increase in the gross salary over the four years of the award.

6 In its contract with customers, a business states that it will increase its annual service fee by 1.8% in the following three years. Their current annual service fee is $750.

a Calculate the annual service fee for each of the following three years.

b What is the increase in the annual service fee over the period?

Application tasks

7 Khanh is comparing two jobs. The starting annual salary is different, and the employers are also offering different percentage increases per year for the following four years.

Employer A	Employer B
Starting salary: $78,500	Starting salary: $76,500
Annual % increase: 2.5%	Annual % increase: 3.5%

Calculate and compare the incomes for each year, and answer the following questions.

a Which job pays the most in the fifth year?

b Which job would you recommend Khanh choose and why?

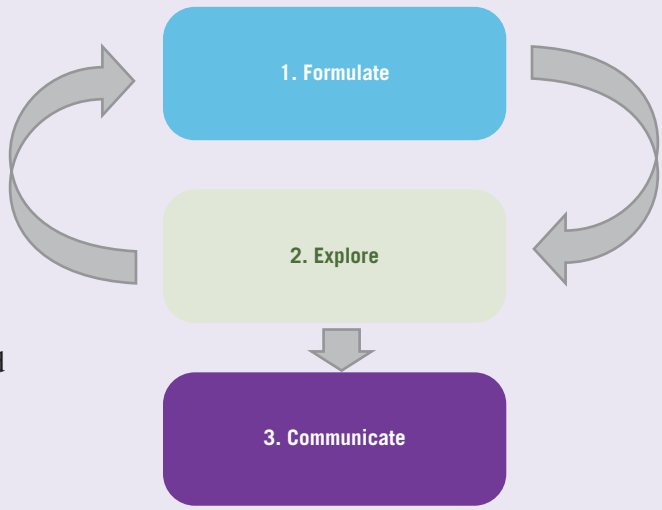
8 Create, either by hand or using a computer, a collage of the aspects of personal finances that you think students need to know. Include information on interest rates and loans, repayments, and wage or price increases. Make it colourful and attractive so that others will want to learn from your work.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Investigations

When undertaking your investigations, remember the problem-solving cycle steps:

- **Formulate** – Sort out and plan what you need to know and need to do to solve the problem.
- **Explore** – Use and apply the mathematics required to solve the problem.
- **Communicate** – Record and write up your results.



1 Student loans

How much does it cost to continue studying once you leave school? And how much assistance does the government provide for you to undertake further education? Your task in this investigation is to research the government HELP and VET student loans that support you to study or undertake training after leaving school.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Formulate

a Search for the following resources.

- HELP student loans: search for 'HELP debt statistics' on the Australian Parliament House (aph) website. Access the links to the most recent data and look for a report titled 'Updated Higher Education Loan Program (HELP) debt statistics'.
- University graduate pay and employment: search for 'HE facts and figures' on the Universities Australia website and download the most recent publication.
- VET training: search for 'Latest VET statistics dashboard' on the NCVER website (NCVER is the National Centre for Vocational Education Research). Follow the link to the latest VET statistics.

b Use the resources listed above and other relevant resources to answer the following initial questions about further education, government support, and graduate pay and employment.

Prior to conducting your research, consider how you will record the data and information. What technology will you use to collect and display the data?

- What trend(s) can you identify in the total amount of HELP debt since the financial year 2011–12?
- What trend(s) can you identify in the number of students with a HELP debt over this period?
- What is the average HELP debt and the number of students who have these debts over the same period?
- What is the relationship between having a university degree and employment?
- What proportion of VET students were in government-funded courses?
- What is the number of apprentices and trainees that were employed once they finished their course?
- How has the VET student loans activity in Victoria changed over the last five years?
- What trend(s) can you identify in trade occupations over the last ten years across Australia?

c Write two or more further questions you would like to answer about HELP debts or student loans.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Explore

d Conduct your research to answer the questions about HELP debts and student loans. Access and download the data relevant to these questions. Sort the data into tables and create or download appropriate graphs to answer these questions. Record the sources used in your research.

e Use your mathematical and statistical knowledge and skills to summarise your data. What story does the data tell about the cost of further education over the time period studied?

Communicate

f Write up and present the findings of your investigation into HELP debts and student loans. You can choose the format of your presentation.

You should:

- include the questions that you asked, and the data that you found
- include any tables, graphs and infographics that you created
- explain the mathematics and statistics that you used in your research
- provide an analysis of the findings of your research
- reflect on how technology was used to conduct the investigation and to present the results
- consider what you would change, and why, if you were to do this investigation again.

2 Finding a job

Your task is to research the entry-level pay and conditions of a job for which you could apply now, or next year.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Formulate

a In a small group or as a class, conduct a brainstorm to identify as many possible entry-level jobs that students might consider applying for now or in the near future.

b From the list of jobs that were identified, select one type of job to research.

c How will you find available jobs and information about the application processes? What resources will you use?

d How will you find the employment conditions of these jobs?

Explore

e Conduct your research. You need to use current and reliable sources. Keep track of what you use and what you find in a table with the hyperlinks.

- Use at least two job search sites for similar jobs to ensure the accuracy of the data that you collect.
- Access the Fair Work Commission website to find the entry-level pay rates for two jobs.
- Are there any other aspects of these jobs that would cost you money (such as needing your own car)? If so, research the cost of these.

Communicate

f Write up and present the findings of your research. You can choose the form of your presentation.

You should:

- explain the reasoning for selecting the jobs you did
- include the questions that you asked, and what you found
- provide the sources of the data that you analysed, including the hyperlinks
- explain the mathematical skills you used in analysing your data
- provide an overall conclusion about your research
- reflect on the technologies that have been used to collect the data initially and what technology was used to collate, present and analyse the data
- consider what you would change, and why, if you were to do this investigation again.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key concepts

- **Personal financial transactions**
  - Financial transactions are money coming into or going out of your accounts.
  - Term deposits are when you deposit your money in an account for an agreed number of years.
- **Earning simple interest**
  - Simple interest (I) can be calculated using the formula:

$$I = \frac{PRT}{100}$$

where:
Principal, P = the amount of money borrowed or invested
Term, T = the time period for which the principal is borrowed or invested
Rate of interest, $R\%$ = the percentage of the principal that is charged for borrowing the money, or paid to you for investing the money.

  - This simple interest formula can be rearranged to make the principal, interest rate or time the subject (and therefore easier to calculate).

$I = \frac{PRT}{100}$	$P = \frac{100I}{RT}$	$R = \frac{100I}{PT}$	$T = \frac{100I}{PR}$

- **Earning compound interest**
  - Compound interest is calculated on the accumulated value of an amount invested or on the amount borrowed; it calculates 'interest on the interest' as well as on the principal. It is the form of interest that you earn when you leave your money in a term deposit. It also applies to investments like buying shares.
  - When interest is compounded, the accumulated value (A) can be calculated using the formula:

$$A = P\left(1 + \frac{r}{100}\right)^n$$

where:
Principal, P = the amount of money borrowed or invested
Term, n = the number of time periods for which the principal is borrowed or invested
Rate of interest, $r\%$ = the percentage of the principal that is charged for borrowing the money or paid to you for investing the money per the time period.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- **Paying off interest and fees when borrowing money**
  - When you borrow money, you pay **interest** for the use of that money.
  - Comparison interest rates include the lender's fees and charges.
  - Real interest rates are calculated by subtracting the inflation rate from the nominal interest rate.
  - The total amount of money received by the end of the lending period is the **accumulated value**. It is made up of the principal plus the interest charged or paid and is calculated using the formula:

$$A = P + I$$

    where:

    A = the accumulated value

    P = the principal

    I = the total amount of interest
  - Most banks or other financial institutions will charge **fees** for administration of the loan. These are in addition to the interest charged. Fees can also be charged for late payments or early repayments of loans. These will all be described in the loan contract.
  - Interest can be **fixed** or **variable**. A fixed interest loan means that the interest rate does not change for the length of the loan. A variable rate means that the interest rate can vary up or down during the length of the loan.
  - Loans can be **principal and interest** or **interest only**. With an interest-only loan you only pay back the interest amount for the length of the loan. It is a way of deferring paying off the full amount of the loan (but you still owe the full amount).
  - **Repayments on a simple interest loan** are calculated using the formula:

$$\text{Amount of each repayment} = \frac{\text{accumulated value}}{\text{number of repayments}}$$

    [For number of repayments: annually = 1, quarterly = 4, monthly = 12]
  - **Repayments on a reducing balance loan** (another name for a compound interest loan) are more easily made using an online calculator.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- **Student loans – Higher Education Loan Program (HELP), VET Student Loans (VSL), Trade Support Loans (TSL)**
  - HELP / VSL / TSL loans accrue while you are studying or in an apprenticeship.
  - Once you are working and you earn above a certain threshold income, you pay the loan back as a percentage of your income. The threshold amount and rate of repayment can be found on the ATO website. These can change every year.
  - No interest is charged on the loan, but once an amount is more than 11 months old on 1 June of each year, it is indexed by a rate set by the ATO. Again, this can be found on the ATO website.
- **Wage growth and the cost of living**
  - Real interest rate = nominal interest rate – inflation rate
  - Wage indexation refers to the automatic adjustment of wages or salaries in response to changes in a specific economic indicator, often the Consumer Price Index (CPI).
  - The annual Consumer Price Index (CPI) inflation rate in Australia is calculated based on changes in the cost of a representative basket of goods and services over time. The CPI is often used as the basis for increasing the price of different goods and services.
- **Use of credit cards**
  - Credit cards need to be used wisely and paid back on time.
  - When deciding on credit cards you need to be aware of annual fees, the length of the interest free period, the charge for a missed or late payment, the extra charge for a cash withdrawal, and the interest rate on your purchases.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Success criteria and review questions

☐ I can perform calculations involving simple interest.

1 Calculate the required item(s) for the following scenarios.

a $10,000 is invested at 4.2% simple interest for four years.
- **i** How much is the total interest earned?
- **ii** What is the value of the investment at the end of the four years?

b Simple interest is charged on a $2,000 loan at 8.3% p.a. for two years.
- **i** How much is the total interest charged?
- **ii** What is the total amount of the loan at the end of the period?
- **iii** How much is each repayment if repayments are made monthly?

c A simple interest loan has an interest rate of 7.5% p.a. over three years with total interest of $337.50.
- **i** What is the principal amount of the loan?
- **ii** What is the accumulated value of the loan?
- **iii** What is each repayment if the repayments are made quarterly?

d A simple interest loan with a principal of $5,600, an annual interest rate of 8.5% p.a. has total interest of $2,856.
- **i** What is the length of time (term) of the loan?
- **ii** What is the accumulated value of the loan?
- **iii** What is each repayment if the repayments are made fortnightly?

2 Calculate the simple interest earned for the following investments.
- **a** $4,500 invested at 4.6% p.a. for three years
- **b** $12,400 invested at 5.5% p.a. for 10 years

3 Marta deposits her birthday money of $850 into a bank account earning simple interest at a rate of 3.3% p.a.
- **a** How much interest will the investment earn in four years?
- **b** How much money will have accumulated after four years?

4 Steph wants to invest her $10,000 inheritance for five years. How much will she accumulate if the simple interest is 3.9% p.a.?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

5 You are thinking of buying a $10,000 car.
- Best Cars is offering you a 5-year loan at 9.35% p.a. simple interest.
- Top Cars is offering you a 4-year loan at 10.09% p.a. simple interest.

Use a spreadsheet to find the monthly repayments and interest charged on each loan.

☐ I can use an online calculator or a spreadsheet to perform calculations involving compound interest.

6 Calculate the amounts, to the nearest dollar, in each of the following scenarios.
- **a** Dina and her partner take out a housing loan. They borrow $525,750 over 30 years, at an interest rate of 5.25% p.a. The bank charges an annual fee of $395. Calculate their monthly repayments.
- **b** Lily borrows $12,000 to finance a holiday. She takes out the loan over 3 years, at an interest rate of 5.95%, p.a. with compounding monthly repayments.
  - **i** What is the accumulated value of the loan?
  - **ii** How much interest does Lily pay in total?

7 You want to invest $4,500 for 3 years, at the bank's compound interest rate of 4.8% p.a., compounded monthly. What will be your accumulated value?

8 Use an online compound interest calculator to work out which is the best deal for a loan of $150,000 taken for a period of 10 years.
- Loan A: 8.2% p.a. fixed rate. Principal + interest. Fees of $40 per quarter
- Loan B: 7.9% p.a. fixed rate. Principal + interest. Fees of $150 per year
- Loan C: 7.6% p.a. fixed rate. Principal + interest. Fees of $15 monthly

9 Use a spreadsheet to calculate the compound interest earned for the following investments.
- **a** $2,500 invested at 3.9% p.a. for 3 years, compounded annually
- **b** $17,500 invested at 4.5% p.a. for 10 years, compounded annually
- **c** $17,500 invested at 4.0% p.a. compounded quarterly for 10 years

☐ I can calculate the real interest rate on loans and investments.

10 Calculate the real interest rates in these scenarios.
- **a** A personal loan with a nominal rate of 9.3% p.a. and an inflation rate of 3.5% p.a.
- **b** An investment with a nominal rate of 5.4% and an inflation rate of 2.6% p.a.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

☐ I can calculate HELP / VSL / TSL loan repayments and index the loan.

11 Use the ATO table shown in section 9E to determine whether any repayment of HELP loans is required for the following incomes in the 2024–25 financial year. If payment is required, calculate the amount at the correct rate.

- **a** Income of $33,999, with a HELP debt of $12,361
- **b** Income of $105,501, with a HELP debt of $8,231
- **c** Income of $64,010, with a HELP debt of $17,488
- **d** Income of $160,235 with a HELP debt of $5,176

12 Use the ATO table in section 9E to determine whether the following HELP loans required indexing on 1 June 2024. If so, calculate the new amount of the debt. Assume that no loan repayments have been made before 1 June 2024.

- **a** $11,850 incurred in Feb 2024
- **b** $6,998 incurred in Mar 2023
- **c** $15,760 incurred in Sep 2023
- **d** $27,000 incurred in Dec 2021

☐ I can calculate wage and price increases based on the Consumer Price Index (CPI).

13 An award hourly rate is $36.40. The award states that this will increase by 1.8% for each of the next three years.

- **a** What will the award rate of pay be after the third year?
- **b** What is the increase in the rate of pay over the four years?

14 A business contract states that the annual fee for a cleaning service will increase by 2.1% in the first two years, followed by an increase of 1.5% in the following year. The current annual service fee is $10,550.

- **a** Calculate the annual service fee for each of the following three years.
- **b** What is the increase in the annual service fee over the period?

☐ I can perform calculations relating to the use of credit cards.

15 Use the Moneysmart personal loan calculator to answer the following question. Jorge uses a credit card for the purchase of a new bike, which costs $3,220.

- **a** What is the minimum monthly repayment if Jorge's credit card has an interest rate of 16.99% p.a. with no annual fee. Assume that Jorge does not purchase anything else and aims to pay it off in 1 year.
- **b** How much extra has Jorge paid because a credit card was used?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mathematical toolkit

1 Reflect on the range of different calculations, technologies and tools you used throughout this chapter, and how often you used them for undertaking your work and making calculations. Indicate how often you used and worked out results and outcomes for each of these methods and tools.

Method and tools/ applications used	**How often did you use this?**
• Calculating and working in your head, and using algorithms	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using pen-and-paper	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using a calculator	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using a spreadsheet	Not at all: ☐ A little ☐ Quite a bit: ☐
• Using measuring tools – name the tool, technology or application: _____ _____	Not at all: ☐ A little: ☐ Quite a bit: ☐ Not at all: ☐ A little: ☐ Quite a bit: ☐
• Using other technology or apps – name the technology or application: _____ _____	Not at all: ☐ A little: ☐ Quite a bit: ☐ Not at all: ☐ A little: ☐ Quite a bit: ☐

2 Did this chapter and the activities help you to better understand how you use different tools and technologies in using and applying mathematics in our lives and at work? In what areas and ways? Write down some examples.

3 In one sentence, explain something relating to tools and technologies that you learned in the unit. Write an example of what you learned.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key vocabulary

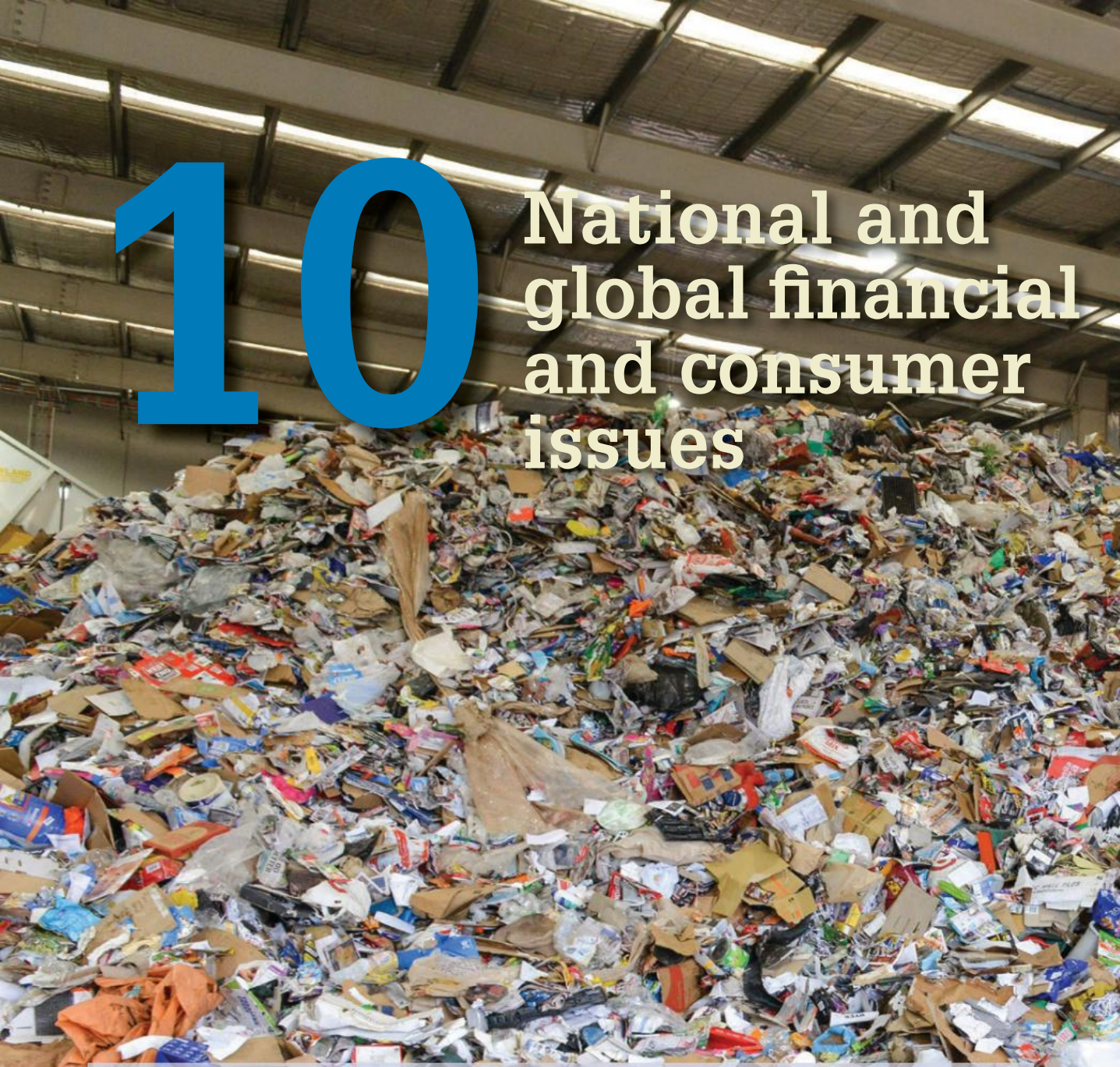
Here is a list of this chapter's key maths terms and their meanings.

Term	Meaning
Accumulated value	The money received back after the lending or investment period. Accumulated value (A) = principal (P) + interest (I)
Annual fee	The upfront amount billed by a credit card provider each year, regardless of how often you use the card.
Annual percentage rate (APR)	The true cost of a loan by adding all fees and charges to the nominal interest rate. Also called the comparison rate.
Australian Taxation Office (ATO)	The Australian Taxation Office operates the tax collection system for businesses and private citizens.
Balance	A number representing the amount of money held in an account, e.g. bank balance.
Compound interest	When there is 'interest on the interest' as well as on the principal – both in lending and investing. The growth in value is exponential rather than linear. The accumulated value can be found using the compound interest formula: $A = P\left(1 + \frac{r}{100}\right)^n$
Consumer Price Index (CPI)	A measure that examines the average change in prices paid by consumers for goods and services over time, expressed as a percentage.
Credit	The ability to obtain goods without paying for them outright.
Credit card	When you use a credit card, you are borrowing money from the bank, and you will have to pay off the amount with interest.
Debit card	When you use a debit card, you are spending money that you already have in your account.
Fintech	A term formed from the words 'financial' and 'technology' to refer to the application of new technologies in financial transactions.
HECS-HELP loans	A government loan program to help with studying costs after students leave secondary school.
Indexation rate	Annual percentage increase of a debt.
Inflation	The increase in the price of goods and services, measured as a percentage rate of change in costs. When inflation goes up, the cost of goods and services go up. The opposite of inflation is deflation.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Term	Meaning
Interest (I)	The amount of money the borrower pays the lender, or the lender receives from the borrower, for using their money.
Interest-only loan	Where you only pay back the interest amount for an initial period of the loan (e.g. 5 years). It is a way of deferring paying off the full amount of the loan (but then you need to pay the loan, and further interest, after that initial period until you have paid off the full amount).
Interest rate (R% p.a.)	A percentage of the *principal* that is charged per year during the *term* of a loan.
Nominal interest rate	The interest rate that is advertised by lenders and investors.
Per annum	An amount for a full year, abbreviated as pa or p.a.
Percentage	A rate, number or amount in each 100. The symbol is %.
Percentage mark-up	A percentage increase on the wholesale price of items bought by the business owner to ensure they can cover all of their business costs.
Personal loan	An unsecured loan, usually for buying a car or household goods, where no property or goods are asked to forfeit if the loan isn't paid.
Principal (P)	The sum of money borrowed or invested.
Proportion	A portion of a whole amount, usually expressed as a fraction or decimal.
RBA	The Reserve Bank of Australia is Australia's central bank.
Real interest rate	This takes into account the effect of *inflation*. Real interest rate = nominal interest rate – inflation rate
Repayments	These are calculated so that you pay off the total loan amount borrowed plus interest and any fees and charges in equal, regular payments over the term of the loan.
Simple interest (I)	The amount can be calculated using the formula: $I = \frac{PRT}{100}$.
Term (T)	The time period (in years) for which the *principal* is borrowed.
Trade Support Loan (TSL)	Loan available to eligible apprentices to cover the cost of living while completing their apprenticeship.
Transaction fee	A fee collected by retailers from purchasers on every purchase.
URL	The address of a World Wide Web (www) page.
VET Student Loan (VSL)	A government program that assists eligible students to pay tuition fees for approved higher-level (diploma and above) vocational education and training (VET) courses.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.



10 National and global financial and consumer issues

Brainstorming activity: Where's the maths?

Using this photo of a plastic recycling storage facility as a stimulus, brainstorm the type of maths related to this task or activity. Think especially about any maths skills related to the content of this chapter – the national and global world we live and work in. Prompt questions might be:

- What is happening in this photo?
- What tasks, functions and processes are undertaken and why?
- What questions and related investigations might you want to ask or know about related to this activity and business?
- What types of mathematical content knowledge and skills would be relevant?
- What different tools, technologies or software might be used?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter contents

Chapter overview and Spotlight

10A Starting activities
10B Tuning in
10C Comparing products and services
10D Responsibilities to our society: Understanding taxes and more
10E National and global money factors
10F Risk versus reward
10G Environmental and health issues
Investigations
Chapter review

From the Study Design

In this chapter, you will learn how to:

- describe and explain taxation scales and related rates and how taxes and superannuation are calculated and distributed at a local, state, national level, and perform calculations with taxation or superannuation
- compare, contrast and undertake routine calculations for non-banking financial products and services such as insurances, mobile phone/internet plans
- interpret and analyse available financial and economic data at the community, national or global level and report on trends and outcomes such as health or environmental statistical data

(Units 3 and 4, Area of Study 3)

© Victorian Curriculum and Assessment Authority 2022

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter overview

Introduction

This chapter explores the role of mathematics in shaping critical understandings of national, and global economic and financial issues, and how they impact on individuals and society, including in relation to humanitarian and environmental issues.

Citizens and consumers in the 21st century are savvy, better educated than in any other time in history, and more aware of global issues. Past wisdom in business assumed that consumers might be easily controlled and directed by marketing campaigns. However, today's citizens, especially younger people, are more likely to make decisions based on their personal values and principles, including ethical and environmental issues related to consumerism. They don't like being told what to do and how to think. They have the internet at their fingertips. They will look for more than just the best price and may be unpredictable in their choices.

In this chapter we will look at, interpret and analyse mathematical information that sheds light on important national financial transactions and processes, such as taxation, superannuation, medical and hospital insurance, and other services and products. We will also look at national and global trends, and consider how adjusting our own financial behaviour through active choices can benefit society, the economy and the environment.

In undertaking any of this analysis, interpretation and comparison requires us to know about and use a range of mathematical knowledge and skills – the knowledge and skills that have been covered in the first nine chapters of this book. You will need to dip into that knowledge bank and into your mathematical toolkit throughout this chapter and the next.

Learning intentions

By the end of this chapter, you will be able to:

- compare products and services
- carry out taxation calculations
- undertake calculations related to superannuation and insurance
- understand global and national money factors
- understand financial risk and reward
- undertake calculations related to health and environmental issues.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Spotlight: George Dermentzis

An interview with a financial adviser

Tell us about your job and some of the work that you do.

My main role is a financial adviser and investment portfolio manager. I research investments and provide advice on what different asset classes my clients should invest in, like Australian shares, international shares, property, fixed interest investments and bonds. I also advise clients on other financial areas such as retirement, superannuation and taxation. For each of my clients, I set up and manage a model portfolio that takes into account all aspects of their financial circumstances and their investments. The average portfolio I manage is about $1.7 million. On an ongoing basis, I meet with clients to review their portfolio's performance and advise on whether some investments should be sold or bought to get back to their desired asset allocations. This also gives me a chance to tailor their portfolio to accommodate their changing circumstances, such as if they have just retired.

What maths do you use regularly in your work?

There are a lot of numbers in what I do. There's plenty of simple maths like allocations of percentages, addition, subtraction and multiplication. I also use financial maths quite a bit, such as present value calculations to give new clients a projection for the amount of wealth they need to accumulate to fit their needs. A calculation example I like to show younger clients is the powerful effect of compounding to demonstrate why they should start saving for their future as early as possible. Say there are two 20-year-olds. The first one decides that they will invest $1000 a month (with an average return of 7% interest) for ten years. Once they're 30 years old, they decide to leave their investments as is and do nothing for the next 35 years. The second 20-year-old decides to start investing later at 30 years old and invests $1000 a month for the next 35 years. At the end, when they are both 65 years old, it is the first person who has accumulated the most wealth (about $50 000 more) due to compounding, even though they did nothing for the last 35 years.

What is the most useful maths-related tool or piece of technology in your work?

I use Excel for everything as it is one of the most powerful tools around. I use a lot of formulas to calculate amounts across large sets of data in a flash, like finding averages and present values. It also enables me to visually show my clients my calculations and projections, especially when demonstrating the effects of compounding. Otherwise, I sometimes use my financial calculator to quickly find ballpark amounts.

What was your attitude towards learning maths in school?

I loved maths in school and continued with it in Year 12. It was also present in a lot of my other commerce subjects like accounting and economics. I still enjoy using and learning maths, and it has been very handy to have always had that interest in numbers as it really helps in my work today.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

10A Starting activities

Activity 1: Ethical trading

Ethical trading is a mindful approach to commerce that prioritises social and environmental responsibility throughout the supply chain. It seeks to ensure that workers are treated fairly, the environment is protected, and communities benefit from the production and sale of goods. Ethical trading aims to encourage consumers and investors to make conscious choices that positively impact workers, communities, and the planet.

You can find more information on ethical trading by looking at the websites for these organisations:

- Ethical Trading Alliance
- Ethical Trading Initiative
- Australian Certified Organic
- Better Cotton Initiative
- Fair Trade International
- Rainforest Alliance.

Discussion questions

1 In pairs or a small group, research ethical trading. Discuss what you knew already and what you found out, especially of any practices you find out about within Australia. Then answer the following questions.

   a Do ethical trading goods cost more and if so, why?

   b How do you convince people to think about buying ethically?

   c In your opinion, what are the most important goods to buy ethically?

2 Find two examples of ethical trading practices or consumer related products in Australia. Explain how they operate and provide some information about their costs and charges and how they might relate to equivalent non-ethical products or practices.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Activity 2: Bottled water

In 2020, *Thankyou* announced that it would stop selling bottled water, saying:

> *To reduce the impact that single-use bottled water has on the planet, well, we have no other option but to leave it behind. We're announcing that this is the end, we're out. As of today, production has ceased, and the last bottles of Thankyou Water will be trickling off shelves over the coming months.*

However, other manufacturers continue to profit from the sale of bottled water.

1 In pairs or a small group, create a mind map, thinking critically about whether selling bottled water is problematic. Your mind map might address these (and other) questions:

- Where and how is the water sourced?
- How is the water transported from the source/s to the factory?
- How is the plastic used to make the water bottles sourced?
- The plastic used to wrap the water bottles for shipping to retailers
- The disposal of used water bottles.

2 Based on what you find in your mind mapping and further research, answer these questions.

a What is the volume of bottled water sold in Australia each year?

b How much is this per person?

c What is the volume or mass of used water bottles disposed of each year in Australia?

d How have these figures been changing over the last few decades?

e Summarise what you have found out.

3 What is your opinion about bottled water in Australia?

4 Do you have a different opinion about the use of bottled water in other parts of the world?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

10B Tuning in

Epic Success: U.N. Sustainable Development Goals

A powerful and current example of thinking big and planning for a better future is being implemented through the United Nations 2015–2030 Sustainable Development Goals (SDGs), covering 17 intentions for improving lives of all citizens across the entire world in the 21st century.

Select one of the 17 SDGs and look at the summary information and infographics on the website (search for 'United Nations Sustainable Development Goals'). Your research may also take you to other relevant sites.

Share your findings across your class so that between you, many different goals will be covered from the list.

Discussion questions

For the SDG you have looked at, report back to your class about the following details. Include summary data and percentage values that are given as evidence.

- How is the UN work progressing towards that goal?
- What barriers or unexpected events have affected that progress?
- What other SDGs have an impact on progress towards the goal you have researched?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Practice questions

Search for 'The Sustainable Goals Report 2024' on the United Nations Statistics division website. Scroll down or follow through on the website to find the link that says 'Explore the Report' for each goal. Read the relevant information about the different goals and then answer the questions below. This provides a reminder of the kinds of everyday maths that are needed to interpret and understand information in the public domain.

1 Goal 1: No poverty

a What was the impact of the COVID-19 pandemic on this goal?

b What have been the changes in the percentage of the world's population living in extreme poverty, including across low-income and lower-middle-income countries?

c What have been the key changes in the global working poverty rate between 2015 and 2023, and how does this vary across the globe?

2 Goal 3: Good health and wellbeing

The population of Sub-Saharan Africa is about 1.2 billion.

a Which region had the greatest proportional decrease in the Under-5 mortality rate between 2015 and 2022? What proportion did it decrease by?

b How does the UN define that a health workforce is considered 'ageing', and which categories of health workers have the highest proportion of an aged workforce?

c How many times higher are the median values for health worker density in high-income countries compared with low-income countries? How do these rates vary across medical doctors, nursing and midwifery personnel, dentists and pharmacists?

3 Goal 4: Quality education

a How has the percentage of primary school teachers with minimum required qualifications varied globally between 2015 and 2022? What are the key issues you can see in this data?

b What are some key issues that are highlighted in the data about the proportion of primary schools with access to basic services?

c Why do you think the worldwide figures for access to computers and the internet is less than 50%, yet the majority of the regions of the world are well above 50%?

4 Goal 13: Climate action

a By what proportion have fossil fuel subsidies changed between 2010 and 2022?

b Based on the graph of the global annual mean near-surface temperature changes for each year from 1850 to 2023, what temperature do you think it might reach in 2028, if you extrapolate the graph?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

10C Comparing products and services

Over the years, you would have been used to looking at the costs of using a mobile phone and comparing mobile phone plans. But you need to also be able to compare lots of other different services and products, such as buying a house. It could be about which gym club you join, or it could be about which airline you might catch to travel on a trip, or even about taking out health or car insurance. When you move out of home, there are further issues to consider, such as who you use as your electricity, gas or water supplier.

In the past, consumers had little choice in relation to their household utility supplier; how they got a loan, or how they paid their bills. Now that we have the power to choose, we need to know how to make informed choices. This now also includes an ever-expanding range of choices for medical and hospital insurance too.

In this section, we will look at some of these issues and use a range of mathematical skills to analyse and compare the alternatives available.

Comparing energy providers

Electricity and/or gas are utility bills that most people need to pay once you leave home – so it's good to know how to choose your provider.

Victorian Energy Compare is a government website that is set up so you can compare different companies and terms and conditions for your different energy or utility suppliers.

But you might need to know the NMI of your electricity meter, which is the unique identifying number for your electricity meter. NMI stands for National Metering Identifier. The NMI is highlighted in yellow in the example shown.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

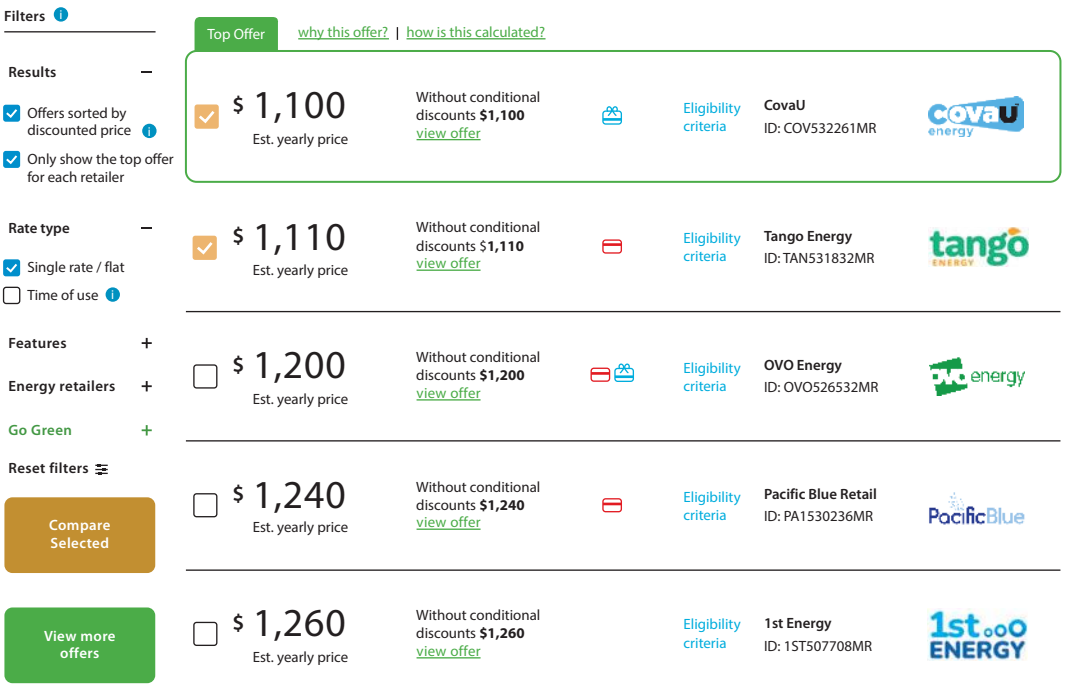
Electricity supply details.

Supply address: 18 Sample Avenue SAMPLETOWN SA 5555
Supply period: 4 Feb 2014 to 3 Mar 2014 (28 days)
NMI: 41020000000
Energy Plan: Selectn 12%

Meter no.	Read date	Read description	Start read	End read	kWh
00000	3 Mar 14	Peak	18,000.111	23,498.773	5,498.662
00000	3 Mar 14	Off peak	21,000.444	25,339.58	4,339.136

Your next meter read is due between 2**8 Mar 14 and 3 Apr 14.** Please ensure easy access to your meter on these days.

Below is what the results of a search about energy suppliers might look like.



You will notice in this electricity comparison site that there is information and conditions that you would need to understand before signing a contract with any of the companies.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Activity: comparing electricity providers

Research two electricity suppliers available in your area. Use the *Victorian Energy Compare* website to do this. You might find it helpful to record your research in a table like this.

Things to consider might include:	Company A	Company B
Is there a difference in price depending on the time of day?		
Is there a surcharge if you pay using your debit card?		
Do you have to pay the full amount every quarter?		
Are people with Centrelink payments eligible for a discount?		
Does the company offer a 'green energy' option?		
What are the fees and charges?		
Does the company have a financial hardship policy?		

Health care insurance in Australia

Medicare is a universal health care system in Australia that delivers affordable, accessible and high-quality health care for most Australian residents. But adults can also choose to take out extra private health insurance to give themselves and their families more health care options and to cover items which are not covered by Medicare. This private health insurance can include different options for higher levels of private hospital care and extra coverage for possible medical issues and incidents.

Some of the key differences between public and private insurance are listed below.

- Medicare only covers the cost of your treatment as a public patient and a set range of non-hospital health services.
- Medicare doesn't include ambulance service costs, glasses/contact lenses or hearing aids. It also excludes therapies such as speech pathology, physiotherapy, osteopathy and remedial massage.
- Private health insurance can give you options about the type of health services used and more coverage for different types of services.

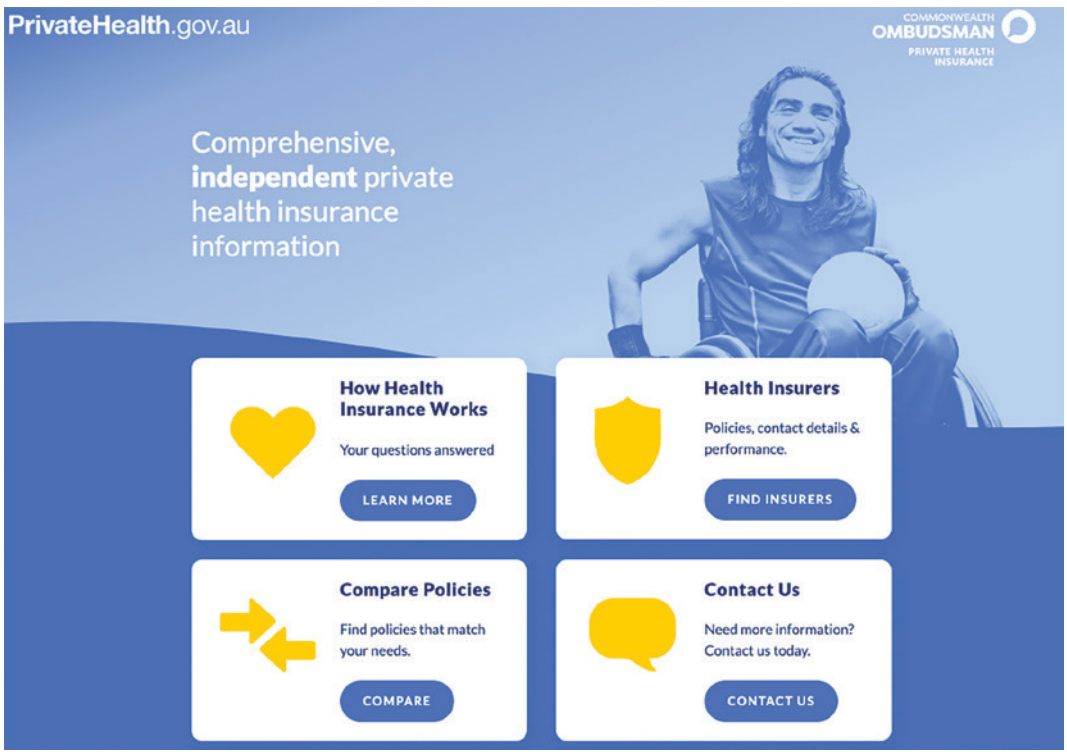
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

An important government policy to know is that if you don't have private hospital cover by the time you turn 31 years of age, there is a lifetime health cover (LHC) levy of 2% p.a. on top of your hospital insurance premium for every year after you turn 30, for a maximum of 10 years. (Once you have paid LHC loading for 10 years of continuous cover, you will no longer have to pay this loading.)

In 2023, approximately 55% of Australians had Extras cover under private health insurance, while 45% of Australians have hospital cover. [Source: The Australian Prudential Regulation Authority (APRA)].

How is private health care insurance structured?

There are so many variables when looking at health care providers, it's hard to know what to do – so let's do some online research. A good starting point is the government website, *PrivateHealth,* which has lots of information about private health insurance information.



Activity: determining your health cover needs

Work in pairs with another student to investigate the following questions related to health insurance.

- What does Medicare cover, and what does it not cover?
- Why bother with private health insurance?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- What are the age and family cover restrictions?
- What are the advantages and disadvantages to taking out private health insurance cover?
- What government incentives and surcharges affect health insurance?
- What are the three levels of hospital cover?
- What are waiting periods?

Copy and complete this table by putting a ✓ if an option is important to you now, and what might be important to you in in 30 years' time.

Option	Important to you now?	Important to you in 30 years?
Accidents		
Ambulance		
Back, neck and spine		
Bones, joint and muscle		
Chemotherapy		
Chiropractic and Osteopathy		
Dental		
Digestive system		
Gynaecology		
Hearing aids		
Joint reconstruction		
Kidney and bladder		
Mental health		
Pain management		
Orthodontics		
Tonsils		

You might also want to work out how much the lifetime health cover levy of 2% p.a. might cost you.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 1 Calculating the lifetime cover levy

Zhi is 33 and has decided to take out hospital cover for the first time. He has found a policy that suits him that is listed as $315.00 per month. How much will Zhi pay, including the lifetime health cover levy (LHC) of 2% p.a.?
How old will Zhi be when the levy is removed?

THINKING	WORKING
STEP 1	
The LHC levy is 2% for every year the insured person is aged over 30 when they open the policy. The levy stays in place for 10 years.	Zhi is 33. $33 - 30 = 3$ $3 \times 2\% = 6\%$ Zhi's policy will be increased by 6%.
STEP 2	
Calculate 6% of the monthly fee.	6% of $315 $= 0.06 \times \$315$ $= \$18.90$
STEP 3	
Find the total monthly cost by adding the LHC levy to the monthly fee.	Total cost per month $= \$315.00 + \$18.90$ $= \$333.90$
STEP 4	
Write your answer, making sure to include the units ($ per month).	Including the LHC levy, Zhi will pay $333.90 per month for his hospital cover. Zhi will be 43 when the levy is removed.

Comparing policies

To allow for simpler comparison of health insurance products, all Australian health insurers are required by law to provide details of each of their products to the Private Health Insurance Ombudsman. The *PrivateHealth* government website allows you to compare the different providers and their options and costs. Click on 'Compare' in the 'Compare Policies' section.

Note that there are private health insurance comparison websites too, but they should be used with the understanding that not all products might be included, and the site may be owned by a group of interested companies.

Before you search, you need to know who you want covered, where you live, and the type of cover you want. Selecting specific hospital services or general treatments will provide more tailored results but will take a bit longer.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

With the partner that you are working with, use the comparison site to work your way through the process of comparing providers, agreeing on what you might want covered if one of you was interested in taking out health care coverage. You also might need to sort the information you get to, by clicking on the headings across the top. You should eventually get to a screen that compares a number of different providers.

Reflect on what you found out after working through this process. What did you find in relation to each of the following?

- How much did the cheapest cover cost per month? How much is this per year?
- How did this compare with the most expensive? What is this as a percentage difference?
- What did you find out that you didn't know about before?
- Do you think Gold cover is necessary? What level would you choose?
- Did anything in particular surprise you?

There are other insurances that you may need to engage with as you go through life. One key one is car insurance, and the other is life insurance.

Car insurance

There are different options and costs for insuring your car. One is compulsory, and the others are optional. Insurance covers drivers and other road users costs as the result of road crashes – for injuries to people and damage to cars and property.

Compulsory third-party insurance

Third-party insurance is compulsory for all motor vehicles and is usually paid annually at the same time as your vehicle's registration. Again, there is usually a government insurance authority that collects this fee. This is the Transport Accident Commission (TAC) in Victoria. It covers you for injuries that might occur to people as a result of a crash involving your car. The cost depends on where you live and the type of vehicle you register.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Comprehensive car insurance

Comprehensive car insurance gives the greatest financial protection for you and your vehicle. It covers loss or damage to your vehicle and other property damaged by the use of your vehicle.

Third-party property insurance

Third-party property insurance covers you for property damage by the use of your vehicle. It can also provide limited cover for your vehicle where the crash wasn't your fault, and you can identify the other driver and if the driver is uninsured.

It is normally recommended that all drivers have this basic insurance protection.

You can also combine this with insurance cover for your vehicle against fire damage or theft.

Costs of non-compulsory insurance

The costs of comprehensive and third-party insurance depend on a number of factors. These include:

- the type and model of car – smaller, less powerful cars will be cheaper than bigger, sportier cars
- the age of the driver – when you are under 25 years of age, you often have to pay higher amounts
- how and where the car is to be parked. If it is locked up in a garage, for example, this may save you money. Different suburbs may cost you more, depending on whether it is an area with high risks in terms of car theft
- the experience of the driver – the more experienced you are and the less accidents you have, the cheaper your insurance might be.

Excess

With most insurance policies you have to pay what is called an **excess**. This is an amount you have to pay as part of the expense to fix any damage. Especially when you are young and inexperienced, the excess you have to pay can be quite high.

Working in a small group, research using the internet to find different car insurance comparison websites. You can also access the *Moneysmart* government website which has independent information and where you can compare different insurance options.

Consider and discuss the following questions in your research.

- What are the differences between compulsory, comprehensive, third-party insurances?
- How much does compulsory third-party insurance cost in Victoria?
- What factors make a difference to the amount of insurance you pay?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Life insurance

You probably think that life insurance isn't for you. But in a few years' time, you might have an education debt, or still owe money on your car loan. What would happen if you can't work and don't have insurance?

The most common types of life insurance are:

- a lump sum that is paid if you die
- a lump sum that is paid if you suffer a permanent disability
- trauma insurance if you are diagnosed with a major illness
- income protection insurance.

You might have a family. If you can't work, what happens to them?

A lot of Super funds include life insurance – but the trap here is that these premiums reduce how much money is going into your Super fund piggy bank for your retirement.

There are a lot of comparison sites. For example, you can learn how life insurance works and access a life insurance calculator on the *Moneysmart* website.

It's a big commitment, so get independent and reliable advice.

Gym or fitness club memberships

It is quite popular for people to join gyms or fitness clubs for their health and fitness.

Activity: choosing a gym or fitness club

With another student, or in a small group, rank these factors in order of importance if you were choosing a gym:

- Type of gym
- Opening hours
- Clean and maintained equipment
- Clean changing areas
- Does it have a pool?
- Location of the gym
- Availability of fitness guidance
- Good atmosphere
- Lockers for valuables
- Availability of classes

Are there any other factors that would influence your decision?

Gym contracts are quite complicated. Research the types of gym contracts available and complete the following table.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Type of contract	Advantages	Disadvantages
Short-term		
'No contract' **direct debit**		
Fixed term		
Other?		

Continue to work together to see what gyms are available in your area and make a table of their costs against each of their different membership or usage options.

Compare similar charges and levels of membership from at least three different providers. Record what you find in relation to each of the following questions.

- What was the cheapest option? What was the most expensive option?
- How much would these options cost per month and per year?
- Anything in particular surprise you in your research?

Before you commit to any contract, whatever the goods or service, you should:

✓ Get information from a current and reliable source.

✓ Decide on the criteria that are important to you.

✓ Check the fine print before you sign up.

10C Tasks and questions

Thinking task

1 When comparing products and services, is the cheapest option always the best option? Why or why not?

Skills questions

2 Research health insurance options for a single person at the Basic or Bronze level, based on the same sets of requirements, including at least Dental and Optical in the Extra's policy. Use the *PrivateHealth* comparison website.

a Find the cost of combined Hospital and Extras cover.

b How many different providers did you find?

c How big are the price differences for each product based on the monthly fee? How much could you save over a whole year? What is the percentage difference in the price between the cheapest and the most expensive?

d What are the Excess fees?

e Which company would you choose and why? How much would this cost you in a year?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3 Trey is 20 and working as an apprentice electrician. He earns $45,000 gross per year. Unfortunately, Trey had a serious car accident, and won't be able to work for three months. Fortunately, Trey has had income protection insurance for two years, which costs $60 per month.

- **a** How much has Trey paid for this insurance?
- **b** The income protection insurance will pay 75% p.a. of his gross wage. How much is this?
- **c** Calculate the maximum amount that the insurance will pay for three months.
- **d** Like most young workers, Trey is paying rent, utilities and a car loan. Explain whether you think Trey made a wise choice by buying income protection insurance.

4 Below are the options for joining a nearby gym group, *Step Up*. Use this information to answer the following questions.

6 MONTH TERM MEMBERSHIP	DIRECT DEBIT	3 MONTH TERM MEMBERSHIP
$495	$21 Weekly Payment	$275
$0 Joining Fee	$49 Joining Fee	$0 Joining Fee
24/7 Access to Step Up Fitness centres	24/7 Access to Step Up Fitness centres	24/7 Access to Step Up Fitness centres
Access To All Group Fitness Classes	Access To All Group Fitness Classes	Access To All Group Fitness Classes
Up To 2 Weeks FREE Suspension	**Unlimited Membership Suspension**	**Up To 1 Week FREE Suspension**
	No Contract	

- **a** How much would you pay if you choose to take the direct debit offer for 6 months?
- **b** Which offer is the cheapest for the first six months?
- **c** What other information or factors might you want to know before selecting an option?

Mathematical literacy

5 With a partner, discuss some examples of different terms and criteria you would consider when making complex consumer choices like the ones discussed in this section. Explain why they are important.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Application tasks

6 Nhung and Xuan need to organise the electricity to be on when they move into their new two-bedroom rental place in Wonthaggi, Victoria. Use the *Victorian Energy Compare* website to find out what providers are available and what the different costs are. Then answer the following questions.

- **a** How many companies are available in their area?
- **b** What are the price differences? How much on average, is each 3-month bill for each company?
- **c** What is the percentage difference between the cheapest and the most expensive provider?
- **d** What are the supply charges and rates for each provider? How different are they, or are they all the same?
- **e** Which supplier would you recommend and why?

7 Working in a small group, compare different car insurance options for a 21-year-old driver who lives in Melbourne. Research using the internet and you will find different car insurance comparison websites. Consider and discuss the following questions in your research.

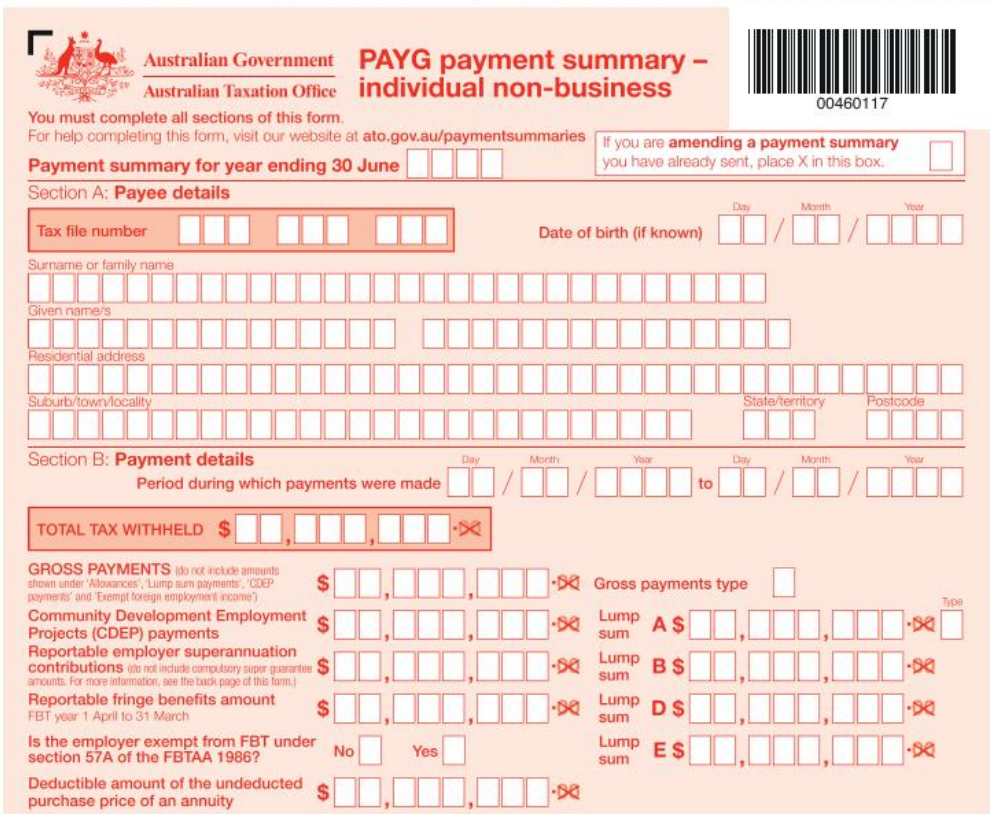
- **a** What are the different types of insurance available (comprehensive, third-party etc.)? What are their differences?
- **b** Decide on the features and level of insurance that you consider important in car insurance.
- **c** Have each group member choose a different car insurance website or a comparison website.
- **d** Compare and contrast the different comparison websites for **similar** insurance coverage. Do any have the same products listed? Are the products listed in the same order?
- **e** Create a table of the different insurance companies and their costs for the same or similar coverages.
- **f** Which insurance offer is the cheapest? Which offer is the most expensive?
- **g** What factors other than price are important when choosing car insurance?
- **h** In your group's judgement, which insurance offer would you suggest? Why?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

10D Responsibilities to our society: Understanding taxes and more

The taxation system serves several essential purposes and plays a crucial role in funding government services and programs. The primary purpose of taxation is to generate revenue for the Australian government. Taxes are collected from individuals, businesses, and other entities to fund public services and infrastructure. The tax collected is used to support critical areas such as health care, education and social welfare programs.

Part of the PAYG tax form that can be used to complete your tax return each year is shown here, although you can now complete your tax return online via *myTax* on the ATO website. Access the ATO website to view the various tax forms.



Australian Government
Australian Taxation Office

PAYG payment summary – individual non-business

00460117

You must complete all sections of this form.
For help completing this form, visit our website at ato.gov.au/paymentsummaries

If you are **amending a payment summary** you have already sent, place X in this box.

Payment summary for year ending 30 June

Section A: **Payee details**

Tax file number

Date of birth (if known) Day / Month / Year

Surname or family name

Given name/s

Residential address

Suburb/town/locality

State/territory

Postcode

Section B: **Payment details**

Period during which payments were made Day / Month / Year to Day / Month / Year

TOTAL TAX WITHHELD $

GROSS PAYMENTS (do not include amounts shown under 'Allowances', 'Lump sum payments', 'CDEP payments' and 'Exempt foreign employment income') $

Gross payments type

Community Development Employment Projects (CDEP) payments $

Lump sum A $ Type

Reportable employer superannuation contributions (do not include compulsory super guarantee amounts. For more information, see the back page of this form.) $

Lump sum B $

Reportable fringe benefits amount
FBT year 1 April to 31 March $

Lump sum D $

Is the employer exempt from FBT under section 57A of the FBTAA 1986? No Yes

Lump sum E $

Deductible amount of the undeducted purchase price of an annuity $

Australia also has a superannuation system. This system aims to promote long-term savings, tax efficiency, and retirement security, especially as our aged population continues to increase. In Australia, life expectancy is increasing. People born in Australia at the beginning of last century could expect to live for around 50 years. The life expectancy for a baby born now is 80+ years.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Superannuation reflects a commitment to individual financial wellbeing and contributes to the overall stability of the nation's economy. Superannuation covers most working Australians, including employees, self-employed individuals and contractors; and it helps to guarantee that people from various employment backgrounds have access to retirement savings.

Understanding the Australian tax and superannuation system is essential for informed citizenship. Whether you're a business owner, employee or freelancer, staying informed about taxation contributes to your financial wellbeing.

For most of us, our employers deal with taking the required tax and superannuation payments amount out of our **gross pay**. What we get deposited into our bank is our **net pay**, after all the deductions, including our tax, is taken out.

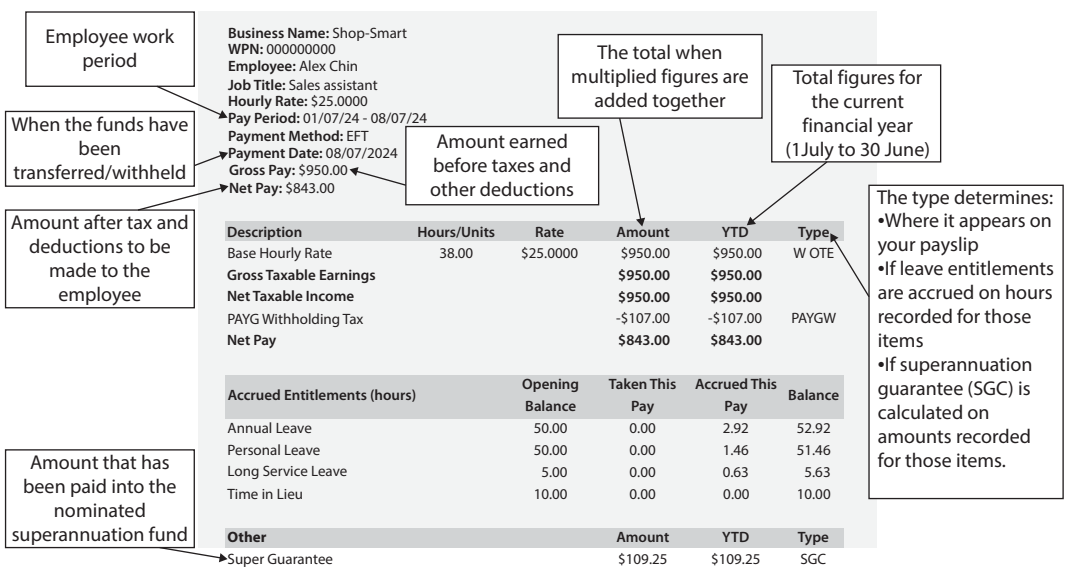
The taxes we pay go to the Australian Taxation Office, usually simply called the ATO.

Personal taxation and superannuation were covered in detail in section 8D of the Units 1 & 2 textbook. Please refer back to that section if you need further information or practice.

Your pay

Regular wage earners are called *Pay As You Go*, or **PAYG taxpayers**.

Here is an example of a PAYG payslip.



In Australia, we have three levels of government that administer different taxes.

Federal government: income tax, Medicare levy, GST, excises.

State government: stamp duty, car registration and insurance.

Local government: rates, service charges.

The **tax year** is from 1 July to 30 June.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Income tax and the Medicare levy

Income tax is the tax we pay on what we earn. Australia uses a **progressive tax scale system** for the purposes of taxing individuals. Under this system, the rate of tax payable increases as taxable income increases.

The Medicare levy is 2% of what we earn.

The table below shows the 2024–25 financial year tax rates, and does **not** include the Medicare levy. (For current tax rates and codes, go to the ATO website.)

Resident tax rates 2024–25	
Taxable income	**Tax on this income**
0 – $18,200	Nil
$18,201 – $45,000	16c for each $1 over $18,200
$45,001 – $135,000	$4,288 plus 30c for each $1 over $45,000
$135,001 – $190,000	$31,288 plus 37c for each $1 over $135,000
$190,001 and over	$51,638 plus 45c for each $1 over $190,000

The above rates **do not** include the Medicare levy of 2%.

Below are some examples of working out tax payable. Note that personal tax is always in whole dollars and rounds down to the nearest lower dollar. The Medicare levy is always rounded to the nearest dollar.

Example 2 Using the tax rate table

In the 2024–25 financial year, Tau's total income was $56,749.67.
Use the 2024–25 tax table to calculate the amount of tax for which Tau is liable.
Include the Medicare levy as a separate line.

THINKING	WORKING
STEP 1	
Work out the tax bracket.	$56,749.67 is in the tax bracket $45,001 – $135,000.
STEP 2	
Calculate the tax from the given tax table. The tax on $56,749 is $4,288 plus 30 cents for each $1 over $45,000. Because we are working in dollars, we need to convert 30 cents to dollars by dividing by 100. Round **down** to the nearest dollar.	Tax = $4,288 + ($56,749 – $45,000) × $0.30 = $4,288 + $11,749 × $0.30 = $4,288 + $3,524.70 = $7,812.70 = $7,812 (rounded down to the nearest dollar)

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 3	
Calculate the Medicare levy, which is 2% of the total income. Round to the nearest dollar.	Medicare levy = 2% of $56,749 = 0.02 × $56,749 = $1,134.98 = $1,135 (rounded to the nearest dollar)
Note: On a smartphone calculator it's just: 56749 × 2% =	
STEP 4	
Calculate the total tax liability by adding the income tax and the Medicare levy.	Tau's income tax liability is $7,812. Tau's Medicare levy liability is $1,135. Tau's total tax liability is $8,947.

When we file a tax return, we must include all our income.

We can also include some **deductions**. These vary, but your work uniform is a good example.

Some of the more common items are shown below.

Taxable income	Eligible deductions
Wages/salaries	Certain work-related expenses (see the list on the ATO website)
Interest earned on savings	Union fees
Dividends paid on stocks/share/bonds	Donations of $2 or more to registered charities
Rent from a rental property	Management fees of a share portfolio
Non-taxable income	Tax agent's charge
Rewards or gifts for special occasions	Rental property expenses (including interest paid on the property loan)
Lotto winnings	
Game show prizes	
Child support/spouse maintenance	

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 3 Calculating taxable income

In the last financial year, Lou earned $132,985 from his employment. He won $982 in Powerball. He had a term deposit that earned $171.66 during the year. His expenses included union fees of $2,659 and laundry costs for his overalls of $480. Calculate Lou's taxable income.

THINKING	WORKING
STEP 1	
First determine what is or isn't included in the calculations as income (to be taxed) and eligible deductions. Note that the Tattslotto win is considered non-taxable income.	Income: Wages $132,985 ✓ Tattslotto win $982 × Term deposit interest $171.66 ✓ Deductions: Union fees $2,659 ✓ Laundry $480 ✓
STEP 2	
Add the included income together. Add the eligible deductions together.	Income: $132,985 + $171.66 = $133,156.66 Deductions: $2,659 + $480 = $3,139
STEP 3	
Calculate the taxable income by subtracting the deductions from the income.	Taxable income = $133,156.66 – $3,139 = $130,017.66
STEP 4	
Write your answer.	Lou's taxable income is $130,017.66, which rounds down to $130,017.

Superannuation

Compulsory superannuation is now a feature of Australian society. Superannuation (often referred to as Super) is an investment for your life when you retire. Since 1992, employers have been required by law to put about 10% of your earnings into a nominated superannuation account. This account is maintained by professional fund managers. It should keep growing throughout your working life and, hopefully, will help sustain you in retirement. This is like compound interest-based investments that we looked at earlier, which means it is exponential growth, and will grow quite strongly as you earn interest on your accumulated amounts.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

No-one is allowed to withdraw from their superannuation until retirement, except for a few special scenarios. You may opt to self-manage your Super fund if you have the skills and resources to do so.

Your employer must pay a percentage of your wage, as an additional amount, into your Super fund. This is called the **Superannuation Guarantee**. This table shows the rates.

Financial year	2023–24	2024–25	2025–26	2026–27	2027–28
Employer contribution	11.0%	11.5%	12.0%	12.0%	12.0%

Example 4 Checking a superannuation allocation based on gross wages

On 23 June 2025, Anika's payslip showed that her gross wages were $457.32. The superannuation contribution amount was shown as $45.73.
Is Anika's superannuation amount correct? If not, what should it be?

THINKING	WORKING
STEP 1	
Determine the relevant financial year. A financial year is 1 July to 30 June.	23 June 2025 is before 30 June 2025, so is in the 2024–25 financial year.
STEP 2	
Use the table to determine the percentage for that year (or look it up on the ATO website).	The correct percentage is 11.5% p.a.
STEP 3	
Use this percentage to calculate Anika's superannuation based on her gross wages.	11.5% of $457.32 $= 0.115 \times \$457.32$ $= \$52.59$
STEP 4	
Compare the calculated figure with the contribution amount on the payslip ($45.73).	$52.59 is more than $45.73.
STEP 5	
Write your answer.	Anika's superannuation on the payslip is not correct. The correct amount should be $52.59.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Your superannuation is your money, so you need to consider carefully when choosing a superannuation fund.

- Choose an account with lower fees.
- Compare your fund's performance with others.
- Combine accounts if you have more than one.
- Check your insurance before you change funds.
- Know what's involved before deciding whether to choose a self-managed superannuation fund (SMSF).
- Be wary of anyone offering to withdraw your super early.

The *Moneysmart* website has useful advice on how super works. You can also get an estimate of how much superannuation you can end up with by using the website's superannuation calculator.

GST

The Goods and Services Tax (GST) is 10% on most things except food. In section 8C in the Units 1 & 2 textbook, we covered GST in detail. Please refer back to that section if you need a refresher, plus there are some examples about calculating GST in Chapter 3 of this Units 3 & 4 textbook.

GST is collected from businesses and employers by the ATO and distributed to the states and territories to use in their budgets.

Fuel excise tax

Fuel excise is a flat sales tax levied by the Australian government on petrol and diesel bought at the bowser when you fill up with petrol. In February 2024, the excise rate was 49.6 cents for every litre of fuel purchased. The rate of fuel excise is adjusted in February and August each year in line with inflation and is in addition to the GST.

Tobacco and alcohol taxes and excise taxes

The Australian government applies different taxes on tobacco products and alcoholic beverages because their consumption and abuse causes social harm. These are sometimes called 'sin' taxes, and they are used to increase prices and reduce demand.

These excise taxes are automatically included in the price, so we don't really notice them, except when petrol prices jump sharply.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 5 Calculating the fuel excise based on the CPI

After a government initiative to reduce the fuel excise rate, the full fuel excise rate was reinstated to 46.00 cents/litre in 2022. The CPI rate was 3.7% p.a. at the time. Calculate the new excise that was charged after the first indexed increase.

THINKING	WORKING
STEP 1	
Write the known information for the fuel excise rate and the consumer price index (CPI).	Excise rate: 46.00 cents/litre CPI: 3.7%
STEP 2	
Calculate the indexed increase by finding 3.7% of 46.00. Then add the increase to the current excise rate. Alternatively, you can use the % key on your smartphone calculator (46.00 + 3.7% =).	Increase = 3.7% of 46.00 = 0.037 × 46.00 = 1.702 New excise rate = 46.00 + 1.702 = 47.702 = 47.70 (rounded to 2 decimal places)
STEP 3	
Write your answer, including the units.	After the first indexed increase, the fuel excise rate was 47.70 cents/litre.

10D Tasks and questions

Thinking task

1 List at least five things that are funded by our taxes. Research each one and find out about how much money is allocated in each of those five areas.

Skills questions

2 Calculate the Medicare levy for each of these taxable income amounts.

a $205,000 p.a. **b** $95,000 p.a. **c** $72,000 p.a.

3 Calculate the superannuation guarantee amounts due for the following gross income amounts in the 2024–25 financial year.

a $85,233 p.a. **b** $45,700 p.a. **c** $122,850 p.a.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4 In the 2024–25 financial year, Sian's monthly income was $12,749.84.

Use the tax table provided in this section to answer these questions.

- **a** In which tax bracket is Sian's income?
- **b** How many cents for each $1 over $135,000 does Sian have to pay?
- **c** On how many dollars does Sian have to pay the amount in part **b**?
- **d** Calculate the annual amount of income tax for which Sian is liable.
- **e** Calculate the annual Medicare levy at 2% p.a. of her gross income.
- **f** How much is the total tax (including the Medicare levy) for which Sian is liable for the year?

5 Dion is paid weekly. One week in the 2024–25 financial year, he worked 36 hours at $35.50/hour.

- **a** Calculate Dion's gross wage for the week.
- **b** If he earned the same amount every week, calculate his gross income per annum.
- **c** Calculate the tax Dion would pay.
- **d** Calculate the Medicare levy that he would pay.
- **e** Calculate the net pay for Dion per annum.
- **f** Calculate the net pay for Dion per week.

6 Harpreet has imported wooden jigsaw puzzles to sell in his toy store. His total cost for each puzzle is $22. To get his base selling price, he applies a markup of 30% that covers his indirect costs and his profit.

- **a** How much is the markup that Harpreet applies to each puzzle?
- **b** What is the base selling price of each puzzle?
- **c** How much GST will Harpreet add to the base price of each puzzle?
- **d** What is the final retail price of each puzzle?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

7 This is an extract from a supermarket docket. The items that attract GST are marked with # on the left-hand side.

	$
#PineO Cleen Disinf Eucalyptus 1.25L	7.00
#Whiskas ohSo Meaty Meat Cuts 12×85g	12.00
^ W/wings Flour Self Raising 2kg	3.60
Campbells Real Stock R/slt Chicken 500mL	
Qty 2 @ $2.30 each	4.60
Uncle Tobys Oats Traditional 1kg	
Qty 2 @ $6.50 each	13.00
#Arnotts Biscuits Ginger Nut 250g	
Qty 2 @ $2.50 each	5.00
Campbells Soup Creamy Celery 410g	
Qty 2 @ $1.80 each	3.60
11 SUBTOTAL	$48.80
TOTAL	$48.80

a How many items had GST applied?

b Calculate the total of the items that had GST applied.

c Calculate the amount of GST that applied to these items.

d What percentage of the total of the docket is GST?

Mixed practice

8 Bindi is a 45-year-old mother of three teens. She is an accountant, earning $86,000 gross per annum. She has developed a critical illness and is unsure if she will be able to return to work. When she was 30, she bought a life insurance policy that costs $55 per month.

a How much has Bindi paid for this policy?

b The trauma insurance in her life insurance policy is capped at $500,000. How many years' work does this amount represent for Bindi?

c Explain whether you think that Bindi has invested wisely with her life insurance product.

9 Joe is 19 and earns a gross annual salary of $45,500, with an employer superannuation contribution rate of 11.5% p.a.

a Use an online superannuation calculator to estimate how much his superannuation will be when he turns 70 years of age (assuming that Joe's income does not change).

b Explain how you think Joe's financial circumstances will change before he retires, and how these changes will affect his retirement superannuation amount.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

10 The following is an excerpt from a fuel docket.

United

Welcome to United United Cranbourne Park
High Street
Cranbourne VIC 3977
PH: 03 5996 6159
Store ABN:
Fuel ABN: 52 995 832 068

TAX INVOICE

*P:6 PREMIUMm95 28.00L @ 2.0179 $/L	$61.01
SALE TOTAL:	$61.01
EFTPOS:	$61.01
GST total in sale:	$5.55

a The petrol was purchased in 2022, during the period that the fuel excise was halved to 22.1 cents/litre. Calculate how much fuel excise was included in the total price.

b If the fuel excise had been at the full rate of 44.2 cents/litre, what would the price per litre have been?

11 Rebecca works two part-time jobs. In the 2024–25 financial year, she earned $52,345 from her first job, and $40,632 from her second job. Her grandmother gave her $10,000 for her 25th birthday. During that year, she made a donation of $1,500 to World Vision.

a Calculate Rebecca's total gross income.

b Calculate Rebecca's eligible total deductions.

c Calculate Rebecca's total taxable income.

d Calculate the tax that she will have to pay.

e How much superannuation contributions would her employers have paid into her superannuation fund that year?

Application tasks

12 Tia is 22 and earns $2,250 gross per fortnight. The Superannuation Guarantee contribution from her employer is 11.5% p.a. She will be eligible for the aged pension when she turns 70 years of age.

a Calculate her annual gross income. (Assume there are 26 fortnights in a year.)

b Put these figures into an online superannuation calculator like *Moneysmart*. Assume she is going to continue to earn the same amount and that she is starting her Super from scratch. What does the calculator indicate that her retirement superannuation amount will be?

c Do you expect that Tia's income will rise during her working life?

d Do you think that this will be enough for Tia to live comfortably when she retires?

e What would happen if she topped up her Super contributions by adding some of her income as salary sacrifice?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

13 Brin earns $122,000 gross per annum. His Superannuation Guarantee is 11.5% p.a.

a Research to find out the maximum combined amount that the compulsory superannuation paid by his boss, and his salary sacrifice, can be in one year.

b What is the tax rate on the salary sacrifice contributions to his superannuation?

c Using the ATO income tax brackets, what is the other advantage to Brin if he makes the maximum salary sacrifice?

14 This table compiled in May 2024 compares five superannuation funds for someone who is aged from 18 to 29, with up to $55,000 in Super savings.

Provider	Product information	Annual fees at $50k balance	1 year return	5 year return
AMAZE! SUPER	*Amaze Super* High Growth (Lifecycle investment)	$497	10.1% High Growth (Lifecycle investment)	7.9% High Growth (Lifecycle investment)
Hero's Choice	*Hero's Choice Super* Balanced (Accumulation)	$382	6.9% Balanced (Accumulation)	6.6% Balanced (Accumulation)
STRIKE	*STRIKE* Balanced Growth	$477	7.8% Balanced Growth	6.7% Balanced Growth
Greensmart Super	*Greensmart Super* Personal Account – Balanced (MySuper)	$351	7.5% Balanced (MySuper)	6.5% Balanced (MySuper)
EQUINOX	*Equinox Super* High Growth (Lifecycle investment)	$497	10.1% High Growth (Lifecycle investment)	7.9% High Growth (Lifecycle investment)

a Based on this table, which superannuation fund would you choose, and why?

b Superannuation funds have a wide variety of additional services and investment options. Do a quick search of several funds to find at least three of these options.

c Now that you've had a closer look at different superannuation funds, list three considerations that you would make when choosing your superannuation fund.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

10E National and global money factors

If you are thinking about going on an overseas holiday, one of the things you will consider is whether your money will give you more or less value in different countries. This is based on the international currency exchange rate.

This is similar to what happens when countries trade goods. Australia has many trade deals with other countries such as NZ, China, US, UK, Japan, Thailand and more. Given that Australia has fairly open trade arrangements with many other countries, when their demand for our goods and services changes, this can have a flow-on effect to our economy.

Supply and demand

If another country has an increase in demand for Australian salmon, but we cannot increase supply, then the price will increase. Likewise, if we have an oversupply but not enough demand for the product then the price will decrease.

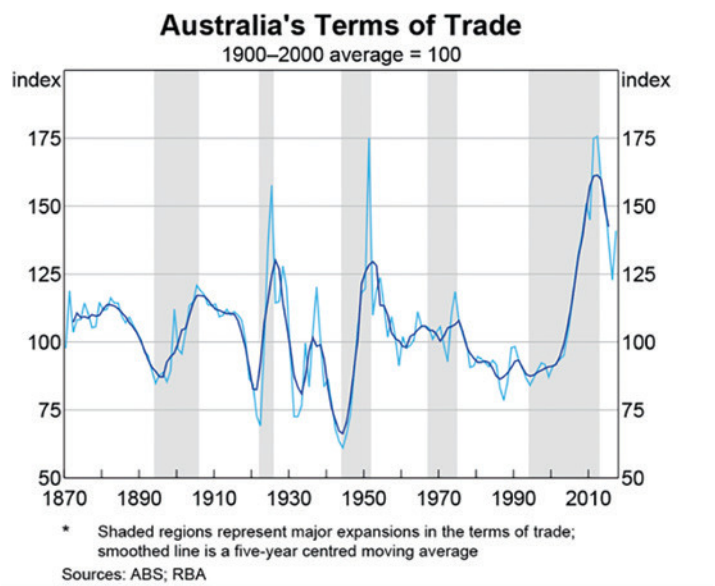
Terms of trade

The ratio of export prices to import prices is called the terms of trade. This graph shows what happened to Australia's terms of trade between 1870 and 2010.

Activity

1 What does the index show? What is the 100 on the scale mean?

2 Can you think of reasons why some periods have spikes and others have troughs?



On the other side of the equation, we have imports. Some imports that we rely on have immediate impact on people's lives. An example of this is fuel prices.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Gross domestic product

The Gross Domestic Product (GDP) is the total monetary or market value of all the finished goods and services produced within a country's borders during a specific time period. In Australia it is reported quarterly.

It serves as a comprehensive scorecard for assessing a country's economic health. A country's GDP tends to increase when the total value of goods and services sold to foreign countries exceeds the value of foreign goods and services bought by domestic consumers (trade surplus). Conversely, if domestic consumers spend more on foreign products than domestic producers sell to foreign consumers (trade deficit), the GDP tends to decrease.

Recessions

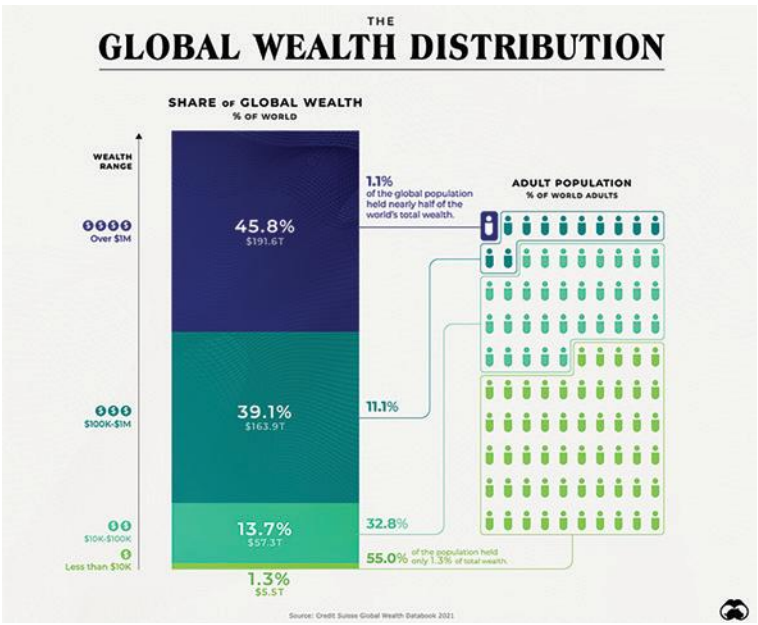
A **recession** is defined differently by different sections of the economy. Journalists often define a recession as when the economy is declining for **two consecutive** 3-month periods, usually referred to as 'quarters' because they are a quarter of the financial year.

Economists define a recession as a significant decline in economic activity (the GDP of a country) that lasts for more than a couple of months. The effects of a recession are lower real wages, lower employment levels and lower retail and wholesale sales.

A **depression** is a severe or long-term recession.

How is the world's wealth distributed?

This infographic was produced in 2021.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Clearly there is a huge difference between personal wealth around the world. About 50% of the world's wealth is in the hands of about 1% of the world's population.

The following chart shows data for total wealth and wealth per adult across different regions in 2022.

Region	Total Wealth (US$B)	Change in Total Wealth (US$B)	Change %	Wealth Per Adult (US$)	Change %
North America	136,316	12,370	10.0	486,930	9.1
Europe	103,213	9,179	9.8	174,836	9.8
Asia-Pacific	75,277	4,694	6.7	60,790	5.0
China	74,884	4,246	6.0	67,771	5.4
India	12,833	–594	–4.4	14,252	–6.1
Latin America	10,872	–1,215	–10.1	24,301	–11.4
Africa	4,946	36	0.7	7,371	–2.1
World	**418,342**	**28,716**	**7.4**	**79,952**	**6.0**

The wealth per adult in North America far exceeds even that of Europe – but we know from our studies with statistics that we cannot apply overall figures to any given individual.

Using the same measures, Australia comes in as the third highest average wealth per adult – behind Switzerland and the United States.

10E Tasks and questions

Thinking task

1 What effect does a strong national and international economy have on you as a wage earner and as a consumer? Share and compare your thoughts with your classmates.

Mathematical literacy

2 Think about the different words and terms related to national and global financial factors that we have met in this section. Some of these include:

- recession
- depression
- supply
- demand
- terms of trade
- GDP.

Work with some classmates to brainstorm the terms you find and what they mean.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Skills and application questions

3 One of the international commodities that varies is the currency exchange. This measures what the Australian dollar is worth in other currencies.

Let's imagine that you have $5,000 to spend on a holiday.

a Find a trustworthy live online foreign exchange calculator. Use the calculator to complete this table.

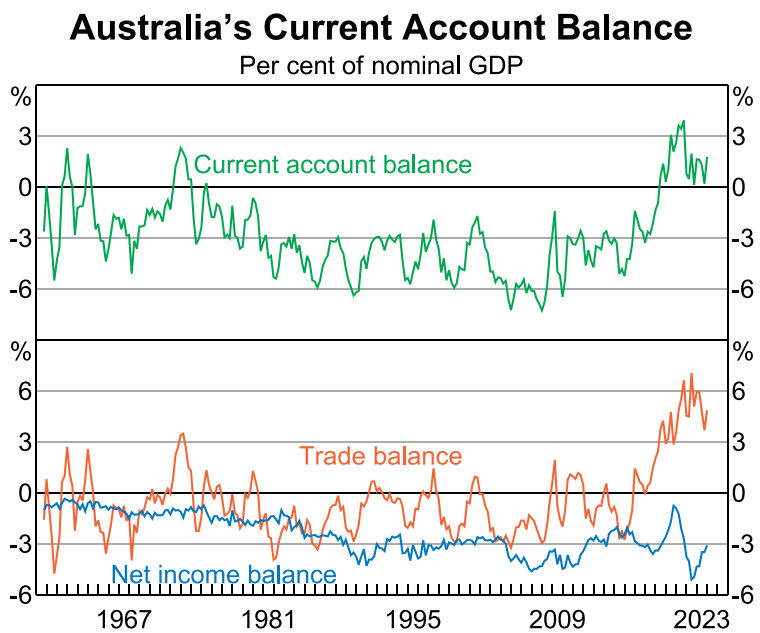
Foreign currency	Amount you get for 1000 Australian dollars	Exchange rate (2 decimal places)
US dollar		
Euro		
Indonesian rupiah		
Japanese yen		
New Zealand dollar		
(*currency of your choice*)		

b What does an exchange rate of greater than 1 mean for your spending money?

c What does an exchange rate of less than 1 mean for your spending money?

d What impact will this have when you are deciding where to go on holiday?

4 Use the graph to answer the questions that follow.



Sources: ABS; RBA.

a Briefly explain what these graphs show.

b Briefly explain what a negative trade balance means in this context.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

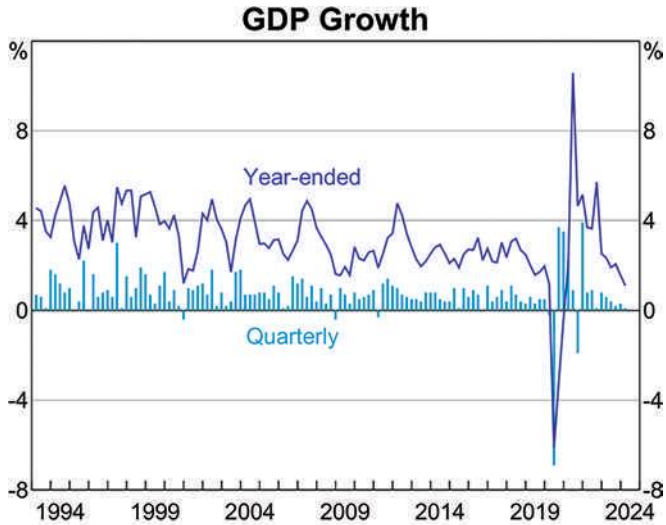
5 Answer the following questions using the graph about Australia's GDP yearly and quarterly growth that follows.

a Explain whether or not you assess this data source as reliable and current.

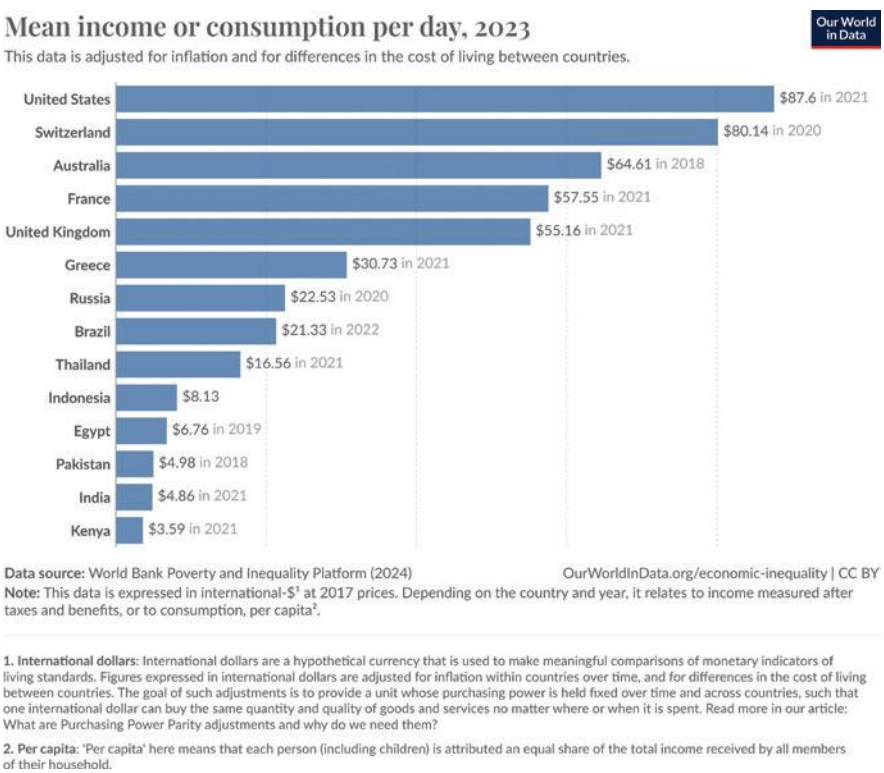
b What further information would you want to see in this data?

c What does it mean if the data is above the zero line?

d What does it mean if the data is below the zero line?



6 Use this graph to answer the questions that follow:



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

a Explain how the mean income might have been calculated.

b Calculate the range of mean values given in this graph.

c Calculate the United Kingdom figure as a percentage of the Switzerland figure.

d Calculate the sum of the top three figures as a percentage of all figures given in the graph.

7 Use this table to answer the questions that follow.

Australia's Major Trading Partners – Exports

Average annual share of Australia's exports by decade, per cent

	UK	EURO AREA	JAPAN	MAINLAND CHINA	SOUTH KOREA	OTHER EAST ASIAN ECONOMIES[1]	UNITED STATES	OTHER ECONOMIES
1900s	48	19	1	1	0	2	5	23
1910s	49	17	3	0	0	3	7	20
1920s	41	23	7	0	0	4	7	16
1930s	52	17	8	2	0	3	6	12
1940s	34	8	1	1	0	4	19	34
1950s	33	22	9	0	0	5	8	23
1960s	18	15	18	4	0	7	11	26
1970s	7	11	29	2	1	10	11	28
1980s	6	10	24	3	4	15	12	28
1990s	5	7	22	3	6	21	10	26
2000s	6	6	17	9	7	18	9	28
2010s	3	4	14	27	7	17	5	22
2020s	4	4	12	35	6	16	6	18

Sources: ABS; DFAT; RBA

1. Other East Asia includes Taiwan, Singapore, Hong Kong, Indonesia, Thailand, Philippines, Malaysia and Vietnam

a Research the sources of this data to assess its reliability and validity.

b Which region fell the most in annual percentage of Australian exports?

c Which region rose the most in annual percentage of Australian exports?

d Briefly explain how Australian exports partners have changed since the 1900s.

8 Search for articles or watch some videos on cobalt mining in Africa.

a Find, analyse and report on some of the data about the production and prices of cobalt worldwide, with a focus on Africa, and in particular the Democratic Republic of Congo.

b List three reasons why cobalt prices have increased.

c What is the main use of cobalt?

d What are some of the problems around the mining of cobalt?

e What products do you own that require cobalt in their manufacturing?

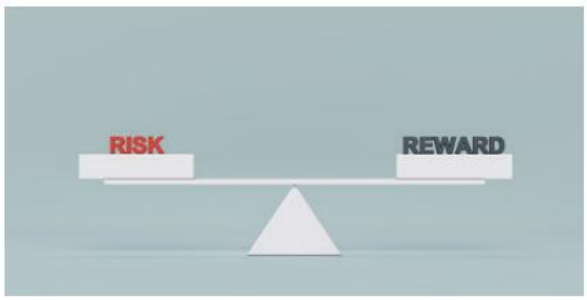
f What could you do to positively impact the world's cobalt problems?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

10F Risk versus reward

In investing terms, risk refers to the potential for financial loss. It represents the uncertainty associated with an investment.

The riskier an investment is, the more likely you could lose your money.



Property investors lose hundreds of thousands of dollars through unregulated real estate advice

ABC RN / By business reporter Michael Janda for *The Money*
Posted Fri 25 Oct 2019 at 6:00 am, updated Fri 25 Oct 2019 at 9:44 am

Examples of higher-risk investments include:

- smaller, less-established firms that may have higher volatility
- growth stocks: stocks that have the potential for substantial gains but also come with higher risk due to their price fluctuations or what economists call volatility
- cryptocurrencies: digital currencies like Bitcoin are known for their extreme volatility.

Reward on the other hand, refers to the financial return an investor receives from investing. Investors seek rewards in the form of capital gains (increased stock value) or dividends (regular payments from a company).

Risk versus reward relationship

These two concepts are intrinsically related. Investors usually expect a greater reward as compensation for taking on more risk. If low-risk investments offered the same reward as high-risk ones, everyone would choose the low-risk option.

The goal is to achieve the maximum reward for a given level of risk.

Managing risk and reward

There are a few approaches that are recommended to manage risk.

- Diversification: spread investments across different assets (companies, sectors, geographies) to reduce risk.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- Index funds and Exchange traded funds (ETFs) are a low-cost way to earn a return and can also help to diversify your investments. ETFs provide exposure to a broad market, reducing individual stock risk.
- Invest a fixed amount regularly to mitigate market timing risk.

The *Moneysmart* website has advice about investments and selecting appropriate funds etc.

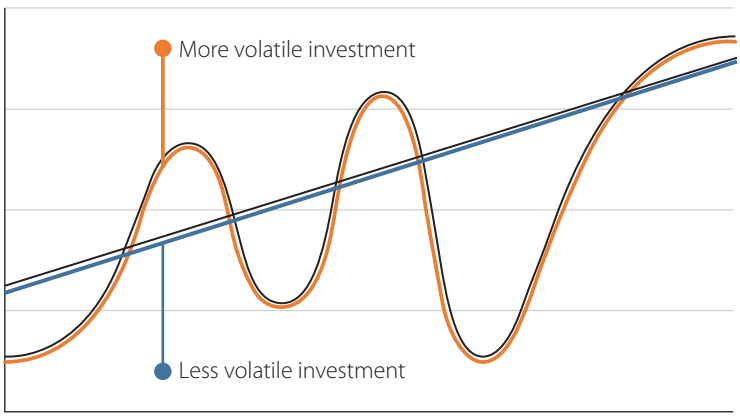
The key word is 'if'!

Investment always has a balance of risk and reward and there is always the risk that you will lose. The more that you risk (invest) the more you can lose.

Finding the right balance between risk and reward is crucial for successful investing. Assess your risk tolerance, set clear objectives, and make informed decisions based on your personal situation.

Volatile investments have large highs and lows, and less volatile investments have steady change.

Which of the two curves shown do you think carries the lower risk?



Choosing investments according to risk and return

There are two key factors that you should consider when deciding if the reward is worth the risk.

- **How long will you invest for?** Remember that while your money is invested you cannot touch it or use it.
- **How much risk are you willing to take?** Consider what you could lose if the investment fails? Are your main assets safe? Can you afford this? Will it negatively impact your future?

Stocks and shares

Buying stocks is a way of investing your money in companies that you believe will result in a good profit when you sell them later. Shares is the value that the market put on the company stocks.

These companies are listed in the Australian Stock Market, known as the ASX. But every transaction, whether buying or selling, will incur a stockbroker fee.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 6 Buying and selling shares on the stock market

Talyia had $5,000 available to buy shares when they were valued at $3.95 per share. The brokerage fee for this purchase was $15.84. Two years later, she sold these shares when they rose in value to $4.80 per share. The same brokerage fee applied. Did she make a profit or a loss? Of how much?

THINKING	WORKING
STEP 1	
List the known information when the shares were bought.	Investment: $5,000 Brokerage fee: $15.84 Share price: $3.95
STEP 2	
Subtract the brokerage fee from the available amount to be invested.	$5,000 – $15.84 = $4,984.16
STEP 3	
Calculate the number of shares bought by dividing by the cost of one share. Round down to a whole number of shares.	$4,984.16 ÷ $3.95 = 1261.8 The number of shares bought was 1261.
STEP 4	
Work out the total cost of the shares. Add the brokerage fee to the cost of 1261 shares.	1261 × $3.95 = $4,980.95 $4,980.95 + $15.84 = $4,996.79 The total cost of 1261 shares was $4,996.79.
STEP 5	
Calculate the value of the shares after two years.	1261 × $4.80 = $6,052.80 Value of the shares after two years was $6,052.80.
STEP 6	
Subtract the brokerage fee from the value of the shares to calculate the amount received after the sale.	$6,052.80 – $15.84 = $6,036.96 The amount received after the sale was $6,036.96.
STEP 7	
Decide whether a profit was made and the amount of the profit or loss.	The amount received after the sale was more than the original investment, so a profit was made. Profit = $6,036.96 – $4,996.79 = $1,040.17

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Cryptocurrencies

What would you do if one of your friends recommended that instead of buying a new phone you should invest in cryptocurrency?

Cryptocurrencies are financial technologies, called **fintech** (a term formed from the words 'financial' and 'technology'). These are not traditional banking currencies and are not as thoroughly regulated as the banking sector. Cryptocurrency is a digital or virtual form of money that operates differently from traditional currencies.

'Crypto' refers to the various encryption algorithms and cryptographic techniques that provide secure online payment entries. Bitcoin, Ethereum and Dogecoin are examples of cryptocurrencies that are popularly traded by investors.

Trade of cryptocurrency is a largely unregulated process, and this leaves space for risky dealings. Crypto-crime is on the rise, with scammers creating fake cryptocurrency trading platforms or fake versions of official crypto wallets to exploit victims. The Australian Competition and Consumer Commission reports that Australians lost $99 million to crypto-asset scams in 2021 (ACCC, 2022).

These are some things you should know.

- Cryptocurrency has unstable prices and can fluctuate by large amounts in short spaces of time.
- Some investors see cryptocurrency as a way to make quick money. The flip side of this is that others will lose a lot of money.
- The transactions that are made with cryptocurrencies are known as blockchain. Once a trader has enough orders for a currency or a block of transactions, they will send an order to buy. Blockchain currencies, such as Bitcoin, then verify the transactions to attempt to prevent fraud.
- The trader is not controlled or regulated.
- Cryptocurrency is not considered to be legal tender. You cannot pay your taxes or rates with cryptocurrencies.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Using these fintech products carries both **risk** and **reward.** Once you are aware of some of the risks (dangers), then you will be more informed to decide whether the risks are justified to potentially get the rewards.

As with all investments, you need to be able to work out the costs of investments in cryptocurrency, and check whether you are making a profit or loss.

Example 7 Calculating profit from Ethereum

Bruce bought $100 of Ethereum when the price for Ethereum was $1,206. How much profit did he make if he sold when the price rose to $1,480?

THINKING	WORKING
STEP 1	
List the known information when the Ethereum coin was bought.	Purchase price: $100 Price of Ethereum: $1,206
STEP 2	
Divide the price Bruce paid by the price of the cryptocurrency.	$100 ÷ $1,206 = 0.0829 Bruce owns 0.0829 of Ethereum coin.
STEP 3	
Multiply the amount of Ethereum coin Bruce owns by the new price.	0.0829 × $1,480 = $122.72 Bruce receives $122.72 after the sale.
STEP 4	
Subtract the purchase price from the new amount.	$122.72 – $100 = $22.72
STEP 5	
Interpret the result and write your answer.	Bruce made $22.72 in profit. However, Bruce will have to pay tax on this income.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Crowdfunding

Crowdfunding is using the internet to access large numbers of people to raise money. Crowdfunding is a method of raising capital through the collective effort of friends, family, customers and individual investors. It taps into the collective power of a large pool of individuals, primarily online via social media and crowdfunding platforms, to leverage their networks for greater reach and exposure.

Some reasons for crowdfunding

- Donating to a cause or person in need – intrinsic rewards, you will feel good that you have helped
- An entrepreneur seeking funds to develop a product – you may get financial shares or products in return
- A new company seeking funds – you may get financial shares or products in return
- Providing loans to people or groups in need – you may receive interest for the loan you provide.

How it works

- The project creator sets up a campaign on a crowdfunding platform, describing their idea, goals and funding needs.
- Backers (individuals or groups) contribute funds to the campaign. The collective contributions add up to try to reach the funding goal.
- If the goal is met within the specified timeframe, the project receives the funds. Otherwise, backers are not charged, and the project may not proceed.

To crowdfund:

- Choose a platform.
- Be clear with your idea.
- Put a value on what you want.
- Write a pitch.
- Design a campaign.
- Use social media to advertise your idea and direct donations to your crowdfunding page.
- Be accountable! Follow through and reward your donors.

Crowdfunding requires you to keep close tabs on how the funding offers are proceeding and whether targets are being achieved or not.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 8 Raising money through crowdfunding

Kaylen is starting a small business and will use crowdfunding to raise $10,000. She estimates that 5% of her subscribers to her social media campaign will pledge about $295 each to her crowdfunding project. If she is aiming for 30% of her funding goal to be met within the first 48 hours, calculate how many subscribers she needs.

THINKING	WORKING
STEP 1	
Calculate 30% of the funding goal.	30% of $10,000 = 0.3 × $10,000 = $3,000
STEP 2	
If the average pledge is $295, divide 30% of the funding goal ($3,000) by $295 to find the number of backers she needs in the first 48 hours.	$3,000 ÷ $295 = 10.169 … Kaylen will need 11 people to pledge $295 to make 30% of the funding in the first 48 hours.
STEP 3	
Calculate the number of subscribers she needs if, on average, only 5% of subscribers become backers.	5% of subscribers = 11 backers 0.05 × number of subscribers = 11 Number of subscribers = 11 ÷ 0.05 = 220
STEP 4	
Interpret the result and write your answer.	Kaylen will need 220 subscribers to get 11 backers in the first 48 hours.

10F Tasks and questions

Thinking task

1 For the table below, decide the risk level for each type of investment – *low*, *medium* or *high* and give at least one reason why. Share and compare your thoughts with your classmates.

Investment type	Risk level	Why?
Cryptocurrency		
Start-ups		
Stocks		
Property		
Savings accounts		

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Skills questions

2 The volatility of Bitcoin shows the perils of investing. This graph charts the daily price of Bitcoin.

a Use the internet to find out when Bitcoin began.

b What was a Bitcoin worth around the start of 2018?

c Looking at the period from 2016 to mid-2020, would you have been happy if you bought into Bitcoin in December 2017?

d Would you have been happy if you bought into Bitcoin at the start of 2021?

e What would your expectation be if you bought into Bitcoin at the start of 2021?

f Estimate how many US dollars came off the Bitcoin value in mid-2021.

g Why would the value increase in the second half of 2021?

h What does the graph show about the value of Bitcoin at the end of 2022?

i What is your projection for the value of Bitcoin in the long term?

j Would you invest your savings in Bitcoin? Why or why not?

3 You invested $3,500 buying shares worth $6.90 and paid a brokerage fee of $17.60.

a How many shares did you buy?

b If you sold these shares when they were worth $6.95, paying the same brokerage fee, did you make a profit or loss? Of how much?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4 You are planning a crowdfunding campaign to raise $10,000 to support the local wildlife rescue centre. You are asking people to pledge $100 to this cause.

- **a** What amount of money should be your target in the first two days?
- **b** How many people do you need to raise the full amount?
- **c** Given that the data shows that only 5% of people contacted will pledge this amount, how many people will you need to contact?
- **d** Explain the period of time that you would run this crowdfunding venture.

5 Suzy wants to buy $500 of the cryptocurrency Litecoin at the market price of $120. If the price of Litecoin falls to $90, how much has she lost?

6 You are crowdfunding $6,000 to renovate the local footy clubrooms to suit the needs of your girls' teams. You aim to raise a minimum of 30% of this amount in the first two days and you're asking people to pledge $50.

- **a** What is the first two days' funding goal amount?
- **b** How many people do you need to make a $50 pledge?
- **c** What strategies could you use to get more people to pledge?
- **d** How would you pitch this crowdfunding to businesses in your local area?

Mathematical literacy

7 Match each term on the left with its meaning on the right.

Term	Meaning
a Crowdfunding	**A** How investments can increase and decrease in price according to various external economic factors. Related to the volatility of investments
b Cryptocurrency	**B** A method of raising capital through the collective effort of friends, family, customers and individual investors
c Risk and reward	**C** The value that the market puts on the stocks of a company
d Shares	**D** Type of digital currency that allows people to make payments directly to each other through online systems
e Stocks	**E** When the value of an investment rises and falls very quickly
f Volatility	**F** Where you are investing your money in companies that you hope will give a good profit over time

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Application tasks

8 Source a graph or chart depicting fluctuations in the value of a cryptocurrency over time (Bitcoin, Dogecoin and Ethereum are good examples). Write a story making mathematical statements about the percentage increase and decrease at various time points.

9 One of your friends recommends that instead of purchasing a new $1,000 phone, you invest that money in a cryptocurrency. Investigate which investment option with cryptocurrency would be most interesting to you with your $1,000.

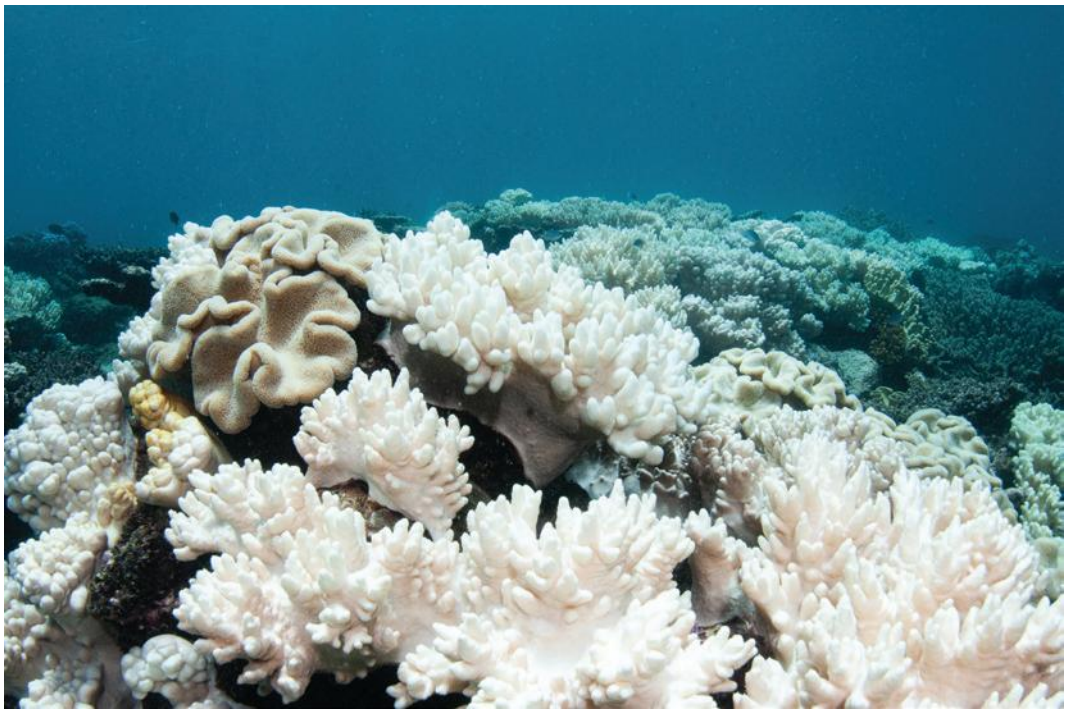
- **a** Choose a cryptocurrency and briefly explain why you have selected this currency.
- **b** What was the value of your currency on 1 March 2023?
- **c** Show what happened to the value in your currency over one week.
- **d** Show what happened to the value in your currency over one month.
- **e** Show what happened to the value in your currency over one year.
- **f** What is your currency worth today?
- **g** Has it increased or decreased in value?
- **h** Show the data on a chart or graph.
- **i** What recommendations would you make to someone considering investing in this cryptocurrency?

10 Research crowdfunding and find some examples of successful and unsuccessful campaigns. Answer the following questions based on your research.

- **a** How is crowdfunding managed and controlled in Australia?
- **b** What are the benefits of crowdfunding?
- **c** What are the challenges and downsides of crowdfunding?
- **d** What is the success rate?
- **e** Are there minimum targets about the funding goal you need to meet?
- **f** Is there any data available about the proportion of subscribers who pay up and become backers?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

10G Environmental and health issues



Data and statistics play a pivotal role in understanding and comprehending environmental issues. Data provides empirical evidence related to environmental changes, and the statistics help quantify trends, correlations and enable researchers to study for any causal relationships.

Regular data collection allows us to monitor environmental factors such as air quality, water pollution, deforestation rates, and climate change indicators. They help track progress over time. Data can reveal patterns, cycles and anomalies.

Such data supports public awareness and advocacy, and you need mathematical knowledge and skills to read and interpret the data visualisations and infographics.

In summary, the mathematics underpinning data and statistics empower us to understand, address and safeguard our environment effectively.

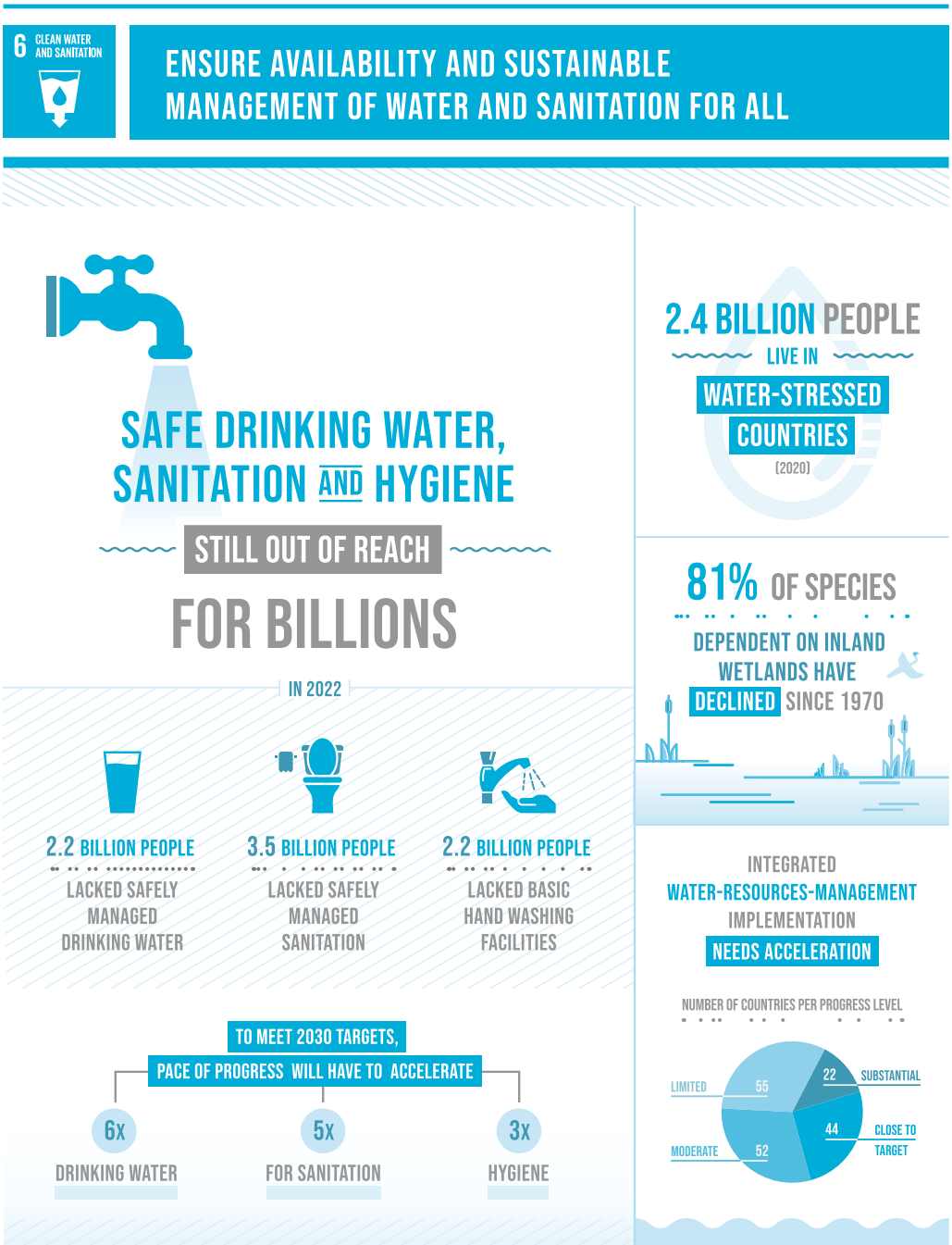
Water

Can you imagine not having clean water to drink and to use in cooking? What about not having flushing toilets and handwashing facilities?

Unfortunately, that is still the case for many people in the world.

This infographic is Goal #6 of the U.N. Sustainable Development Goals (SDGs).

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.



A summary of the SDGs 2023 Report says that:

- To achieve safe drinking water for everyone by 2030, the world's efforts will have to increase by a factor of 6.
- In 2020, 2.4 billion people (about 30% of the world's population) live in water-stressed countries.
- Only 0.5% of water on Earth is useable and available fresh water.

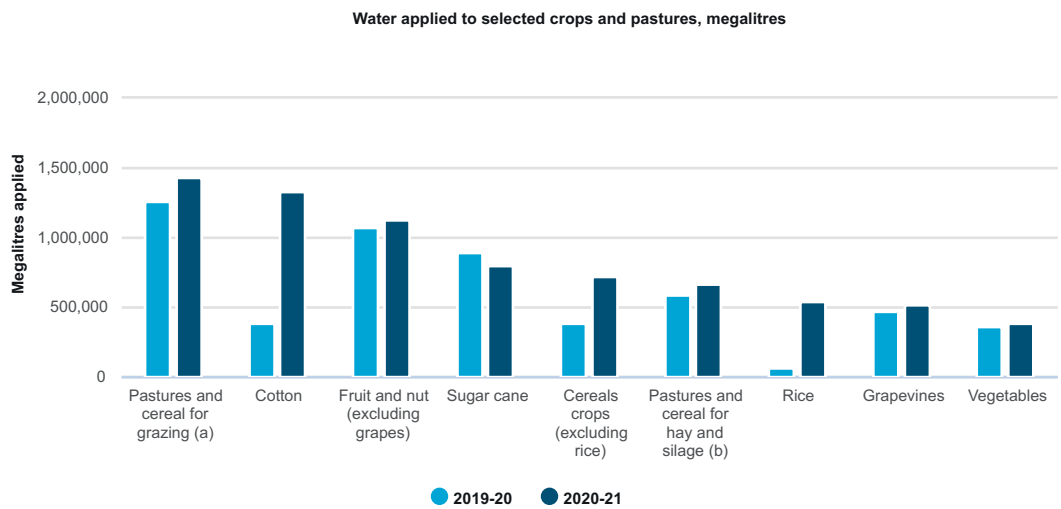
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Australia has a complicated relationship with water. In some parts of the country, too much rain means devastating flooding, while other areas suffer from prolonged droughts. Sometimes these weather extremes are referred to as a 'Once in a 100 years' event. This does not mean that the event will happen only once in a hundred years. It does mean that the event is extreme and unusual.

The Australian Government National Water Initiative (NWI) has the following goals:

- *prepare water plans with provisions for the environment*
- *achieve sustainable water use in over-allocated or stressed water systems*
- *introduce registers of water rights and standards for water accounting*
- *expand trade in water rights*
- *improve pricing for water storage and delivery*
- *better manage urban water demands.*

The ABS found that in 2019–20 and 2020–21, water was applied to selected crops and pasture in the following amounts in Australian agriculture.

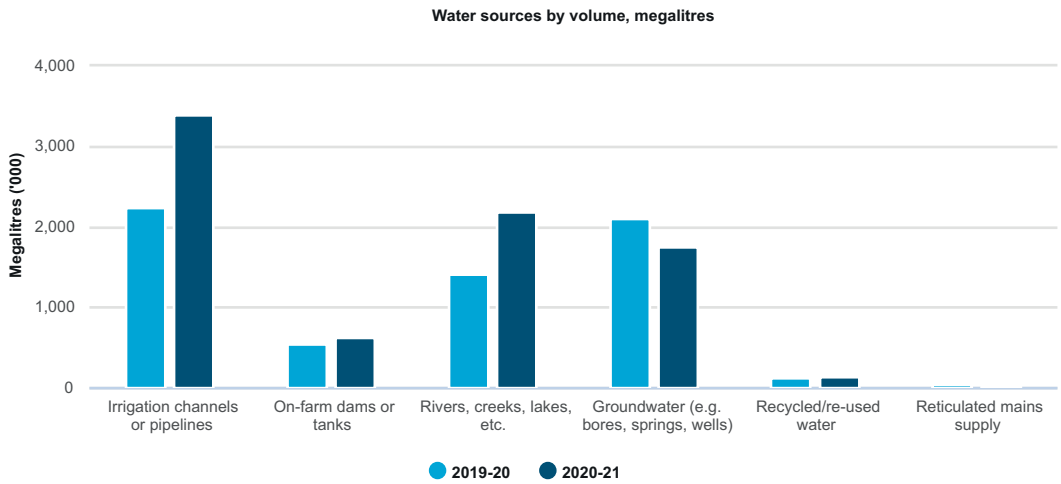


(a) Includes both lucerne pastures and areas of cereal crops fed off
(b) Includes lucerne pastures cut for hay and silage

Source: Australian Bureau of Statistics, Water Use on Australian Farms 2020-21 financial year

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

The sources of this water for agricultural production are shown in this graph.

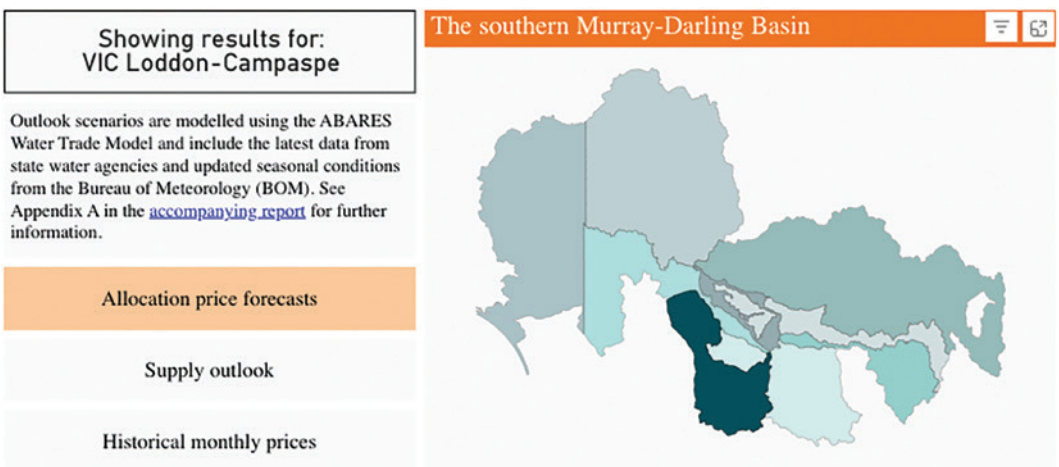


Source: Australian Bureau of Statistics, Water Use on Australian Farms 2020-21 financial year

Different regions in Australia have different authorities allocating and charging for water for farming irrigation. One region is the Southern Murray Darling Basin, which covers both NSW and Victoria. The water prices fluctuate depending on environmental conditions (rainfall, temperature, need to maintain environmental flows etc.).

Regional water usage and costs

An example of water costs is shown.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 9 Calculating a farmer's water costs

A farmer has 20 000 prime lambs on irrigated pasture, which require irrigation levels and drinking water equivalent to 0.7 L per animal per day in winter and 1.5 L per animal per day in summer or dry conditions.
What water allocation in megalitres, ML, will this farmer need if there are dry conditions for a whole year?
Assuming that the cost of the irrigation water in this year of dry conditions is $203 per ML, what will be the cost of water?

THINKING	WORKING
STEP 1	
Multiply the number of sheep by the annual water requirement for each sheep when there are dry conditions.	20 000 × 1.5 L × 365 = 10 950 000 L
STEP 2	
Convert litres to megalitres by dividing by 1 000 000.	10 950 000 L ÷ 1 000 000 = 10.95 ML
STEP 3	
Determine the cost for dry conditions and multiply this by the required volume of water.	$203 per ML × 10.95 ML = $2,222.85
STEP 4	
Write your answer.	In dry conditions, the farmer needs 10.95 ML of water each year at a cost of $2,222.85.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Car fuel

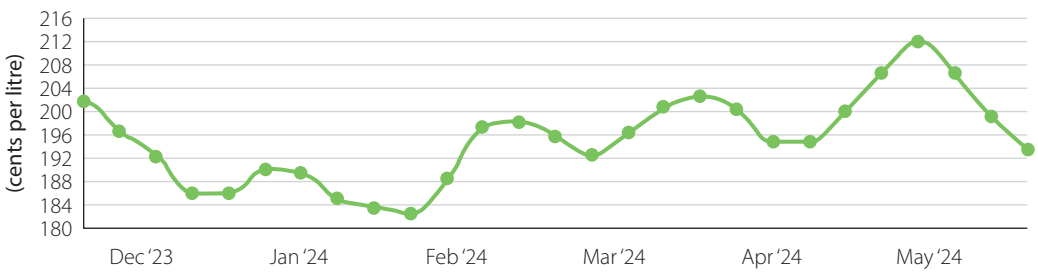
There are finite stores of fuel in the world as fuels come from vast reservoirs which were created millions of years ago when plants decomposed. There are approximately 1.6 trillion barrels of oil left in the world, which is roughly 47 years left at our current rate of consumption.

However, it would be entirely irresponsible if we burned all this oil due to the effect it has on climate change.

Fuel prices increase or decrease due to several factors such as:

- changes in international prices
- changes in supply
- value of the Australian dollar
- amount of competition there is
- wholesaler and retailer price setting.

This graph shows the average weekly petrol price in Australia over a 6-month period from November 2023 to May 2024.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Governments have a responsibility to shift consumer behaviour in Australia away from fossil fuels – petrol, diesel and gas – to responsible sources of energy such as renewables. They can do this through taxes (fuel excise tax) and policies such as installing electric charging stations for electric vehicles to encourage more people to buy electric vehicles.

In May 2024, the excise tax on unleaded petrol was $0.496 per litre (that's 49.6 cents per litre).

Example 10 Fuel price and excise

A Toyota Corolla petrol tank has a capacity of 55 litres. If fuel is 214.9 cents per litre, including the excise tax of 49.6 cents per litre, answer the following questions.

a How much will it cost to fill the tank?

b Of this cost, how much is fuel excise?

THINKING	WORKING
STEP 1	
Understand and interpret fuel prices. Fuel prices are written in cents, but we want to work in dollars.	214.9 cents per L = $2.149 per L
STEP 2	
Calculate the cost of filling the tank by multiplying the cost per litre by the number of litres.	Fuel cost: $2.149 per L × 55 L = $118.20
STEP 3	
Convert the fuel excise to dollars.	49.6 cents per L = $0.496 dollars per L
STEP 4	
Calculate the cost of fuel excise by multiplying the cost per litre by the number of litres.	Excise: $0.496 per L × 55 L = $27.28
STEP 5	
Interpret the results and write your answers.	a It will cost $118.20 to fill the tank. b The fuel excise in this cost is $27.28.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Solar energy

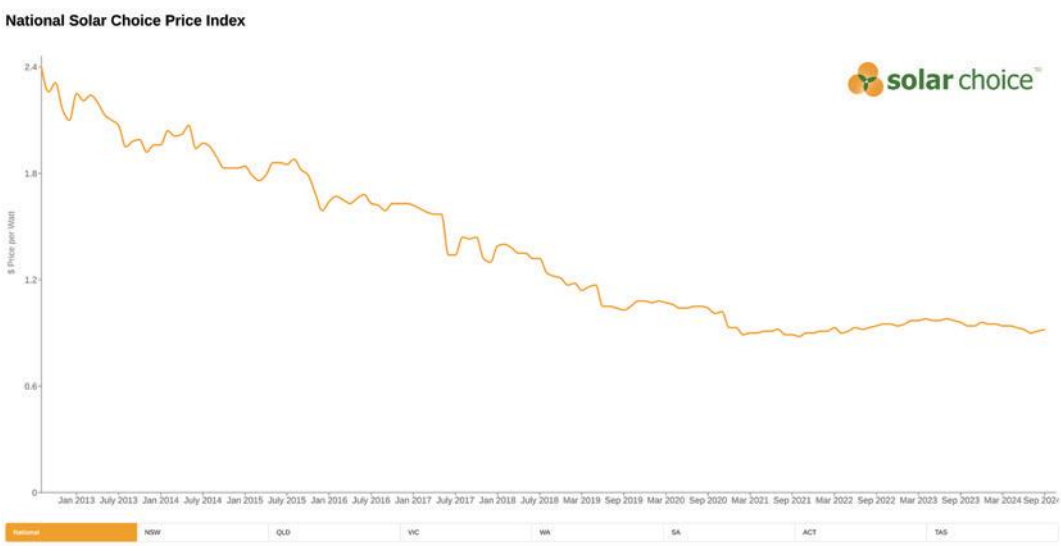
Climate change is a consideration for many Australians when selecting energy sources and providers for their home. Given that many Australian homes have been affected by the changing climate such as increasing bushfire frequency and ferocity, and increased flooding frequency, or more intense storms that cause widespread damage, affordability of solar panels is an important consideration.

The following table provides the average cost of different solar systems in Australia as of 2024. Can you think of some reasons why some areas cost more than others for the same number of kilowatts?

	3 kW	4 kW	5 kW	6 kW	7 kW	10 kW
Adelaide, SA	$3,760	$3,910	$4,610	$5,300	$6,370	$8,530
Brisbane, QLD	$3,700	$4,540	$4,980	$5,420	$6,210	$9,140
Canberra, ACT	$4,510	$4,760	$5,150	$5,810	$6,770	$8,770
Darwin, NT	$4,730	$6,780	$7,760	$9,320	$10,060	$13,060
Hobart, TAS	$5,050	$5,610	$6,180	$6,750	$7,710	$11,190
Melbourne, VIC	$4,300	$4,420	$4,940	$5,420	$6,330	$8,510
Sydney, NSW	$3,850	$4,230	$4,700	$4,880	$5,920	$7,970
Perth, WA	$3,370	$3,890	$4,210	$5,360	$5,950	$9,760
All	**$4,160**	**$4,770**	**$5,320**	**$6,030**	**$6,920**	**$9,620**

Source: solar choice

The cost of solar installation has been steadily declining in Australia as it becomes cheaper to produce solar panels and there is more competition in the market.
Of course, once you have paid off your solar panels, the only cost is maintenance.



Source: solar choice

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Physical activity and health

According to the government health website, about 13 million adults and 3 million children participate in sport each year. About two-thirds of the 15 to 24-year-old age group engage in physical activity three times a week.

About three-quarters of the 18 to 24-year-old age group reported that their main motivation for participating in sport and physical activity was to maintain health and fitness, while about half reported that it was for fun and enjoyment.

We all know that physical activity is beneficial to our physical, mental and social health. But how do we fit it into our busy lives?

Unfortunately, a 2019 study of 1.6 million school students found that Australia ranked 140th out of 146 countries for teens participating in physical activity.

The data from the Australian Institute of Health and Welfare and the ABS show that more than half of the adult population does not meet the physical activity guidelines.

Adults should be active most days, preferably every day. Each week, adults should do:

- 2.5 to 5 hours of moderate intensity physical activity – such as a brisk walk, golf, mowing the lawn or swimming

  or

- 1.25 to 2.5 hours of vigorous intensity physical activity – such as jogging, aerobics, fast cycling, soccer or netball

  or

- an equivalent combination of moderate and vigorous activities.

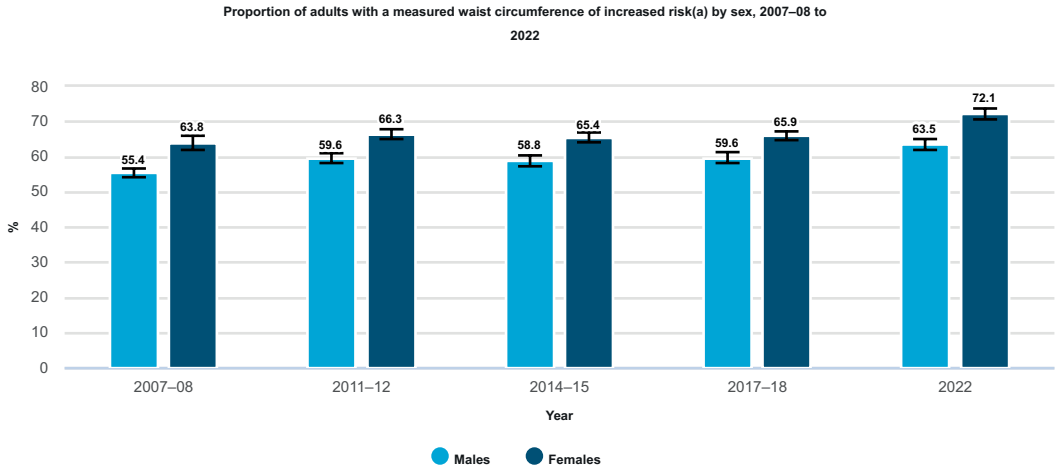
Barriers to participating in physical and sporting activities include not enough time; not enough disposable income to spend on sport; limited facilities in the local area; the cost of participation, and lack of transport.

Lack of regular physical activity is linked to a number of long-term health issues such as obesity, cardiovascular disease, high blood cholesterol, diabetes and strokes.

Waist circumference is a commonly used measure to assess the risk of developing obesity-related chronic diseases. A higher waist measurement is associated with an increased risk of disease.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

This graph from the Australian Bureau of Statistics shows the percentage of adults with a measured waist circumference of increased risk from 2007 to 2022.



a. A waist measurement of 94cm or more for males and 80cm or more for females.

Source: Australian Bureau of Statistics, Waist circumference and BMI 2022

10G Tasks and questions

Thinking tasks

1 In 2006, the Victorian government banned the selling of soft drinks by school canteens. However, this ban did not extend to fruit juices, milks or artificially sweetened drinks.

Then in 2020, the Victorian government updated its policy on school canteens only offering healthy food, and specifically banned all high sugar-content drinks and confectionery. Why do you think they made this updated change in 2020?

2 Why would the WHO be interested in increasing physical activity?

Skills questions

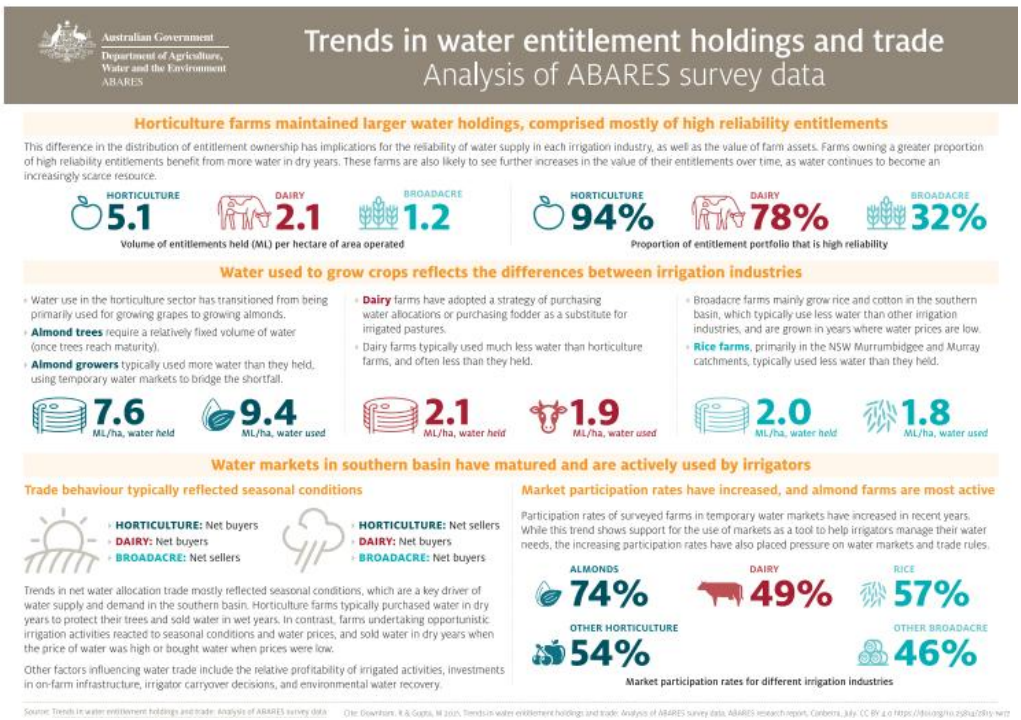
3 Answer the following questions that relate to the cost of fuel and the fuel excise.

a Calculate the cost of fuel if you buy 60 litres of petrol at $2.83 per litre. How much of this is the fuel excise? (The fuel excise levy is $0.496 or 49.6 cents per litre.)

b Calculate the cost of fuel if you buy 85 litres of LPG fuel at $1.99 per litre. How much of this is the fuel excise? (The LPG fuel excise levy is $0.162 or 16.2 cents per litre.)

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4 This infographic about how the water in the Murray Darling Basin is used, held and traded was published in July 2021.



a Explain the terms 'horticulture', 'dairy' and 'broadacre' and give an example of what each type of farm produces.

b Which product uses the most water? Did you find this surprising? Why or why not?

c How have dairy farms reduced their water use?

d What do the terms 'net buyer' and 'net seller' mean in this context?

e How does the weather affect how the horticulture farms trade in water?

f Research and briefly explain how the control of the use of the Murray Darling Basin has affected the wetland environment in South Australia.

5 Ask your teacher for access to a spreadsheet with the data for greenhouse gas emissions in Australia. It is called 'Greenhouse emissions Australia'. One source is the Department of Climate Change, Energy, the Environment and Water. Alternatively, you can search for the data yourself.

a Create a scatterplot.

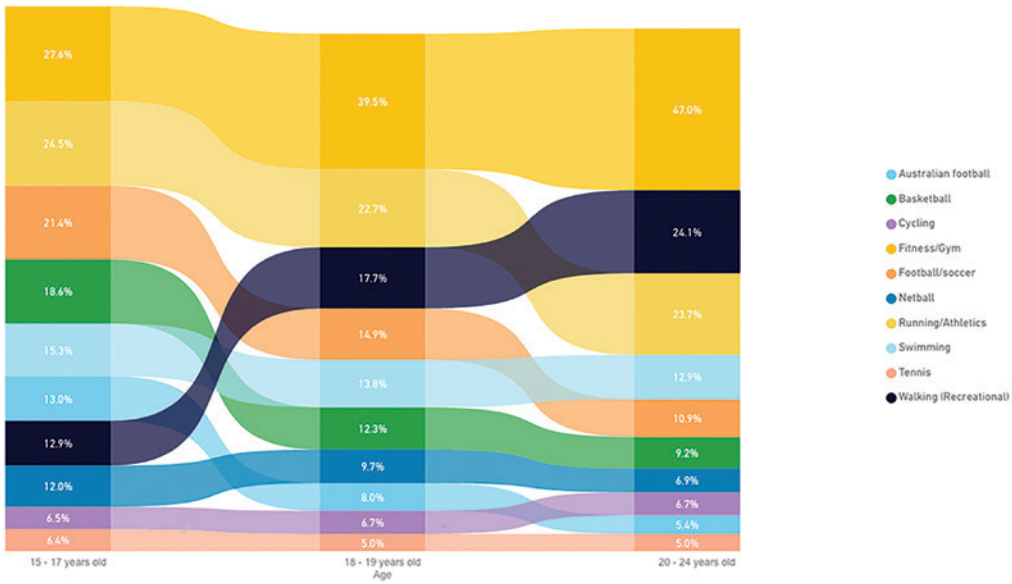
b Insert a trendline into your graph.

c Use this trendline to estimate the emissions for the following two years.

d Describe the overall trend of the carbon emissions.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6 Use this chart to answer the questions that follow. It is about participation of young Australians in different sports in 2022–23.



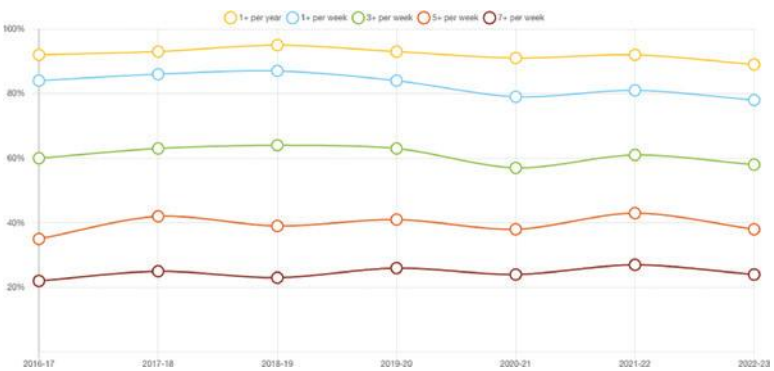
a Briefly explain what the graph shows.

b Describe the trend for participation in tennis.

c Describe the trend for participation in swimming.

d What does this graph indicate about total sport participation as people aged from 15 to 24 years old.

7 Use this chart to answer the questions that follow. It is about the frequency of participation of young Australians aged 15–19 in sport in Australia in 2022–23.



a Briefly explain the top line of the graph.

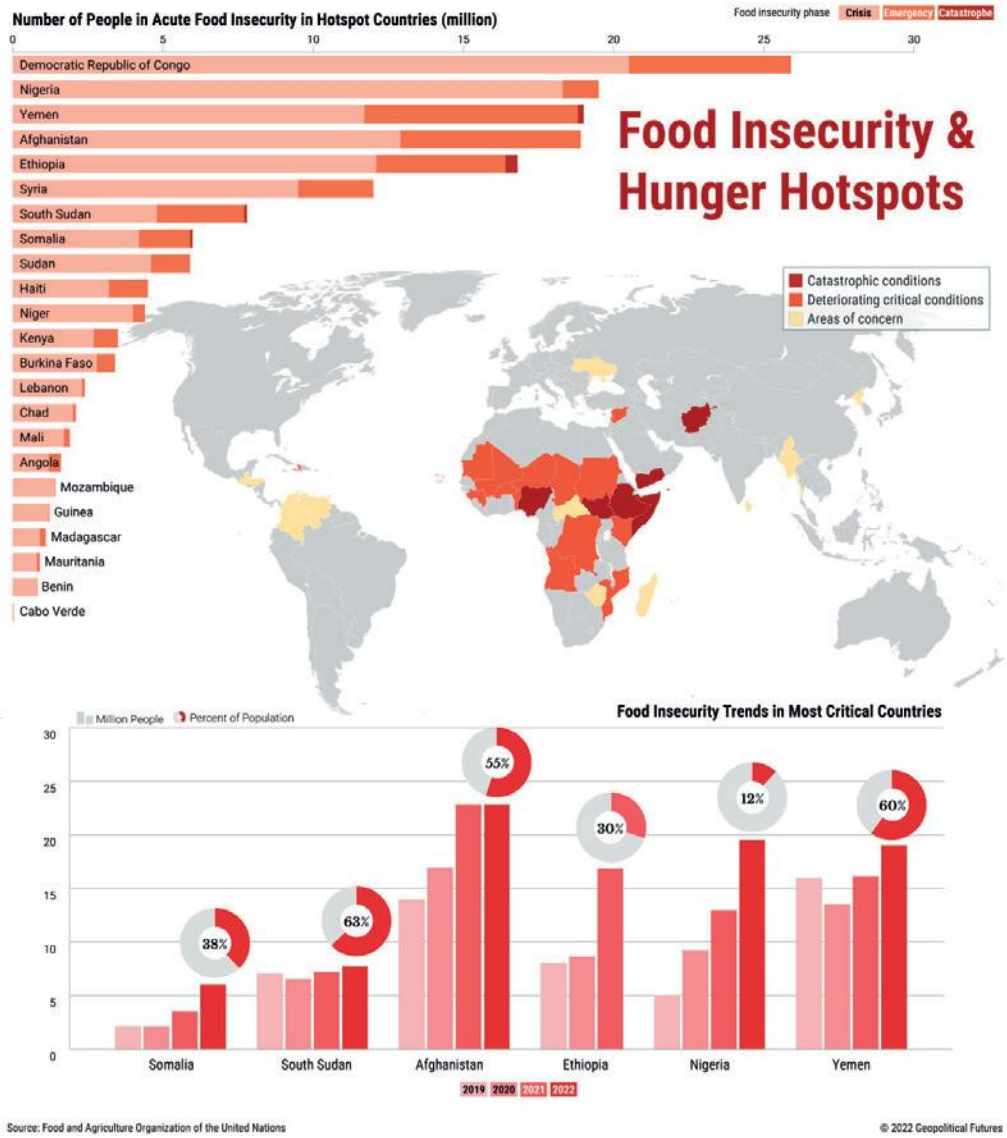
b Describe the trendline for participation of 1+ per week.

c Describe the trendline for participation of 7+ per week.

d What does this graph indicate about total sport participation between 2016 and 2023?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

8 Use this infographic to answer the questions that follow.



a Explain whether you consider the source of this data to be valid, reliable and current.

b Research and briefly explain the term 'food insecurity'.

c Which country has the highest number of people living with catastrophic food insecurity?

d Which country has the highest percentage of its population living with catastrophic food insecurity?

e Research and briefly explain three global factors that contribute to food insecurity.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9 Beef cattle require irrigation levels and drinking water equivalent to 42 L per animal per day in winter and 100 L per animal per day in summer or in dry conditions. A farmer has 120 beef cattle on irrigated pasture.

- **a** What water allocation in megalitres, ML, will this farmer need over a year where there are 8 months at winter levels and 4 months (December to end of March) at dry, summer condition levels?
- **b** Assuming that the cost of water during this period averaged $115 per ML, what will be the cost of water?

Application tasks

10 Work in a small group to research and find a recent report about renewable energy that includes datasets. Work through the following questions.

- **a** Discuss the claims, data and evidence that are presented in the article.
- **b** How can you tell if a claim is fact or opinion? Who made the claims? What expertise do they have? Are they trustworthy?
- **c** Complete a 'fact' or 'opinion' table that summarises what you found.
- **d** List three arguments that you could use to persuade a family of four to become (or not to become) an 'all electric' household.

11 Undertake some research about calculating and comparing the sugar content in drinks and yoghurt. Research how to convert grams of sugar into teaspoons or find a site that provides the data in teaspoons.

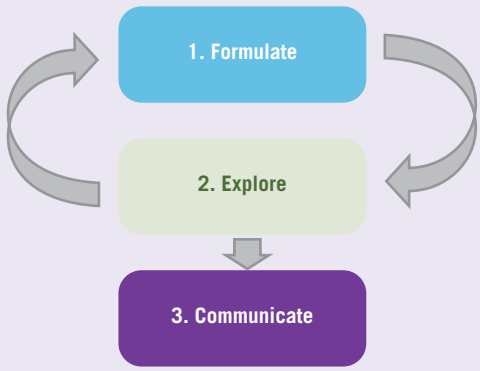
- **a** How many teaspoons of sugar is in a 600 mL bottle of Solo? In a bottle of Coke? In a high energy drink? In a bottle of fruit juice? Make sure you compare them against the same volume – maybe consider working out the sugar content per 100 mL.
- **b** Which drink or drinks had the highest sugar content?
- **c** Now compare that information with how many teaspoons of sugar are in a 160 g individual cup of yoghurt? Get the data for different types of yoghurt.
- **d** Research the WHO recommendation for adult daily sugar intake.
- **e** If you had a 600 mL bottle of Solo and a 160 g container of yoghurt as part of your lunch, by how much are you exceeding the WHO recommendation?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Investigations

When undertaking your investigations, remember the problem-solving cycle steps:

- **Formulate** – Sort out and plan what you need to know and need to do to solve the problem.
- **Explore** – Use and apply the mathematics required to solve the problem.
- **Communicate** – Record and write-up your results.



1 Global uptake of renewable energy

Your task in this investigation is to research the global uptake of renewable energies. From the information that you research, you will identify which countries are ranked best in terms of replacing fossil fuels with renewable energy sources.

Formulate

Are all countries converting from using fossil fuels to generate energy to renewable sources? Are some countries undergoing this transformation much faster than others? Answer the following questions to gather data about how different countries are progressing towards cleaner energy generation.

a What are the six most common sources of renewable energy?

b What is the international renewable energy 2030 goal?

c What is the international carbon emission target for 2050?

d What percentage of the global population lives in countries that are net-importers of fossil fuels? Why is this a problem for the health of the people who live in these countries? Why is this a problem for the world to reach its clean energy targets? Why does this matter?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

e What are the top 10 countries in terms of replacing fossil fuels with renewable energies? What measures are you using to compare the countries?

f What forms of renewable energy have these countries used to replace fossil fuel energy?

Use a suitable technological tool to record the results of your research in spreadsheets with appropriate titles.

Explore

g Rank your countries from 1st to 10th in terms of replacing fossil fuel with renewable energy sources. Make sure that you apply a consistent method of rating across all the countries.

Include the following data for each country:

- The ranking of the country and the measure you have applied to compare countries
- The forms of renewable energy that each country has used to replace fossil fuels.

h Now compare Australia with the countries in your list and use the same rating method to rank Australia in comparison with the other countries.

i Using technology, create appropriate tables and graphs to display the information collected for each category.

Communicate

j Write up and present the findings of your investigation into global uptake of renewable energy. You can choose the format of your presentation.

You should:

- include the questions that you asked, and what you found
- list the sources of the data that you analysed, including the hyperlinks
- include the tables and graphs that you created
- explain the mathematical and statistical skills you used in analysing your data
- provide an overall interpretation about the global uptake of renewable energy sources
- reflect on how technology was used to conduct the investigation and present the results
- consider what you would change, and why, if you were to do this investigation again.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

2 Electric vehicles

Your task in this investigation is to research the current use of electric and hybrid cars in Australia and around the world, and to make projections about their future use.

Formulate

a Develop a plan for your investigation, including what questions you want to answer.

Here are some issues that you might want to investigate:

- The proportion of electric and hybrid vehicles in Australia, and how this compares with other countries
- The infrastructure needs of electric and hybrid vehicles
- The projections of the uptake of electric and hybrid vehicles in Australia and other countries
- The impact on the environment of the production and use of electric vehicles.

You will need to consider:

- where and how will you find the information you need
- how you will record your investigation and the outcomes
- what technology you will use to conduct your investigation.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Explore

b Conduct your research to find valid, reliable and current data about electric and hybrid vehicles both in Australia and other countries.

c After you have downloaded data, modify it so that it addresses the questions that you are asking.

d Conduct analysis of the data.

- Use your data to create appropriate graphs.
- Use your extrapolation skills to predict future trends both in Australia and in other countries.
- Use your knowledge of statistics to analyse the central tendencies of your data.
- Use your knowledge of rates and ratios to analyse the costs involved with electric and hybrid vehicles compared with their petrol or diesel counterparts.

Communicate

e Write up and present the findings of your investigation into current and projected use of electric and hybrid cars in Australia and around the world. You can choose the format of your presentation.

You should:

- include the questions that you asked, and what data you found
- list the sources of the data that you analysed, including the hyperlinks
- include the tables and graphs that you created
- explain the mathematical and statistical skills you used in analysing your data
- provide an overall conclusion about your research
- reflect on how technology was used to conduct the investigation and present the results
- consider what you would change, and why, if you were to do this investigation again.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key concepts

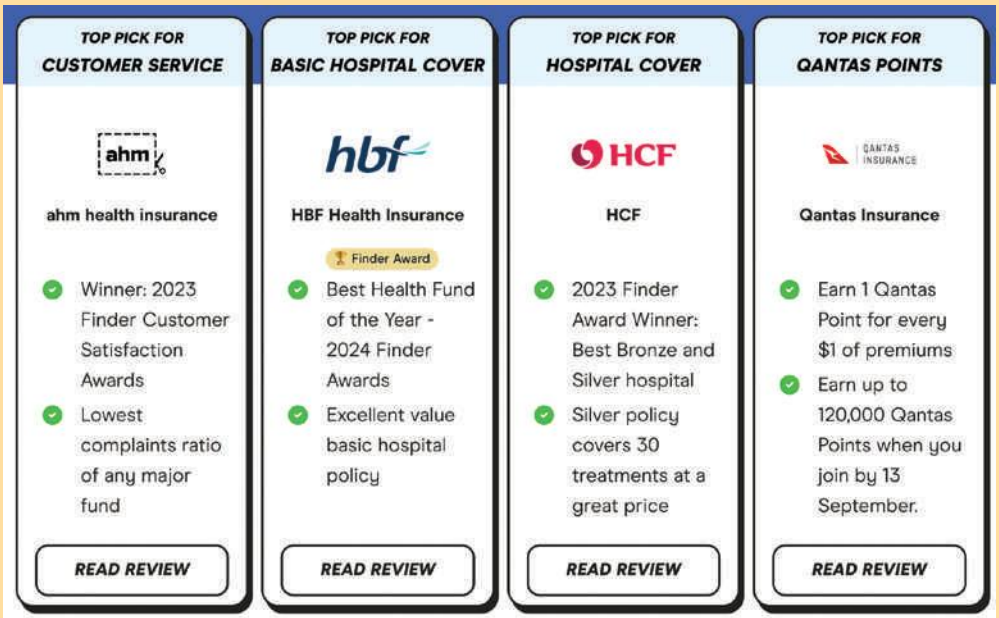
- It is important to be able to **compare** different aspects of living and paying for relevant products and services. Each one requires you to understand costs and related mathematical knowledge and numerical calculations, especially involving percentages and comparing different sets of data. This includes:
  - Utility providers such as for electricity and/or gas. There is a useful Victorian Energy Compare site that you can use.
  - There is also the need to understand about health and medical cover, including about Medicare and health care insurance. These are complex systems that require a good understanding of the different underlying factors and options.
  - Other insurances that also require mathematical understanding include car insurance, and life insurances.
- In Australia we have three levels of government which administer different **taxes**.
  - **Federal government:** income tax, Medicare levy, GST, excise
  - **State government:** stamp duty, car registration and insurance
  - **Local government:** rates, service charges.
- For our financial wellbeing, we need to be aware of:
  - the **Australian tax system** and how to calculate tax payments, including knowledge of gross pay and net pay
  - Australia's **superannuation** system where employers must put a percentage of your wage, as an additional amount, into your Super fund, as a form of saving for retirement.
- Australia has fairly open **trade arrangements** with many other countries, and when their demand of our goods and services changes, this can have a flow-on effect to our economy. There is the need to have an understanding of national and global financial factors such as supply and demand, recessions, terms of trade and GDP.
- There is the issue of **risk and reward** in relation to investments, that also require the ability to apply knowledge about data and trends. There is the need to understand about risk and the potential for financial loss. Using contemporary **fintech** products may carry both risk and reward. They include cryptocurrency and crowdfunding.
- At a global level, there is a need to look at and analyse data and information, often graphically, in relation to **environmental** issues, damage and costs.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Success criteria and review questions

☐ I can compare products and services.

1 Use the graphic to answer the questions below.



a Why is **ahm** the Top Pick for Customer Service?

b What does **HCF** offer that does not seem to be an option with the other insurers?

c Does the **Qantas** Health Insurance look like a good choice for you? Why or why not?

d Would you choose **ahm** because of the lowest complaints?

e Does the excellent value basic hospital policy lead you to choosing **hbf**?

f Explain what you would do next when choosing a health insurance provider?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

☐ I can calculate the 2% p.a. lifetime health cover loading if a private health insurance policy is taken out by a person older than 30.

2 Freddie, who is 39, has purchased a family policy at $269 per month.
- **a** How many years does Freddie have to pay the lifetime health cover loading?
- **b** How much will the policy cost Freddie per month?
- **c** How much will he pay over the total period that he is paying the lifetime health cover loading?

☐ I can calculate income tax including the Medicare levy.

3 Use the tax table below to answer the following questions.

Resident tax rates 2024–25	
Taxable income	**Tax on this income**
0 – $18,200	Nil
$18,201 – $45,000	16 cents for each $1 over $18,200
$45,001 – $135,000	$4,288 plus 30 cents for each $1 over $45,000
$135,001 – $190,000	$31,288 plus 37 cents for each $1 over $135,000
$190,001 and over	$51,638 plus 45 cents for each $1 over $190,000

- **a** Calculate the tax for a person who earns $95,000 gross p.a.
- **b** Work out the 2% p.a. Medicare levy amount.
- **c** Calculate the total tax due.

4 In the financial year 2024–25, Jessie earned $96,780 from her primary employment, $650 from tutoring casually, and $45 interest on a savings account. She also received a gift of $1,500 from her parents for her birthday. During the year, she also spent $250 on work uniforms. Calculate her taxable income.

☐ I can work out if my superannuation deduction on my payslip is correct.

5 If my pay is $585, what is the amount of Super my employer should be paying me, based on the current Superannuation Guarantee rate?

☐ I can calculate GST.

6 Work out the GST that needs to be added to a jacket that cost $95.

7 Work out how much of a $66 selling price is GST.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

☐ I can calculate the fuel excise.

8 Mannie pays $142.35 to fill his car with 65 litres of petrol. The fuel excise at the time was 49.6 cents/litre.

a What was the cost per litre of the petrol?

b What was the amount of excise that Mannie paid?

☐ I can determine the targets for raising funds using crowdfunding.

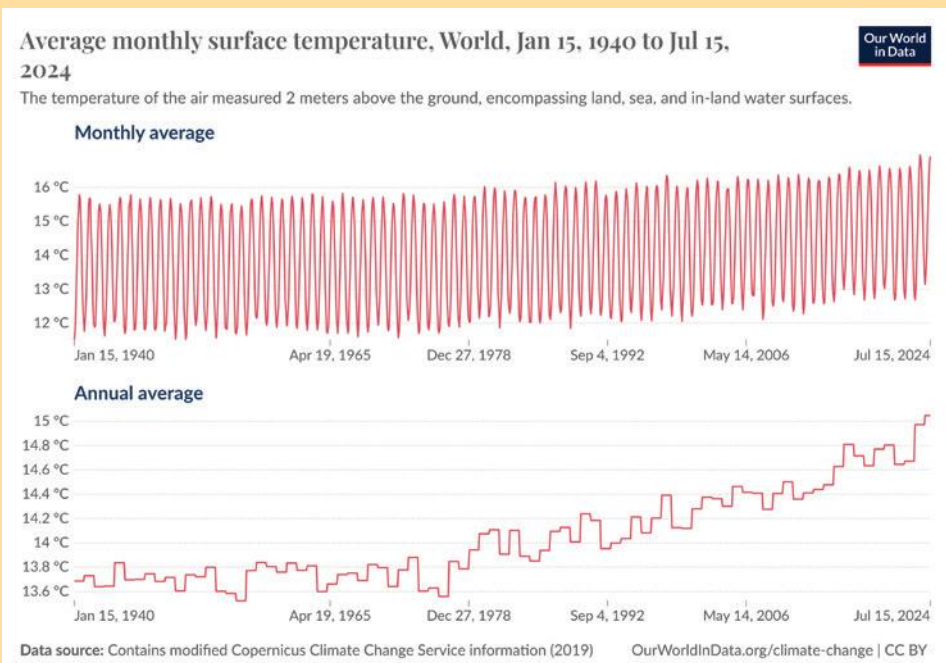
9 A campaign to raise $4,000 through crowdfunding aims to raise 30% of the funding within the first two days of campaigning. If people are being asked to pledge $25 to the cause, calculate:

a the 2-day funding goal amount

b the number of donations required to reach the crowdfunding goal.

☐ I can interpret long-term global data.

10 Use this graph which shows the average global surface temperatures from 1940 to 2024 to answer the questions below.



a Briefly explain what this graph is about.

b Briefly explain the message conveyed by this graph.

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mathematical toolkit

1 Reflect on the range of different calculations, technologies and tools you used throughout this chapter, and how often you used them for undertaking your work and making calculations. Indicate how often you used and worked out results and outcomes for each of these methods and tools.

Method and tools/ applications used	How often did you use this?
• Calculating and working in your head, and using algorithms	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using pen-and-paper	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using a calculator	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using a spreadsheet	Not at all: ☐ A little: ☐ Quite a bit: ☐
• Using measuring tools – name the tool, technology or application: _____ _____	Not at all: ☐ A little: ☐ Quite a bit: ☐ Not at all: ☐ A little: ☐ Quite a bit: ☐
• Using other technology or apps – name the technology or application: _____ _____	Not at all: ☐ A little: ☐ Quite a bit: ☐ Not at all: ☐ A little: ☐ Quite a bit: ☐

2 Did this chapter and the activities help you to better understand how you use different tools and technologies in using and applying mathematics in our lives and at work? In what areas and ways? Write down some examples.

3 In one sentence, explain something relating to tools and technologies that you learned in the unit. Write an example of what you learned.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key vocabulary

Here is a list of this chapter's key maths terms and their meanings.

Term	Meaning
Consumer Price Index (CPI)	A measure that examines the average change in prices paid by consumers for goods and services over time, expressed as a percentage (%).
Crowdfunding	Using the internet to access large numbers of people to raise money.
Cryptocurrency	A type of digital currency that allows people to make payments directly to each other through online systems.
Depression	A severe or long-term *recession*.
Direct debit	When your nominated account is debited in regular payments by the entity you are paying.
Eligible deductions	These reduce your taxable income and include union fees, uniform expenses and donations to registered charities.
Ethical trading	When broader social justice and factors other than simple profit are considered when making investments or purchases.
Excess	The amount you have to pay if you make a claim on your insurance policy.
Exchange rate	The value of one currency when it is being converted to a different currency.
Extras	A type of health insurance that covers you for out-of-hospital medical care, e.g. dental treatment and physiotherapy.
Federal government taxes	These include income tax, Medicare levy, GST and excises.
Fintech	A term formed from the words financial' and 'technology' to refer to the application of new technologies in financial transactions.
Fossil fuel energy	Energy derived from coal or gas.
Goods and Services Tax (GST)	A tax added to most goods sold (except for fresh food) and to services.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Term	Meaning
Gross Domestic Product (GDP)	The measure of all goods and services produced in a set period of time (usually 3 months).
Gross earnings	Your income before tax and the Medicare levy are applied.
Health insurance	Also called private health insurance, it usually comes as a combination of Hospital and Extras cover.
Income tax	This is the tax we pay on what we earn and is set by the federal government.
Indirect taxes	These are automatically included in the price, so we don't really notice, e.g. excises on fuel, tobacco and alcohol.
Life insurance	Usually includes cover for death, permanent incapacity, trauma and income protection.
Local government (council) charges	These include rates (a form of property tax) and service charges such as for garbage collection.
Market value	The market value is determined by the insurer. In the context of car insurance, this will reduce your premiums but may result in the car not being as valuable as when you bought it.
Medicare levy	A charge that helps to pay for our public health systems. It is deducted through your tax and is 2% p.a. of your taxable income.
Medicare levy surcharge	A levy applied if you don't have private health insurance before you turn 31.
Net income	Your earnings that are paid into your bank – the 'take home' pay.
No claim bonus	A discount on your insurance policy when you have not made any claims.
Non-taxable income	This includes rewards or gifts for special occasions, Lotto winnings, game show prizes, child support/spouse maintenance.
Recession	A significant decline in economic activity (*GDP*) which lasts for more than a couple of months.
Renewable energy	Energy derived from sources like the sun and the wind.
Risk and reward	Risk is related to volatility – how investments can increase and decrease in price according to various external economic factors. Reward is the return on your investment if prices increase.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Term	Meaning
Shares	The value that the market puts on the stocks of a company.
State government taxes	These include stamp duty, car registration and insurance, payroll tax, land tax and gambling taxes.
Stocks	Where you are investing your money in companies that you hope will give a good profit over time. These companies are listed in the Australian Stock Market, known as the ASX.
Superannuation	Employers are required by law to put an additional percentage of your earnings into your superannuation account. This account will help sustain your life in retirement.
Sustainable	Able to be reliably maintained over a longer period of time.
Taxable income	This includes wages/salaries, interest earned on savings, dividends paid on stocks/share/bonds, rent from a rental property. *Deductions* are allowed, and you pay tax on the remaining amount.
Volatility	When the value of an investment rises and falls very quickly.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

11 The maths of business

Brainstorming activity: Where's the maths?

Using this photo of a small business owner as the stimulus, brainstorm the type of maths related to this task or activity. Think especially about any maths skills related to the content of this chapter – the world of business.
Prompt questions might be:

- What might this person be doing in this photo?
- What activities and tasks might they be undertaking?
- What types of mathematical content knowledge and skills would be relevant?
- What different tools, technologies or software might be used?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter contents

Chapter overview and Spotlight

11A Starting activities

11B Tuning in

11C Financial planning and business revenue

11D Expenses and the BAS

11E Financial statements

Investigations

Chapter review

From the Study Design

In this chapter, you will learn how to:

- undertake routine calculations or transactions related to the income and expenditure for businesses such as invoicing, BAS, superannuation and leave entitlements

  (Units 3 and 4, Area of Study 3)

© Victorian Curriculum and Assessment Authority 2022

ISBN 978-1-009-11065-5 Sakurai et al.

© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter overview

Introduction

Mathematics is an integral part of business, providing tools and processes that enable business owners and staff to make informed decisions and achieve their goals. Here are some of the ways that mathematics helps support business success.

Financial analysis: Mathematics underpins budgets and financial plans, monitoring financial risks and performance, and calculating profit or loss. Mathematical models help in evaluating the financial health of a business.

Pricing strategies: Setting the right price for your products or services is critical. Maths enables you to calculate costs and profit margins, and create competitive pricing. A well-structured pricing strategy supports profitability and competitiveness.

Forecasting and planning: Maths allows you to predict future trends, demand and market fluctuations, and helps in inventory management, production scheduling and resource allocation.

Data analysis: Businesses collect vast amounts of data, and you need your maths knowledge and skills to analyse this data to identify patterns, trends and correlations.

Risk assessment: Quantitative risk assessment involves probability calculations. Maths helps evaluate risks associated with investments, market changes and operational decisions.

Operations management: Mathematics is used to optimise business operations, including supply chain management, production scheduling, inventory management and logistics.

Visualisation and reporting: Graphs, charts and visual representations of data aid in conveying complex information to stakeholders.

This chapter explores some of these aspects of running a business and includes some introductory activities that illustrate tasks that small business owners and managers need to undertake. You will also be introduced to some key economic and financial terminology that goes hand-in-hand with financial mathematics.

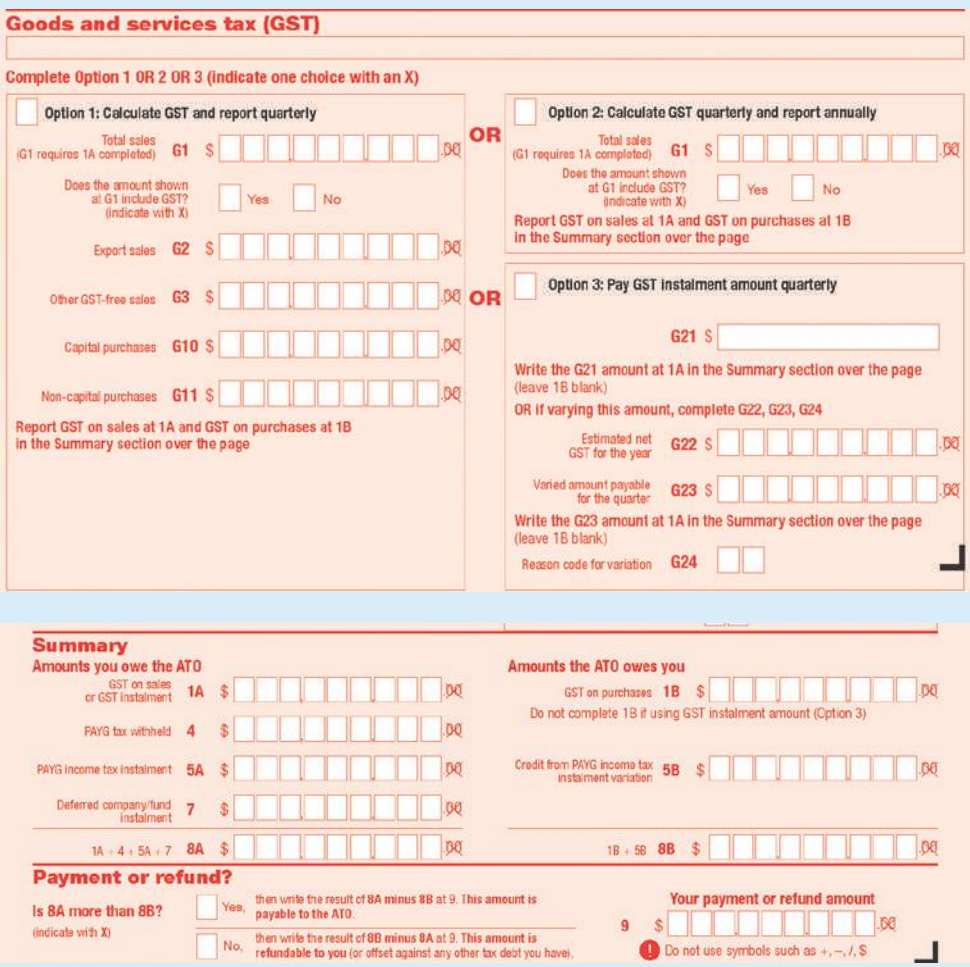
Undertaking any of this financial analysis requires the mathematical knowledge and skills that have been covered in the first eight chapters of this book. You will need to dip into that knowledge bank and into your mathematical toolkit throughout this chapter.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Learning intentions

By the end of this chapter, you will be able to:

- understand business related financial terms regarding income and expenses
- understand, interpret and create invoices
- understand and can interpret business costs such as superannuation, GST, taxes, insurances and leave entitlements
- undertake routine calculations or transactions related to income and expenditure for businesses such as invoicing, BAS, currency exchanges, taxation, superannuation, insurance and leave entitlements
- read, understand and complete basic financial statements and documents such as business activity statements, balance sheets, cash flow statements, and profit and loss statements.



Goods and services tax (GST)

Complete Option 1 OR 2 OR 3 (indicate one choice with an X)

Option 1: Calculate GST and report quarterly

Total sales (G1 requires 1A completed) G1 $ .00

Does the amount shown at G1 include GST? (indicate with X) Yes No

Export sales G2 $ .00

Other GST-free sales G3 $ .00

Capital purchases G10 $ .00

Non-capital purchases G11 $ .00

Report GST on sales at 1A and GST on purchases at 1B in the Summary section over the page

OR

Option 2: Calculate GST quarterly and report annually

Total sales (G1 requires 1A completed) G1 $ .00

Does the amount shown at G1 include GST? (indicate with X) Yes No

Report GST on sales at 1A and GST on purchases at 1B in the Summary section over the page

OR

Option 3: Pay GST instalment amount quarterly

G21 $

Write the G21 amount at 1A in the Summary section over the page (leave 1B blank)

OR if varying this amount, complete G22, G23, G24

Estimated net GST for the year G22 $ .00

Varied amount payable for the quarter G23 $ .00

Write the G23 amount at 1A in the Summary section over the page (leave 1B blank)

Reason code for variation G24

Summary

Amounts you owe the ATO

GST on sales or GST instalment 1A $ .00

PAYG tax withheld 4 $ .00

PAYG income tax instalment 5A $ .00

Deferred company/fund instalment 7 $ .00

1A + 4 + 5A + 7 8A $ .00

Amounts the ATO owes you

GST on purchases 1B $ .00

Do not complete 1B if using GST instalment amount (Option 3)

Credit from PAYG income tax instalment variation 5B $ .00

1B + 5B 8B $ .00

Payment or refund?

Is 8A more than 8B? (indicate with X)

Yes, then write the result of 8A minus 8B at 9. This amount is payable to the ATO.

No, then write the result of 8B minus 8A at 9. This amount is refundable to you (or offset against any other tax debt you have).

Your payment or refund amount

9 $ .00

Do not use symbols such as +, −, /, $

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Spotlight: Alfredo Santo

An interview with a former hairdresser and business owner

Tell us about some of the work you have done in your career.

I started my career in accounting and worked in the accounts department of a retail store while doing further accounting study part time. However, after 12 months, I decided to follow my dream and become a creative stylist. I started out as a hairdresser, which ultimately led me into a creative career of 40 years that I enjoyed immensely and resulted in the opening and operating of my successful hair salon in Melbourne. I have also lectured in the education and creative direction speaking circuit for over 15 years in Australia and overseas, where I have shared my extensive knowledge on the importance of education, marketing, creative programs and business management (including the accounting side of things) in the hair and beauty industry. Throughout my career, I achieved awards such Australian Hairdresser of the Year, Educator of the Year and Best Market Salon.

What maths did you use regularly in your work?

My knowledge of finance and accounting became one of the most important aspects of managing my large business, particularly in keeping abreast of overall profit and expenses. It involved a lot of understanding percentages and figures relating to sales and goals. I had to deal with payroll, commissions, budgets, salon and individual performance, gross takings, and preparing all the necessary business figures for accounting purposes. I also needed maths when liaising with suppliers to try to get the best price for the products needed.

Looking after my staff was always a priority. I worked out staff incentives to keep my staff motivated to perform better with their sales, not just their creativity, which, in turn, gave me more money to help grow my business. Once my business became successful, I then employed other people to manage the administrative and marketing needs of the business. At any one time, I managed about 25 staff members.

What was your attitude towards learning maths in school? Has this attitude changed over time?

I was not interested in maths in my early years of school. It seemed like a waste of time to me as I was always thinking of an artistic career. In later school life, it turned around. I became more involved with numbers and liked problem solving, so maths became a little more interesting to me. I am now grateful that maths changed for me in later school life as it allowed me to succeed in all areas of my artistic and business working life. My attitude towards maths has definitely changed, and when I was teaching on the education circuit, I would always express the importance of understanding how to work with figures in all careers, even in the hair and beauty industry. I don't know how many times I've said 'Thank goodness I had knowledge of maths to help succeed in this creative career' in these lectures!

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

11A Starting activities

Activity 1: Do you want to run your own business?

1 Below are some aspects of running your own business. Complete this table by putting a ✓ in the appropriate column on whether you think each is an advantage or disadvantage. Share and compare your thoughts with your classmates.

Aspect of running your own business	Advantage	Disadvantage
You are your own boss – you make your own decisions.		
You must get your own work.		
You must plan your work schedule.		
You receive all the income and profits generated by your business.		
You must supply all the equipment that you need.		
You must write quotes for your work.		
Flexibility and independence: allows you to set your work hours etc.		
You must hire subcontractors as needed.		
You must chase up payments from your customers.		
You must keep accurate accounts of your business.		
You must ensure that your business pays you a living wage.		
You must make enough so that if you're sick you are OK for money.		
Something else? You put it here.		

2 Think about the costs of establishing a small business in Australia. There will be a number of initial **expenses** that will be incurred before a new business generates any income. Work with some fellow students to explore some common start-up costs. Remember that start-up costs will vary based on the business type, structure and industry. Maybe consider a couple of examples of businesses and see how the start-up costs might vary.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Activity 2: Exchange rates

When selling or purchasing goods with overseas countries, understanding **exchange rates** is crucial. When we undertake online shopping on overseas websites, we often need to convert the costs in that country's monetary system into our Australian dollars, or vice versa if you want to know what an Australian item costs compared with the costs in a different currency. We also do this when we travel overseas.

In relation to an Australian business that imports products from another country, the customs value of these goods must be expressed in Australian currency. The foreign currency needs to be converted into Australian dollars at the exchange rate applying on the day of export from the origin country.

Australia has what is called a **floating exchange rate**, which means that movements in the Australian dollar exchange rate are determined by the demand for, and supply of, Australian dollars in the foreign exchange market.

To convert between currencies using the current known exchange rates it is best to use a reliable online currency converter. There are many currency converters online, for example, the Australia Post currency converter and the Commonwealth Bank international foreign exchange calculator.

Practice questions

1 The unit of currency in Vietnam is the dong (VND). Assume the exchange rate is 1 AUD = 16426.57 VND.

   a How much is $50.00 AUD in VND?

   b How much is 1 million dong worth in AUD?

2 Use an online currency converter to convert 10,000 Australian dollars (AUD) into the foreign currencies shown in this table.

Foreign currency	Exchange rate	Value in the foreign currency
a US dollar		
b euro		
c Thai baht		
d Japanese yen		
e Indonesian rupiah		

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3 Use an online currency converter to determine what the foreign currency value is in Australian dollars (AUD).

Foreign currency amount	Exchange rate	Value in AUD
a 100 New Zealand dollars		
b 750 euro		
c 2,500 Norwegian kroner		
d 23,500 UK pound		
e 125,000 Japanese yen		

Discussion questions

4 Answer the following questions about currency rates.

a What does an exchange rate that is greater than 1.0 mean in terms of the buying power of AUD?

b What does an exchange rate that is less than 1.0 mean in terms of the buying power of AUD?

c How do you think this affects Australian businesses that import and export goods or services?

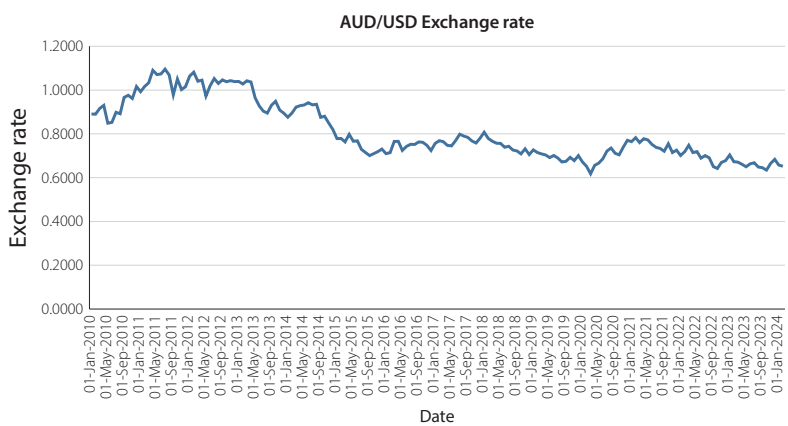
d Share and compare your thoughts with your classmates.

5 Below is a graph of the exchange rate between the Australian dollar (AUD) and the United States dollar (USD) since the beginning of 2010. Use it to answer the questions below.

a Interpret the information in the graph and describe the trends and changes in the exchange rate over this period.

b How would Australian import businesses be affected?

c How would Australian exporters to the USA be affected?

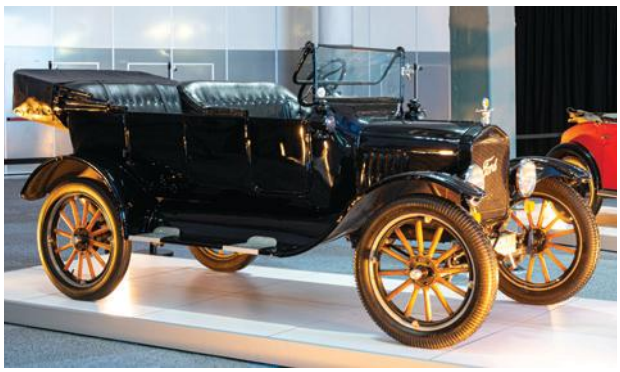


Source of data: WM/Reuters

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

11B Tuning in

Epic Success: Henry Ford



Henry Ford was from Michigan in the USA and started his career with an **apprenticeship** at Detroit Dry Dock Company. In 1891, Ford became an engineer working for Thomas Edison at the Edison Illuminating Company of Detroit. As chief engineer by 1893, he worked on gas engines and honed his skills tinkering with gas-propelled vehicles.

He used this knowledge and the skills he gained as an engineer converting gas to electricity to design an automobile in 1896. Being so exciting at the time, this invention attracted investors and he began his own company, the Detroit Automobile Company, in 1899.

Unfortunately, this company floundered as the costs of production were too high to make a profit and the company closed in 1901. However, the entrepreneurial young inventor persevered and by 1903 Henry had found new investors with whom he started the Ford Motor Company. Amongst a string of new models, the famous Model T Ford was launched in 1908 and the rest, as they say, is history.

The Ford Motor company is still a world leader in manufacturing cars and in today's market has **annual sales worth over $136 billion**. Not bad for a young apprentice with a big dream!

Discussion questions

1. How many cars does the US Ford Motor Company sell each year?
2. Find the annual profit for Ford over the last 20 years and create a graph. Do you notice a trend? Describe the trend.
3. Find the share prices for the US Ford Motor Company since 2000 and create a graph. Do you notice a trend? Describe the trend.
4. What does the term 'investment' mean?
5. Describe what an entrepreneur does.
6. What risks did the young Henry Ford have to take to start his company?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Time periods and financial calculations

When undertaking financial calculations in a range of areas it is important to be able to change values across different time periods. For example, sometimes you need to be able to work with an hourly rate of pay or on other occasions use an annual income. This relates to timesheets and payslips, and is also crucial in relation to taxation, superannuation and more.

The common conversions required include:

- converting annual income to weekly, fortnightly and monthly income
- converting weekly income to annual, monthly and fortnightly income
- converting monthly income to annual, weekly and fortnightly income
- converting hourly income to annual, weekly and fortnightly income.

In terms of a business, it is also possible you will be required to report or work out costs for a quarter of a year, which is 3 months or 13 weeks.

In financial calculations it is important to be accurate and follow the time conversion procedures correctly. A couple of key points are:

- It needs to be remembered that there are NOT 4 weeks per month. All months, except February, have more than 4 weeks, as 4 weeks is only 28 days and there are either 30 or 31 days in every other month.
- When you change an hourly rate of pay to a weekly pay you need to multiply the hourly rate by the number of working hours in the week.

Here are the critical relationships between the different time periods.

365 days = 1 year
52 weeks = 1 year
26 fortnights = 1 year
4 quarters = 1 year
12 months = 1 year

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Practice questions

1 Convert the following wages and payments into the nominated time-period. In each case, state what mathematical operation or operations you had to undertake to get your answer. Give your answers to the nearest dollar.

- **a** An annual salary of $75,500 into an equivalent weekly payment
- **b** A fortnightly payment of $225 into an equivalent annual amount
- **c** An annual pay of $118,600 into an equivalent fortnightly payment
- **d** A monthly pay of $345.45 into an equivalent annual amount
- **e** A fortnightly payment of $450 into an equivalent quarterly amount
- **f** A weekly pay of $395.00 into an equivalent annual payment
- **g** An annual fee of $21,600 into an equivalent quarterly amount

2 Basia is paid $21.50 an hour for normal working hours. What is the equivalent annual total income from normal hours worked if the normal working hours are 37.5 hours per week?

3 George is a casual bartender who is paid $15.50 an hour for normal working hours. What is the total earnings if they worked for 25 hours?

4 Javi earns a salary of $58,800 a year working in the kitchen of a restaurant.

- **a** What is the weekly income?
- **b** What is the monthly income?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

11C Financial planning and business revenue

Your group is thinking of running a stall selling hot chocolate with marshmallows as part of your school's fundraising day. Here is what your group has researched for this activity.

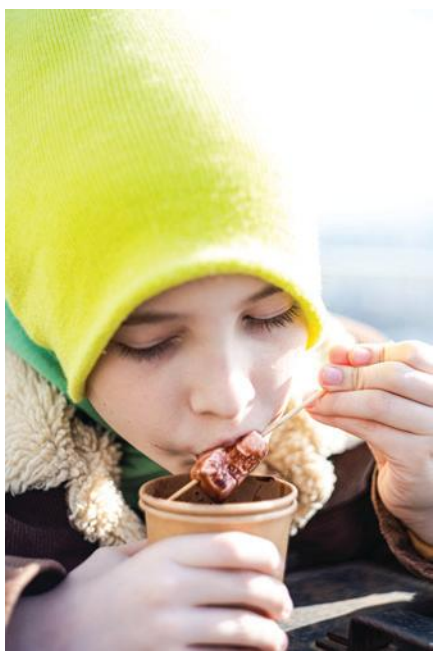
Set-up costs	**Amount**
Daily rental of 2 hot water urns	$50.00
Pack of 50 bamboo cups (250 mL each)	$9.50
Cost of ingredients	
Fair Trade hot chocolate (1 kg)	$22.50
2 packs marshmallows (250 g each)	$11.00
3 types of milk (4 L each)	$24.00
Total costs	**$117.00**

It's a good start, but how will you know if you are going to make a **profit** or a **loss**?

You will need to calculate how many cups of hot chocolate you can make so that you can set your price to ensure a profit.

This type of planning is essential for businesses. This is all part of financial planning.

If you have a part-time job and/or receive an allowance (pocket money), you likely have a regular or predictable minimum income to budget each week. Ideally, you understand that you can't spend more than you have earned (okay, you might borrow from a family member or friend from time to time). You will calculate whether you can afford that new hoodie you want, or whether you will have to save up for it.



As an individual, these are relatively straightforward concepts and calculations. But in the world of business, the required tasks and calculations become more complicated.

Although this course does not require us to go deeply into financial planning and running businesses as that is covered in other VCE subjects such as Accounting or Business Management, we will look into different aspects related to the finances of running a business and related financial planning activities.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

A financial plan is a document that is prepared in advance, to show the expected expenses and income of a business. This is essential so that the business can be successful in making a profit and can meet its obligations to pay staff wages, taxes, suppliers, rent/utilities, and so on. In section 11E, we will look in more detail at some of the processes and documentations that are standard practice in relation to financial planning and running a business.

Accounting software

Most businesses use accounting software to help record the flow of their business's money and monitor and manage their financial status and performance. They enable them to record transactions, generate reports, manage customer and vendor contacts, create purchase orders, track stock levels, bill customers, and monitor account balances. There are numerous ones available in Australia, including *Xero*, *MYOB*, *QuickBooks*, *Reckon* and *Freshbooks*.

Sole traders

One relatively easy way to set up and run a business, especially for young people starting out, is to operate as what is called a **sole trader**. A sole trader is a self-employed person who owns and runs their business as an individual. The individual is legally responsible for all aspects of the business, including debts and losses. You can still hire people under this business structure. Many tradespeople operate their businesses as a sole trader.

The GST

When you operate a business, two critical aspects you need to know about are the GST and the Australian Business Number (ABN) .

GST requirements

The **goods and services tax (GST)** is a tax added to most goods sold (except for fresh food) and services. Currently (as of 2024) the rate of GST is 10%.

We have looked at calculating GST in both the Units 1 & 2 textbook and also in earlier chapters of this book. In running a business, a critical role is the payment and collection of the GST.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

There are specific rules and requirements related to the GST when running a business.

People must register for GST when:

- their annual GST turnover (**gross** income from all businesses minus GST) is $75,000 or more (this is the **GST threshold**)
- they expect their turnover to reach the GST threshold (or more) in the first year of operation
- a non-profit organisation has a GST turnover of $150,000 per year or more
- when people provide taxi or limousine travel for passengers (including ride-sourcing), regardless of their GST turnover.

But before registering for GST, companies or individuals need to have an Australian business number (ABN).

Businesses charge and collect GST from their customers on taxable supplies (goods and services). When they sell products or services, the GST amount is added to the sale price. This additional 10% charge on top of their regular fees must be recorded and **paid** to the government through the **Australian Taxation Office (ATO)**. However, the businesses can then claim back the GST they've paid on any of their own business purchases. This is called an **input tax credit** or a **GST tax credit**.

They do this by lodging a **business activity statement (BAS)**. The ATO will balance these credits against the GST you owe, determining whether you'll receive a refund or have a GST bill.

When companies or individuals register for GST, they will be assigned a taxation period (usually quarterly, but it can be monthly or annually). They need to file a GST return via the BAS at the end of each taxation period and pay any GST owing.

Calculating how much GST you owe or are due

To work out if they need to pay extra GST or get a credit, a business needs to calculate the difference between the GST they've collected and the GST credits they're claiming.

$$\text{GST payable} = \text{GST collected} - \text{GST credits claimed}$$

- If they've collected **more** GST than they've claimed, they have to pay the difference to the ATO.
- If their GST credits exceed the GST they collected, they'll receive a refund.

Note: A negative amount would mean that the ATO owes the business that amount of money.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 1 Calculating how much GST you owe or are due

A clothing store has the following expenses and sales over the last quarter.

- Income from sales of clothes and related products was $175,375 including GST.
- Their total GST-related expenses for purchasing clothes and other products over this period were $135,856 including GST.

a Do they need to pay GST for their business?

b What is their GST payment status for this quarter? Do they need to pay the ATO some money for GST or are they owed a refund? How much is this amount?

THINKING	WORKING
STEP 1	
Determine their GST payment status for this quarter. Is the GST turnover (gross income from all businesses minus GST) greater than $75,000?	**a** They do need to pay GST as the income from sales is well above the GST threshold of $75,000.
STEP 2	
Calculate the GST collected. Remember that to work out the GST when it has been included in the price, divide by 11. The ATO rounds amounts to the nearest dollar.	**b** GST collected = $175,375 ÷ 11 = $15,943.18 … = $15,943 (to the nearest dollar)
STEP 3	
Calculate the GST paid by dividing the GST-related expenses by 11.	GST paid (credits) = $135,856 ÷ 11 = $12,350.54 … = $12,351 (to the nearest dollar)
STEP 4	
Calculate the GST owed or due.	GST payable = GST collected – GST credits claimed = $15,943 – $12,351 = $3,592
STEP 5	
As the amount is a positive value the business owes the tax office GST.	The amount the business must pay the tax office is $3,592.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Australian business number (ABN)

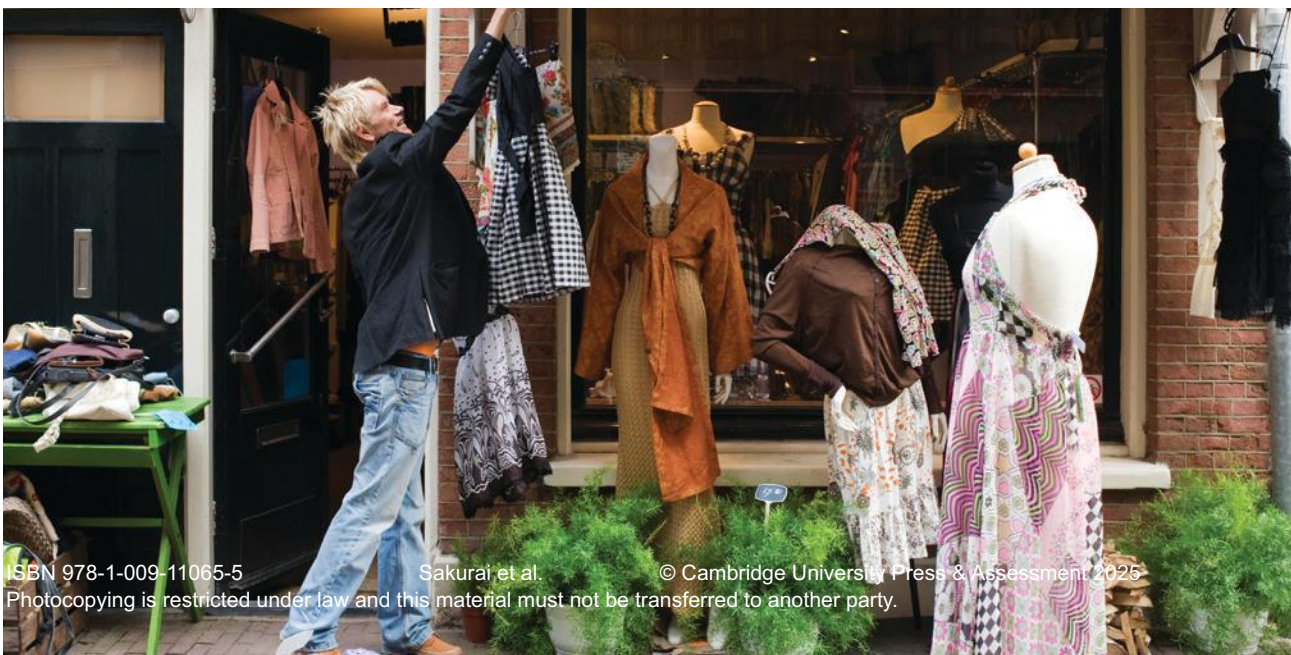
An Australian business number (ABN) is a unique 11-digit identifier issued by the ATO to businesses operating in Australia. It is a national code and registration system that is used for:

- **Identification**: The ABN serves as a way to identify a business or organisation to the government and the community.
- **Tax and business purposes**: The ATO uses the ABN to track business income, monitor financial transactions, and ensure compliance with taxation regulations. It is used in relation to important taxation purposes related to pay-as-you-go (PAYG) tax on payments.
- **GST credits**: Businesses that are registered for goods and services tax (GST) claim GST credits using their ABN.
- **Invoicing**: The ABN must appear on tax invoices and other tax-related documents issued by a business.

Business revenue and income

Business revenue refers to the total income that a business generates from its primary operations, typically through the sale of products and services. It is the money earned by a business before deducting any operating costs, expenses and taxes. Revenue is a key **financial** indicator of a company's performance and success.

Some businesses will have only one income stream such as a plumber or a furniture removalist. Other businesses will have multiple streams of income to increase their revenue. For example, a hairdresser will be paid to cut and style customers' hair, but to increase revenue they may also sell hair styling products and equipment. A clothing store may also sell jewellery and handbags etc.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 2 Calculating revenue

A carpenter charges $150 call-out fee and $75 per hour when attending a job. Calculate the revenue made for the work done by the carpenter over two days.
Day 1: 1 job, 6 hours
Day 2: 3 jobs, 1 hour at each job

THINKING	WORKING
STEP 1	
Calculate the revenue for each day	**Day 1** Revenue = 1 call-out fee + 6 hours at $75 per hour = $150 + (6 × $75) = $600 **Day 2** Revenue = 3 call-out fees + 3 hours at $75 per hour = (3 × $150) + (3 × $75) = $675
STEP 2	
Add the revenue for the two days.	Total revenue = $600 + $675 = $1,275
STEP 3	
Write your answer.	Carpenter makes a revenue of $1,275 over two days.

Looking at the example above, why do you think tradespeople might charge a call-out fee?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Hot chocolate stall

At the start of this section, there was the example of running a stall to sell hot chocolate with marshmallows as part of your school's fundraising day. How can you work out a price to sell the hot chocolate drinks for?

Example 3 Calculating expected profit for a business

The following table shows the costs involved in setting up a stall to sell hot chocolate drinks.

Set-up costs	Amount
Daily rental of 2 hot water urns	$50.00
Pack of 50 bamboo cups (250 mL each)	$9.50
Cost of ingredients	
Fair Trade hot chocolate (1 kg)	$22.50
2 packs marshmallows (250 g each)	$11.00
3 types of milk (4 L each)	$24.00
Total cost	**$117.00**

Calculate the expected profit for the hot chocolate stall.

THINKING **WORKING**

STEP 1

Determine how much the costs are per cup of hot chocolate. Assume that all 50 bamboo cups are used.

Number of cups to be sold = 50
Total expenses = $117.00
Cost per cup = $117.00 ÷ 50 = $2.34
Therefore, to make a profit you need to sell all 50 cups at more than $2.34 each.

STEP 2

Determine the profit based on different sales prices. Create a table to compare the different prices. In this example,
Total revenue = price × number of cups sold
Profit = total revenue – total expenses

Price of a hot chocolate	Number of cups sold	Total revenue	Total expenses	Profit
$2.50	50	$125	$117	$8
$3.00	50	$150	$117	$33
$4.00	50	$200	$117	$83
$5.00	50	$250	$117	$133
$6.00	50	$300	$117	$183

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Then you need to decide what is a good amount to make for the fundraising activity, balanced by the fact you don't want to charge too much. People may not pay if it's too expensive. These are the types of decisions that businesses have to make all the time.

Think about these questions:

- What price would you charge for each cup of hot chocolate?
- What else could you do to make more money for the fundraising?
- For a business, you also have to take into account your time and wages – what are the implications then?

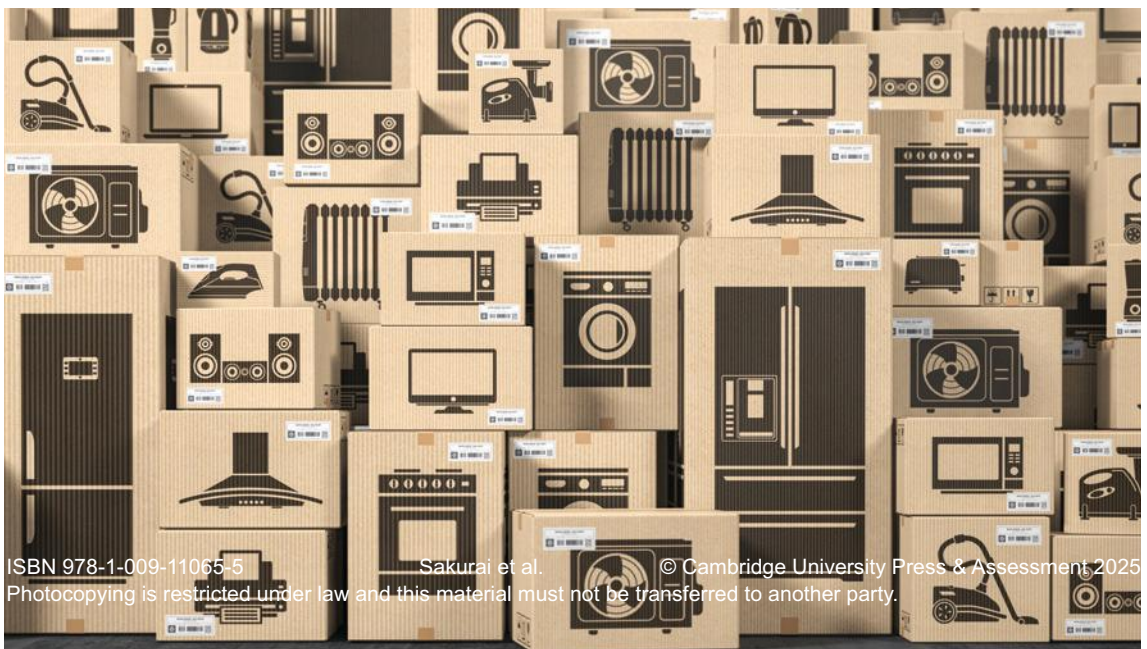
Purchasing goods from overseas

Businesses that import goods also need to consider other costs that are payable at the time of importing. Generally, all goods imported into Australia are liable for duties and taxes unless an exemption or concession applies. A 5% import duty and an import processing charge must be paid, alongside GST, in order for goods to be released by customs (unless the particular goods have an exemption).

The appropriate import processing charge can be found on the government website for Australian Border Force (ABF). You need to search for cost of importing goods. The duties and other charges are dependent on the value of the imported goods.

For example, the following import processing charges apply for electronic goods.

Consignment value	Charge (AUD)
Less than or equal to $1,000	$0.00
Between $1,000 and $10,000	$50.50
$10,000 and above	$152.50



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 4 Calculating the cost of importing goods

A retail shop is importing electronic goods from China. The cost of the products and transportation to a port in Australia is 22,000 Chinese yuan. The exchange rate at the time of exportation from China is 1 CYN = 0.12 AUD. Calculate the duties and tax payable to Australian Customs to import the goods.

THINKING	WORKING
STEP 1	
Convert the value of the goods to Australian dollars by multiplying the Chinese yuan by the exchange rate.	Value in AUD = 22,000 × 0.12 = $2,640
STEP 2	
Calculate the import duty by finding 5% of the value in AUD.	Duty = 5% of $2,640 = 0.05 × $2,640 = $132
STEP 3	
Determine the GST payable on the value in AUD and the import duty.	Value + import duty = $2,640 + $132 = $2,772 GST = 10% of $2,772 = 0.10 × $2,772 = $277
STEP 4	
Determine the import processing charge. Use the government website for Australian Border Force (ABF) and search for cost of importing goods. Look at duties and other charges which are dependent on the value of the imported goods.	Charge for processing electronic goods valued between $1,000 and $10,000 is $50.
STEP 5	
Add all the charges (import duty + import processing charge + GST) to determine the total amount payable to customs.	$132 + $50 + $277 = $459 The total amount of duties and tax payable to customs to import the goods is $459.

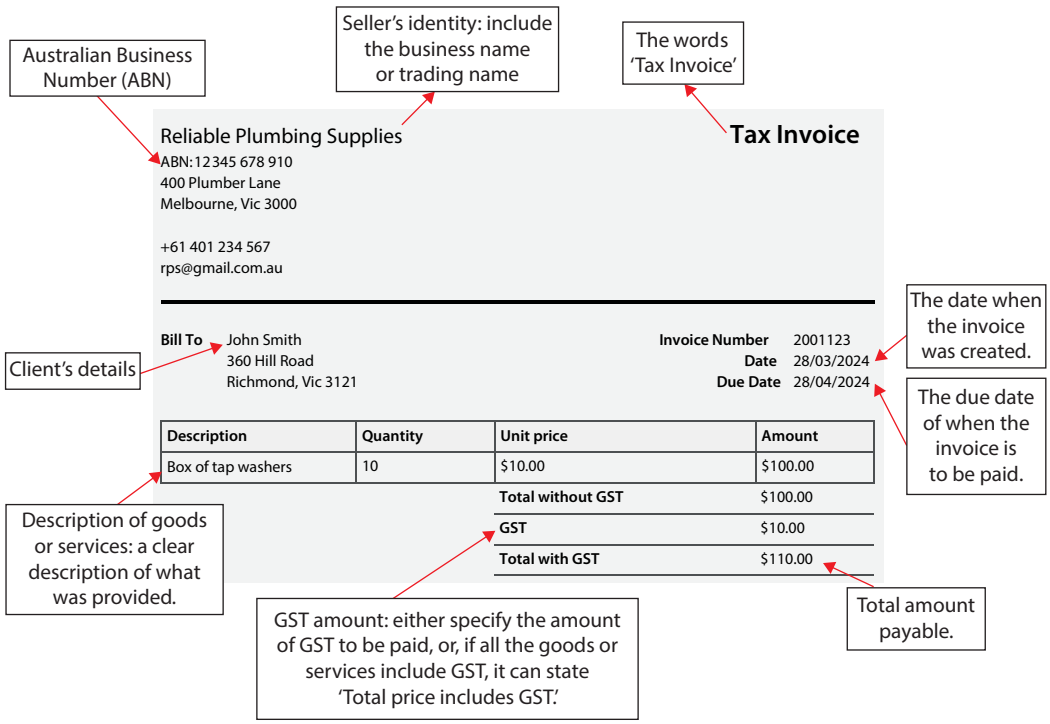
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Invoices

An **invoice** is the bill that the business or service provider sends to the customer. Most businesses will need to be able to create and generate invoices. This is an essential and compulsory part of running a business, as it relates to how you collect your revenue, and for the previously discussed issues of collecting and paying GST to the government.

It should contain all the information about what you are paying for as well as when and how you have to pay. If required, it needs to include the GST amounts.

An example of a tax invoice is shown below and should include the following items.



If the business or individual does **not** meet the GST threshold then the invoice does not need to state the GST amounts, but in that case it should not say 'Tax invoice', but simply 'Invoice'.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example: Completing an invoice

Alba's Coffee Van & Catering are asked to cater for and serve a lunch for 24 people.

The client is Beth Ford and Alba's costs and charges were:

- Drinks: $150
- Food: $27.50 per person
- Alba's time was 4 hours, and she charges $60 per hour.

Alba has a template for creating invoices. She follows the steps and calculations listed below to complete the invoice which are shown as red text in the invoice.

- Insert invoice number.
- Insert details of client.
- Insert description, date of job and required quantities.
- Enter charges for drinks, food and service charge.
- Then calculate and add on the GST cost.

Alba's Coffee Van & Catering
Tax Invoice

Invoice #: 2024 065 **ABN: 12 345 678 910**

To:	Ms Ford 12 Third Street Four Springs VIC 3297		From:	Alba's Coffee Van & Catering 14 Bean Road Green Springs VIC 3298

Job description: **Date:** 12 December 2024

- Cater for lunch for 24 people
- Provide food and drinks
- Serve food

Task/Item	Quantity	Cost	Total cost
Drinks		$150	$150
Food	24	$27.50 per head	$660
Service charge	4	$60 per hour	$240
		Sub total	$1,050
		GST 10%	$105
		Total amount owing	**$1,155**

Date: 16 December 2024
Invoice prepared by: Alba Green

Balance due within 7 days of the completion of work.

The total owing on the invoice for this job was $1,155 including GST.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

11C Tasks and questions

Thinking task

1 Work in a small group to think about and plan the possibility of one of you setting up a small business as a sole trader. Research and consider the following issues and questions.

- What type of business might be of interest and what options are there? Think about online stores, social media, pet services, handcrafts, cafes etc.
- Remember that the key to a successful small business is identifying strengths, interests and needs of your target audience.
- What are the benefits of having a sole trader business structure?
- What are the risks of being a sole trader?

Skills questions

2 Calculate the GST that would be added on to the wholesale prices of these items.

a Jacket $94.50
b Belt $35.90
c Shoes $168.00
d Suit $269.99

3 Calculate the GST included in the prices of these items.

a Bike $1946.70
b Helmet $85.99
c Bike shoes $135.90
d Bike carrier $450.00

4 *Alba's Coffee Van & Catering* is planning how much should be charged for home-made biscuits and muffins to be sold along with drinks. Alba has made some estimates of how many can be made and sold in a day. Use this information to answer the questions below.

Item	Number she thinks she can make and can sell	Estimated total expenses
Biscuits	150	$175
Muffins	50	$85

a What is the cost price for Alba to make each item?

b Use your answers to part **a** to work out what Alba's possible profits would be if all the items were sold in a day and she charged:

i double the cost price per item (round up to the nearest 50c price point)

ii triple the cost price per item (round up to the nearest 50c price point)

c What price would you charge, and why?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

5 *J&K's Bike Store* has the following expenses and sales over the December quarter.

Use this information to answer the questions below.

Income (GST inclusive)	Expenses (GST inclusive)
Bike sales: $125,678 Equipment sales: $9,245 Services: $5,698	Bike costs: $105,678 Equipment costs: $2,237 Service goods costs: $398

a Do *J&K's Bike Store* need to pay GST for their business?

b Do they need to pay the ATO some money for GST or are they owed a refund?

c How much is this amount?

6 Last year a small company generated $150,000 in revenue.

a Does this company have to register for GST?

b In the following reporting period, this company collected $12,745 in GST and the GST paid was $5,136. Calculate the total GST amount owed to the ATO.

7 The unit of currency in Indonesia is the rupiah (IDR). Assume the exchange rate is 1 AUD = 10,388.97 IDR.

a Would 100 AUD make you a millionaire in Indonesia (ignoring charges imposed by any currency exchange dealers)?

b Look up today's exchange rate for AUD to IDR – would this still be true or not?

8 The unit of currency for the United States (US) is the dollar (USD). Assume the exchange rate is 1 AUD = 0.65 USD.

a What would you get for 500 AUD in USD (ignoring charges imposed by the currency exchange dealers)?

b What would you get if you exchanged 500 USD into AUD (to the nearest dollar)?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9 Use an online currency converter to convert the following amounts from Australian Dollars into the foreign currency.

Australian amount	Foreign currency	Exchange rate	Value in the foreign currency
a $750.00	Chinese yuan		
b $199.50	euro		
c $65.00	Indonesian rupiah		
d $124,595	Japanese yen		

10 Use an online currency converter to determine what the foreign currency value is in Australian dollars (AUD) for the following amounts.

Foreign currency amount	Exchange rate	Value in AUD
a 3,457.50 US dollars		
b 125,000 euro		
c 2,500 Canadian dollars		
d 1,500 UK pound		

11 Use this invoice to answer the questions that follow.

Pay now VISA MasterCard AMERICAN EXPRESS PayPal

TED'SGOLF EQUIPMENT

Ted's Golf Equipment
Ted Jones
20 Main Street Melbourne,
Vic 3000
Australia

Phone number +61 412345678
ABN 12 345 678 910

TAX INVOICE

Invoice number: 123123
Invoice date: 3 June 2024
Due Date: 17 June 2024

Amount Due:
$263.12

Bill To:
golflover2233@yahoo.com

Description	Quantity	Price	Amount
Nike Driver - Nike SQ MachSpeed Black Round Driver	1	$299.00	$299.00*
Complimentary Lesson	1	$0.00	$0.00
	Subtotal		$299.00
	Discount (20%)		-$59.80
	GST (10%)		$23.92
	Total		**$263.12**

**Taxable item*

Notes
Thank you for your business. Enjoy your driver.

Terms and conditions
Full refund for 60 days after purchase.

Powered by PayPal

a What is the invoice number?

b What is the invoice for?

c What is the total amount due?

d Is GST included? If so, how much was it and show how it was calculated?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

12 Use this invoice to answer the questions that follow.

TAX INVOICE **# INV-27**

National Building Supplies
135 Dwelling St
Sunshine VIC 3020

Number	INV-27
Issue Date	Jun 1, 2024
Due Date	Jul 1, 2024
Amount Payable	$846.80

Bill To
ABC Plumbing
bill@abcplumbing.com.au
500 Calder Fwy,
Mebourne VIC 3000

Qty	Item	Unit Price	Amount
20	32 mm Pop Up Basin Waste	$14.80	$296.00
40	15 x 75 mm Chrome Plated Brass Male Female Extension Discount for bulk purchase	$9.10	$327.60 Includes 10% discount
40	15 mm Chrome Plated Brass Tee Discount for bulk purchase	$6.20	$223.20 Includes 10% discount

Sub Total	$769.82
GST	$76.98
Total	$846.80

MAKE CHEQUE PAYABLE TO:

National Building Supplies

BANK DEPOSIT:

Name: Simple Invoices
BSB: 111222
Acc No.:1234 9876

National Building Supplies ABN: 22 333 444 555 Email: info@nationalbuildingsupplies.com.au www.nbs.com.au

a What is the invoice number?

b When is the payment due?

c How much is to be paid?

d Does this amount include GST? If yes, how much is the GST?

Application tasks

13 A plumber charges a $100 call-out fee and $80 per hour when attending a job. Answer the questions below.

a How much would they earn in total for the following jobs over one week.

- Monday: 1 job, 5 hours
- Tuesday: 2 jobs, 3 hours at the first and 2.5 hours at the second

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- Wednesday: 3 jobs, each of 2 hours
- Thursday 2: 4 jobs that took a total of 6 hours
- Friday 1: 1 big job of 7.5 hours.

b If this weekly income is maintained over a whole year, and the plumber works for 48 weeks in the year, what would be the annual gross income based on that weekly amount?

c The plumber collects GST on the work. How much GST would have been included in the charges?

14 Complete the costs and charges for the invoice below for *Carla's Gardening Services*. The client is Barry Ford and Carla's costs were:

- 3 gum trees at $150 per tree
- 2.5 cubic metres (m^3) of garden mulch at $50.00 per cubic metre
- Carla's time was 3.5 hours, and she charges $75 per hour.

<table>
<tr><td colspan="4">Carla's Gardening Services
Tax Invoice
Invoice #: 3006 1234 ABN: 12 345 678 910</td></tr>
<tr><td>To:</td><td>Mr Ford
12 Third Street
Four Springs
VIC 3297</td><td>From:</td><td>Carla's Gardening Services
14 Snail Road
Green Springs
VIC 3298</td></tr>
<tr><td colspan="4">Job completed:
• Deliver and plant 3 gum trees
• Deliver 2.5 cubic metres (m^3) of garden mulch</td></tr>
<tr><td>Task/Item</td><td>Qty</td><td>Cost</td><td>Total cost</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Sub total</td><td></td></tr>
<tr><td colspan="3">GST 10%</td><td></td></tr>
<tr><td colspan="3">Total amount owing</td><td></td></tr>
<tr><td colspan="4">Date: 26 June
Invoice prepared by: Carla Green</td></tr>
<tr><td colspan="4">Balance due within 7 days of the completion of work.</td></tr>
</table>

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

11D Expenses and the BAS

Business expenses are the costs that a business incurs in the process of operating and maintaining its activities. These expenses are subtracted from the revenue to calculate the profit of the business (referred to as the 'bottom line'). Understanding and managing business expenses is crucial for financial planning, budgeting and overall profitability.

Business expenses can include:

- Salaries and wages and related costs such as taxation and superannuation
- Operating expenses such as rent of warehouse and retail spaces
- Insurances, such as WorkCover
- Utilities such as electricity, water and internet
- Equipment, machinery and technologies
- Cost of raw materials and components used to produce goods and services
- Purchases of goods and products to on sell
- Marketing and advertising
- Logistics
- Business related financial costs, such as banking fees and charges, accountants fees etc.

It's important for businesses to carefully track and categorise their expenses for financial reporting, budgeting and tax purposes. Effective expense management is key to maintaining a healthy bottom line and ensuring the overall financial wellbeing of the business.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 5 Calculating expenses

A group of students are planning to set up a coffee cart business and list the planned expenses for operating the coffee cart over a weekend.
- Rent of equipment: $120.00
- Wages: 18 hours @ $19.20/hour
- Cost of supplies: $145.50

What are the expected expenses for the coffee cart business for one weekend?

THINKING	WORKING
STEP 1	
Calculate the wage expenses.	$18 \times \$19.20 = \$345.60$ The wage expense is $345.60.
STEP 2	
Calculate the total expected expenses for the weekend by adding the other expenses to the wage expense.	$\$345.60 + \$120.00 + \$145.50 = \$611.10$ The expected expenses for the coffee cart business for one weekend will be $611.10.

Leave entitlements

If a business employs staff, it has to also factor **leave entitlements** into its running costs. The most common forms of leave that employees are entitled to in Victoria are:

- Public holidays
- **Annual leave**
- Sick or carer's leave
- Compassionate and bereavement leave
- Parental leave
- Family and domestic violence leave
- Long service leave.

Most full-time employees are entitled to four weeks of paid annual leave.

Part-time employees are entitled to annual leave on a **pro rata** basis. This means that if you are employed at a rate of 75% of a full-time job, you are entitled to 75% of the annual leave that a full-time employee would get.

An example of this is if an employee normally works 20 hours a week throughout the year, they will be entitled to 80 hours of annual leave because this is the equivalent of 4 weeks' work.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Leave entitlements and conditions vary depending on the employee's working conditions, and the industry in which they work. These are set out in each industry's **Award**, which is a legally binding contract between employers and employees.

Employees can check their leave entitlements by using the information and calculators on the Australian Government **Fair Work Ombudsman** site.

GST

As we have seen in earlier chapters and in section 11C, a business needs to collect and pay the GST. This expense needs to be planned and accounted for and is paid via the Business Activity Statement (BAS), which is explained in more detail below.

Superannuation

The issue of the compulsory superannuation payment by employers on behalf of their workers was covered in Chapter 10. Superannuation (often referred to as Super) is an investment for your life when you retire. Employers must pay a percentage of the employee's wages, as an additional amount, into their nominated Super fund. This is called the **Superannuation Guarantee**. Here are rates that employers need to pay:

Financial year	2023–24	2024–25	2025–26	2026–27	2027–28
Employer contribution	11.0%	11.5%	12.0%	12.0%	12.0%

Insurances, including Workcover

There are also expenses related to having to take out insurance for running small businesses in Australia. These vary quite a lot, depending on the type of business. The key ones include:

- Compulsory workers' compensation insurance which covers employees for work-related injuries or illnesses, including their wages, while they're unable to work and medical expenses. In Victoria, this is called WorkCover.
- Third-party personal injury/compulsory third-party insurance when a company owns vehicles, which covers compensation costs if people are injured or killed in an accident involving a company vehicle.
- Public liability insurance, while not compulsory, helps protect a business for when they're liable for negligence; for example, if a business causes injury or death, such as your food making a customer sick.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- General liability insurance which covers legal costs if someone sues a business for injury or property damage.
- Business property insurance which protects physical assets, like equipment, products, and building against damage or loss.

WorkCover

All employers in Victoria are required to have **WorkCover** insurance. This insurance covers employees in case of work-related injuries or illnesses.

Here are its key objectives:

- Injury compensation: covers injured workers so they get compensation for medical expenses, rehabilitation and lost wages resulting from workplace accidents or occupational diseases.
- Prevention and safety: WorkCover also promotes workplace safety through education, training and enforcement of safety regulations.
- Rehabilitation: WorkCover assists injured workers in their recovery process by facilitating rehabilitation services and vocational training.

Employers are required to pay an annual fee for their WorkCover insurance.

The fee is based on a number of factors, including:

- the total amount paid to workers during the year including wages, superannuation, leave and fringe benefits (called remuneration)
- the industry classification of the business
- any previous claims – past claims made by the business can impact the premium.

The average premium rate for 2024–25 was 1.8% of total remuneration.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 6 Calculating the WorkCover premium for a cafe

Rodrigo runs a small cafe and is trying to estimate his WorkCover premium for the 2024–25 financial year. The standard WorkCover premium for cafes and restaurants is 1.113% of total remuneration. He is expecting to pay $124,000 in wages for the year.

THINKING	WORKING
STEP 1	
Determine the remuneration figure for the year. Remuneration includes wages and superannuation. Employer contribution for superannuation for the 2024–25 financial year is 11.5%.	Superannuation = 11.5% of $124,000 = 0.115 × $124,000 = $14,260 Remuneration = $124,000 + $14,260 = $138,260
STEP 2	
Use the published industry rate for cafes to estimate the WorkCover premium. (This rate varies depending on the particular business's history of claims so is only an estimate.)	Industry rate for café = 1.113% WorkCover premium = 1.113% of $138,260 = 0.0113 × $138,260 = $1,562.34
STEP 3	
Write your answer.	The estimated WorkCover premium for this year is $1,562.34.

Taxation

In Australia, businesses are subject to several taxes. The key ones include:

- Company tax: Australian resident companies pay company tax at a rate set by the Australian Government. Currently, a smaller business's company tax rate is 25%, while larger businesses with a turnover greater than $50 million pay a company tax rate of 30%.
- Capital gains tax (CGT): This tax applies when a company makes a capital gain by disposing of assets.
- Goods and services tax (GST): which we have looked at earlier.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- Payroll tax: Payroll tax is imposed by state and territory governments and applies to employers based on their total wages paid.
- Other business taxes: Apart from the taxes mentioned in this list, businesses may encounter other taxes, such as fringe benefits tax (FBT), fuel tax and customs duties, depending on their specific activities and circumstances.

Example 7 Calculating the company tax for a small business

In the current financial year, an electronics company had an assessable income of $5,430,500 and eligible deductions of $3,890,900. Calculate the company tax that is payable for the year.

THINKING	WORKING
STEP 1	
Calculate the assessable income less deductions.	Assessable income – deductions = $5,430,500 – $3,890,900 = $1,539,600
STEP 2	
Determine which company tax rate is applicable.	The company turnover (income) is less than $50 million so the company tax rate is 25%.
STEP 3	
Calculate the company tax.	Company tax = 25% of $1,539,600 = 0.25 × $1,539,600 = $384,900
STEP 4	
Write your answer.	The company tax payable for this financial year is $384,900.

Collecting employee tax on behalf of the government

In section 10D Responsibilities to our society: Understanding taxes and more, personal employee taxation was covered in some detail from the perspective of an individual paying tax, but not from the business perspective.

The same calculations need to be used by an employer when paying their workers and calculating how much tax to take out from a worker's wages. The business is responsible for collecting these tax amounts and paying them to the government through the ATO. These are then paid through the Business Activity Statement (BAS) process, which is discussed in more detail over the next few pages.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

There are two key ways a business accounts for and pays the government the tax they collect from their employees:

- pay as you go (PAYG) withholding
- pay as you go (PAYG) instalments.

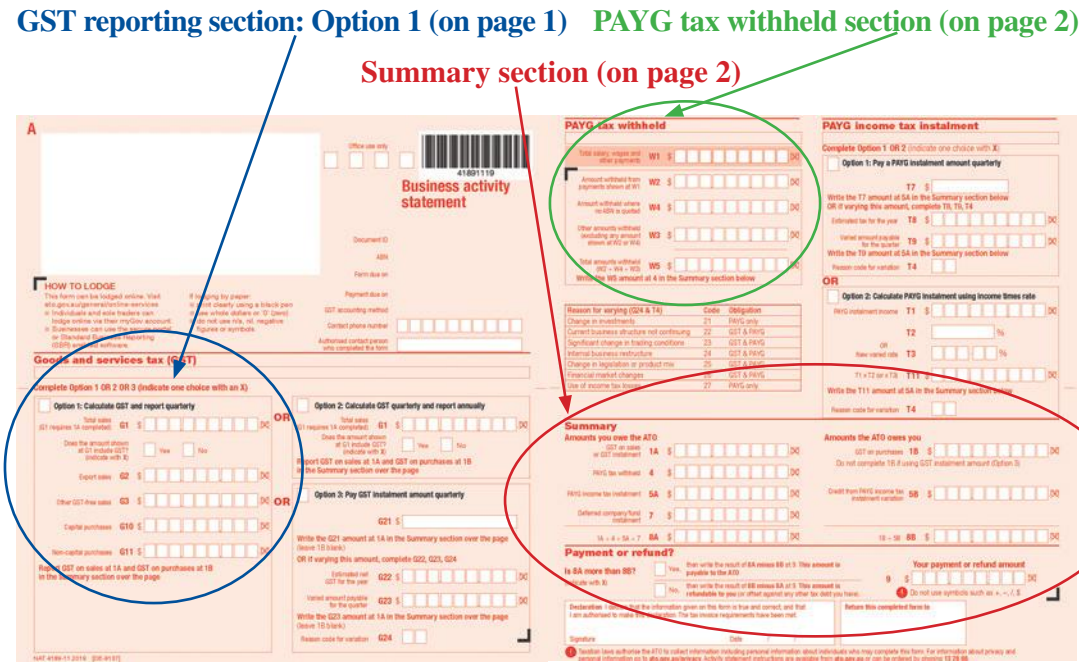
It's important to understand the difference between PAYG withholding and PAYG instalments. When you pay your employees, you must withhold a certain amount of tax from their pay. You then send this tax to ATO. The ATO calls this Pay As You Go (PAYG) withholding.

When a business's income reaches a certain amount, they'll be expected to pay their income tax in instalments. These payments are usually quarterly. PAYG instalments help them to avoid a large tax bill after they lodge their income tax return.

Business activity statement (BAS)

A **business activity statement (BAS)** is the form used to report and pay various tax obligations to the Australian Taxation Office (ATO), especially GST and taxes deducted from an employee's pay. Businesses are required to submit it on a regular basis, typically quarterly.

Below is a copy of the PDF version of the BAS which can be used if submitting the BAS via a hard copy. For most smaller sized businesses that do not use the PAYG instalment process, there are three sections of the BAS that need to be filled out as shown below.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Companies and businesses can also lodge their BAS returns online.

- For individuals and sole traders – this can be accessed through the *myGov* website.
- For businesses – a secure ATO website is used for a range of business tax affairs, including the BAS.
- Secure online lodgement is also possible directly from approved financial, accounting or payroll software, and often integrated with business software that's tailored to specific industries.

The BAS incorporates the GST calculations and payments that were covered in the previous section but is complicated by the additional requirement to report on and pay any taxes collected from an employee's wages and salaries.

The main components included in a BAS include:

- GST collected on sales (GST collected) which is **owed to the ATO**
- GST paid on purchases (GST credits) which is **owed to the business** by the ATO
- Pay As You Go (PAYG) income tax withholding amounts from employees's wages
- If relevant, PAYG instalments towards the business's expected income tax liability.

The formula for working out whether a payment to the ATO is due or not on the BAS is:

> GST collected on sales, less GST paid on purchases (credits), plus tax withheld on wages (PAYG withholding) to employees plus any income tax instalment due (PAYG instalment).

This can be written more formally as:

> Tax payable = GST collected – GST credits + PAYG withheld + PAYG instalments

ISBN 978-1-009-[illegible]-5 Sakurai et al © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 1: with no PAYG instalment process in place

The statement below is from the summary section of a BAS transaction made with the ATO. It is simpler to read and understand than the full BAS statement, which we will look at next.

Statement summary

Description	Reported Value	Owed to ATO	Owed by ATO
Goods and services tax (GST)			
1A Owed to ATO		$10,803.00	
1B Owed by ATO			$4,082.00
G1 Total sales	$118,843.00		
Does this include GST?	Yes		
7A Deferred imports amount		$0.00	
PAYG tax withheld			
4 Income tax withheld amount		$10,006.00	
W1 Total salary, wages and other payments	$46,738.00		
W2 Amount withheld from total salary, wages and other payments	$10,006.00		
W3 Other amounts withheld	$0.00		
W4 Amount withheld where ABN not quoted	$0.00		

The calculation for the amount owed to the ATO is:
Tax payable = GST collected – GST credits + PAYG withheld + PAYG instalments

From the BAS above:

GST collected (item 1A) = $10,803

GST credits (item 1B) = $4,082

PAYG withheld (item 4) = $10,006.00

PAYG instalments = $0 (not applicable).

So, tax payable = $10,803.00 – $4,082.00 + $10,006.00 + $0 = $16,727

Example 2: with PAYG instalment process in place and filling out the whole form

A company has the following tax-related payments due to be submitted via the BAS in the current quarter. They calculate their GST and pay and report their BAS quarterly.

Their quarterly GST, wages and PAYG tax figures are as follows.

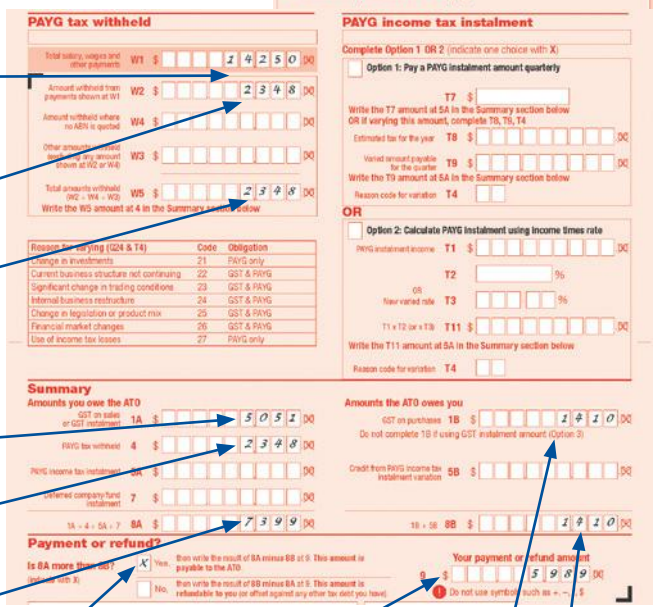
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

GST Option 1 (page 1):

- Total sales (item G1): $55,571, which includes GST
- **Non-capital purchases** (item G11): $15,510

PAYG tax withheld (page 2):

- Total salary, wages etc. (item W1): $14,250, which includes GST
- Amount withheld (item W2): $2,348
- Total amounts withheld (item W5): $2,348



Summary (page 2):

- GST on sales (item 1A): $5,051
- PAYG tax withheld (item 4): $2,348
- 1A + 4 + 5A + 7 (item 8A): $7,399

Payment or Refund?:

- Is 8A more than 8B?: Yes
- Your payment or refund amount (item 9): $5,989

Amounts the ATO owes you:

- GST on purchases (item 1B): $1,410
- 1B + 5B (item 8B): $1,410

Note: This is the amount payable by the company to the ATO.

Although this is worked out on the BAS statements, here are the calculations related to the summary section:

GST collected (item 1A) = $5,051

GST credits (item 1B) = $1,410

PAYG withheld (item 4) = $2,348

PAYG instalments = $0 (not applicable).

Tax payable = GST collected – GST credits + PAYG withheld + PAYG instalments

Tax payable = $5,051 – $1,410 + $2,348 = $5,989

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

11D Tasks and questions

Thinking tasks

1 Work in a small group to come up with an idea for a business (it could relate to the Thinking task you worked on in section 11C). Agree on what the aims of the business are: is it about running an online store, a pet business, making and selling handicrafts, running a café or a food truck, running classes, or more? Research and consider what the expenses might be for such a business. Think about the following possible expenses:

- Salaries and wages and related costs such as taxation and superannuation
- Accommodation and operating expenses such as rent or leases
- Insurances such as WorkCover
- Utilities such as electricity, water and internet
- Equipment, machinery and technologies
- Cost of raw materials and components needed to produce goods and services
- Purchases of goods and products to on sell
- Marketing and advertising
- Business related financial costs, such as insurance premiums.

Consider the following issues and questions.

- Are there other expenses that were not listed above?
- Which expenses will be significant, and which ones might be smaller?
- Are there alternative ways to operate your business and reduce costs and expenses?

2 In the 2024–25 financial year, the average WorkCover premium rate was 1.8% of total remuneration. There were three industries with a rate above 10%:

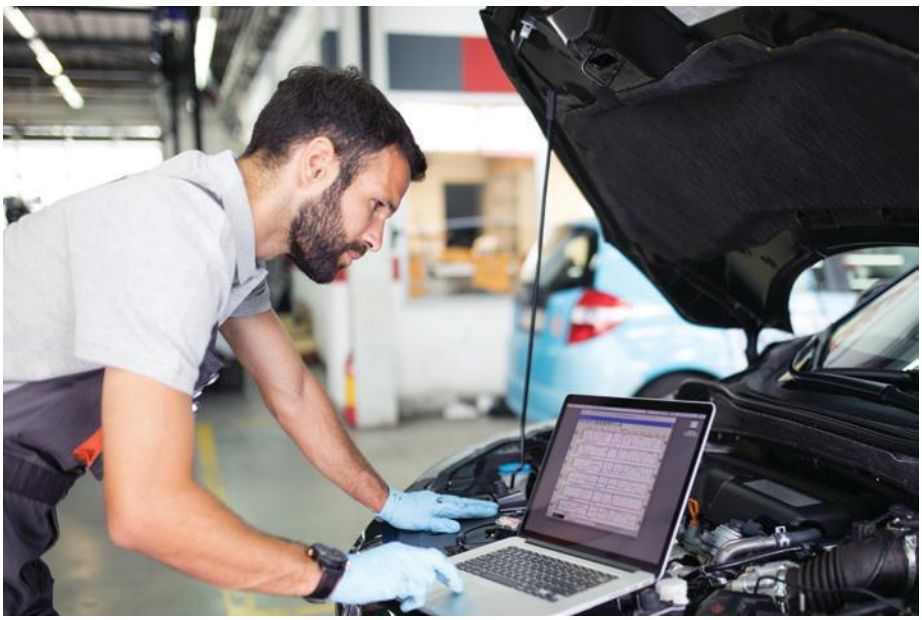
- Other Non-Metallic Mineral Product Manufacturing 18.000%
- Tiling and Carpeting Services 13.181%
- Stevedoring Services 10.865%.

Why do you think this might be the case?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Skills questions

3 Identify the following as revenue (R) or expenses (E) for an automotive business.



a Wages
b Rent
c Spare part sales
d Fee charged for servicing cars
e Superannuation
f Purchase of spare parts
g Purchase of workshop equipment
h Utility bills
i Insurance

4 An employee is entitled to 4 weeks annual leave, which starts to accumulate from when a job is commenced. Kyla has worked for the company for 5 months. Approximately how many days of annual leave has Kyla accumulated if she hasn't taken any annual leave so far?

5 Calculate the current Superannuation Guarantee amounts due for the following gross income amounts in the 2025–26 financial year.

a $65,240 p.a. **b** $95,800 p.a. **c** $112,854 p.a.

6 Steph runs a photography business and is trying to estimate their WorkCover premium for the 2024–25 financial year. They are expecting to pay $84,500 of wages for the year. Their expected WorkCover industry rate is 0.406%. Based on this rate, what is Steph's expected WorkCover premium for the year?

7 In the current financial year, *R&H Real Estate* company had an assessable income of $1,745,700 and eligible deductions of $1,090,900. Calculate *R&H Real Estate*'s company tax that would have been payable for the year.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

8 Last year a small company generated $100,000 in revenue.

a Does this company have to submit a BAS statement?

b In the reporting period, this company collected $10,445 in GST and the GST paid was $4,736. The tax withheld from wages was $10,503. They do not do PAYG tax instalments. Calculate the total amount owed to the ATO.

9 *Bill's Bicycle Company* had an income of $340,575 in the final quarter of the year. Their GST and PAYG tax payments were:

GST collected: $8,051

GST credits: $12,410

PAYG withheld: $22,348

PAYG instalments: $10,350

Calculate the amount owed to the ATO.

Application task

10 Below is a set of quarterly GST and taxation figures for *Carla's Gardening Services*. They calculate and report their GST payments quarterly, and do not pay GST instalments. *Carla's Gardening Services* transactions and payments were:

Total sales and income: $19,986 including GST

There were no Export sales, other GST-free sales or **Capital purchases**.

Non-capital purchases: $6,511

Total salary and wages: $5,525

Amount withheld from payments: $538

There were no other amounts withheld.

GST collected: $1,816

GST credits: $444

PAYG withheld: $538

PAYG instalments: Not applicable

a Complete the relevant fields in a copy of the extracts of the BAS form provided in the Interactive textbook.

b Does *Carla's Gardening Services* owe the ATO money, or does the ATO owe *Carla's Gardening Services* money?

c Calculate the total amount owed.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

11E Financial statements

For a business to be profitable, the revenue needs to be greater than the expenses. Profit is calculated by subtracting expenses from revenue:

$$\text{Profit} = \text{revenue} - \text{expenses}$$

If the revenue is less than the expenses, then the business makes a loss; hence, the need for good financial planning and for the ongoing monitoring of how the business finances are going.

Financial plans and statements

Financial planning and monitoring requires research into the expected costs and revenues of a business. The federal government has a business site that provides much of the background information about all of the above, and also provides templates for companies and businesses to access and use. Search for financial tools and templates on the business.gov.au site.

There are three main financial statements that companies use to track their performance:

- Balance sheet
- Cash flow statement
- Income (profit and loss) statement.

Balance sheet

The **balance sheet** provides an overview of the business **assets**, **liabilities** and the **owner's equity**.

- Assets are what a business owns.
- Liabilities are what a business owes.
- The owner's equity is the residual amount of the assets after liabilities are deducted.

These are related by the formula: Owner's equity = assets − liabilities

For example, the balance sheet for a café is shown below.

Assets		**Liabilities**	
Cash in bank	$2,400	Creditors	$7,220
Stock	$5,250	Loan	$10,500
Equipment	$12,475	**Total liabilities**	**$17,720**
		Owner's equity	**$2,405**
Total assets	**$20,125**	**Total liabilities + equity**	**$20,125**

Note that the total liabilities + equity must equal the total assets.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Cash flow statement

A **cash flow statement** reports all the cash flows in and out of a business during a reporting period. Cash flows are categorised as operating activities, investing activities and financing activities.

- Operating activities result in cash flows from running the business – like selling products and/or services.
- Investing activities result in cash flow from selling or purchasing assets.
- Financing activities result in cash flow from investors or banks.

For example, here is a cash flow statement for a dog grooming business.

Cash flow statement for 2024–25 financial year	
Cash flow from operations	
Earnings	$34,500
Additions to cash	$1,245
Cash flow from investing	
Purchasing equipment	$12,050
Cash flow from financing	
Repayment of loan	$4,000
Cash flow 2024–25	

Note that repayment of loan and purchasing equipment is coloured red to indicate a cash flow out of the business. Sometimes this can also be shown in brackets as ($12,050) to show it as an outgoing payment.

The cash flow is calculated as: $34,500 + $1,245 – $12,050 – $4,000 = $19,695

This means that $19,695 flowed into the business during this time.

Income or profit and loss statement

A profit and loss (or income) statement lists your sales and expenses. It tells you how much profit you're making, or how much you're losing. You usually complete a profit and loss statement every month, quarter or year. You use your profit and loss statement to help develop sales targets and an appropriate price for your goods or services.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

A business is **insolvent** when the income is not enough to cover the expenses.

There are three main ways that this could this happen.

- Expenses rise without the business being able to generate more income.
- Income falls without the business being able to reduce expenses.
- An event occurs where the business is forced to carry out reduced (or no) business but is still liable for expenses such as wages and leases on equipment.

Full profit and loss statements sum up all of the money that a business has made (revenue) or lost (expenses) over a period of time. These statements include operating and non-operating revenue, operating expenses incurred such as payroll, advertising, rent and insurance, cost of goods sold (COGS), taxes and non-operating expenses. Most businesses generate profit and loss statements quarterly and annually, with some business owners also choosing shorter or longer periods of time.

Here is an example of a profit and loss (P&L) statement.

Profit & Loss Statement		
for the period 1 January	to 31 December 2024	
Income		
Sales	$120,200.00	
Services	$55,000.00	
Other Income	$2,520.00	
Total Income		$177,720.00
Expenses		
Accounting	$2,500.00	
Advertising	$7,500.00	
Assets - Small	$100.00	
Bank Charges	$962.40	
Depreciation	$2,385.00	
Electricity	$2,994.90	
Hire of Equipment	$4,200.00	
Insurance	$1,221.00	
Interest	$2,401.66	
Motor Vehicle	$1,203.50	
Office Supplies	$962.11	
Postage & Printing	$725.00	
Rent	$15,610.00	
Repairs & Maintenance	$1,082.00	
Stationery	$660.00	
Subscriptions	$3,690.00	
Telephone	$2,165.00	
Training / Seminars	$2,200.00	
Wages & Oncosts	$65,000.00	
Total Expenses		$117,562.57
Profit / (Loss)		**$60,157.43**

Top line

Bottom line

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

P&L statements follow a general format. Starting with the revenue entry, also known as the 'top line', they then subtract the costs of doing business (such as wages, rent, taxes, operating expenses, interest, product expenses) from the revenue. The result is the profit, also known as the 'bottom line'.

Gross profit versus net profit

Gross profit is the amount of money you are left with after deducting the cost of goods sold from revenue. **Net profit** reflects the amount of money you are left with after having paid all your allowable business expenses. Gross profit provides the money for running the business. You need to calculate gross profit to arrive at net profit.

Here is an example of a P&L statement with both the gross and net profits shown.

Note: Remember that an expense (or a loss) in financial statements are often put in brackets, like the Cost of Goods Sold (25,000) and the Total Operating Expenses (50,000) in this example.

Income Statement
For The Year Ended 31 December 2024

Total Revenue	$150,000
Cost of Goods Sold	(25,000)
Gross Profit	**$125,000**
Operating Expenses	
Payroll	15,000
Utilities	10,000
Rent	15,000
Depreciation	10,000
Total Operating Expenses	**(50,000)**
Interest	(15,000)
Taxes	(15,000)
Net Profit	**$45,000**

Profit margins

There are two common measures of profit margins.

- **Gross profit margin**: Gross profit margin is the percentage of revenue left after deducting the cost of goods sold (COGS). It's calculated by dividing gross profit by total revenue.
- **Net profit margin**: Net profit margin assesses the profitability of a business after considering all expenses. It's calculated by dividing net profit by total revenue.

They are typically expressed as a percentage but can also be represented in decimal form. Generally, the gross margin of a company needs to be a minimum of 45% and preferably 50% to make a fair and reasonable net profit. Often net profits are much lower, and anywhere above 10% is considered acceptable.

Simpler P&L calculations

Often, a small business, especially a sole trader, may record all revenue coming into the business in a cash receipts journal and all expenses paid out of the business in a cash payments journal. A simple profit and loss statement for such a small business might only include cash inflows and outflows of a business during a specific period.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example: Cake chef

The two tables below show the cash receipts and cash payment journals in March for a cake chef.

Cash receipts – March

Date	Customer	Invoice number	Fees	GST	Total payment
Mar 3	J. Freid	102	$245.00	$24.50	$269.50
Mar 7	L. Roma	103	$150.00	$15.00	$165.00
Mar 8	J. Lippet	104	$310.00	$31.00	$341.00
Mar 14	T. Henry	105	$195.00	$19.50	$214.50
Mar 28	R. Singh	106	$245.00	$24.50	$269.50

Total amount received in March = $1,259.50

Total amount of GST received in March = $114.50

Total revenue = $1,259.50 – $114.50 = $1,145.00

Cash payments – March

Date	Details	Reference number	Expense	GST	Total amount paid
Mar 1	Supermarket supplies	79	$256.50	$25.65	$282.15
Mar 7	Cake shop supplies	80	$122.99	$12.30	$135.29
Mar 10	Social media marketing fees	81	$45.00	$4.50	$49.50
Mar 17	Supermarket supplies	82	$98.68	$9.87	$108.55
Mar 20	Party shop supplies	83	$23.45	$2.35	$25.80

Total amount of money paid out in March = $601.29

Total amount of GST paid in March = $54.67

Total expenses = $601.29 – $54.67

= $546.62

To calculate the profit for March:

Profit = revenue – expenses

= $1,145.00 – $546.62

= $598.38

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example: Hotel

Below is the P&L statement for *J&D's Hotel* for the December quarter in 2024.

Profit and loss for J&D's Hotel: October - December 2024

	October	November	December	Quarter total
Income				
Sales	61,500	96,379	123,125	**281,004**
Food and beverages	8,500	13,321	17,017	**38,838**
Events	5,500	20,893	26,691	**53,084**
Refunds	–8,200	–9,840	–13,284	**–$31,324**
Gross profit/net sales				
Expenses				
Accountant fees	1,250	1,250	1,250	**$3,750**
Advertising and marketing	1,950	2,145	2,360	**$6,455**
Bank fees and charges	1,009	1,110	1,222	**$3,341**
Utilities (electricity, gas, water)	2,300	2,530	2,783	**$7,613**
Telephone	749	824	906	**$2,479**
Lease/loan payments	7,100	7,100	7,810	**$22,010**
Repairs and maintenance	1,950	2,145	2,010	**$6,105**
Motor vehicle expenses	757	833	916	**$2,506**
Stationery and printing	545	599	6,560	**$7,704**
Insurance	1,725	1,725	1,725	**$5,175**
Superannuation	2,804	3,084	3,392	**$9,280**
Income tax	6,675	7,342	8,077	**$22,094**
Wages (including PAYG)	26,700	29,370	35,244	**$91,314**
Supplies	5,600	6,160	6,776	**$18,536**
Total expenses	**$61,114**	**$66,217**	**$81,031**	**$208,362**
NET PROFIT (net income)				

Assumptions: Figures include GST.

We can use this P&L statement to complete the missing entries in the cells highlighted in green to find the gross profit and net profit for October, November and December, and the total for the quarter.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Gross profit

Gross profit = sales + food and beverage + events – refunds

October: Gross profit = 61,500 + 8,500 + 5,500 – 8,200 = $67,300

November: Gross profit = 96,379 + 13,321 + 20,893 – 9,840 = $120,753

December: Gross profit = 123,125 + 17,017 + 26,691 – 13,284 = $153,549

December quarter: Gross profit = 281,004 + 38,838 + 53,084 – 31,324 = $341,602

Net profit

Net profit = gross profit – total expenses

October: Net profit = 67,300 – 61,114 = $6,187

November: Net profit = 120,753 – 66,217 = $54,536

December: Net profit = 153,549 – 81,031 = $72,518

December quarter: Net profit = 341,602 – 208,362 = $133,240

We can also work out the gross profit margin and net profit margin over the December quarter for the company. In both cases, we first need to know the total revenue.

$$\begin{aligned}\text{Total revenue for the quarter} &= 281{,}004 + 38{,}838 + 53{,}084 \\ &= \$372{,}926\end{aligned}$$

Gross profit margin is calculated by dividing the gross profit by the total revenue. We can express this margin as a percentage by multiplying by 100.

$$\begin{aligned}\text{Gross profit margin} &= \frac{\text{gross profit}}{\text{total revenue}} \times 100\% \\ &= \frac{341{,}602}{372{,}926} \times 100\% \\ &= 91.6\%\end{aligned}$$

Net profit margin is calculated by dividing the net profit by the total revenue.

$$\begin{aligned}\text{Net profit margin} &= \frac{\text{net profit}}{\text{total revenue}} \times 100\% \\ &= \frac{133{,}240}{372{,}926} \times 100\% \\ &= 35.7\%\end{aligned}$$

The gross profit margin is very high, whereas the net profit margin is a lot lower, but still very good. Based on these profit margins, it appears that this company is in a strong financial position. It should be noted that some costs, such as company tax, have not been included in the P&L statement for *J&D's Hotel*.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

11E Tasks and questions

Thinking task

1 What could a small home business do if the gross profit is not enough to cover its running expenses? Share and compare your ideas with your classmates.

Skills questions

2 Complete this table and then answer the questions below.

Cash flow from operations	
Earnings	$17,200
Additions to cash	$3,980
Cash flow from investing	
Purchasing equipment	$10,300
Cash flow from financing	
Repayment loan	$15,000
Result	

a What type of financial statement is this?

b What is the balance of this business?

c Is this business currently financially successful? Why or why not?

d If you owned this business, what would you do first to improve the financial outlook?

3 Complete this table and then answer the questions below.

Assets		**Liabilities**	
Cash in bank	$5,500	Creditors	$6,700
Stock	$6,205	Loan	$8,160
Equipment	$10,435	**Total liabilities**	$13,500
		Owner's equity	
Total		**Total liabilities + equity**	$22,140

a What type of financial statement is this?

b What is the owner's equity?

c Is this business currently successful?

d If you owned this business, what would you do first to improve the financial outlook?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4 Complete this table and then answer the questions below.

Revenue	
Fees paid by clients	$14,000
Sale of additional products	$1,055
Expenses	
Wages	$9,135
Advertising	$150
Stock purchase	$6,450
Result	

a What type of financial statement is this?

b What is the balance of this business?

c Is this business currently financially successful? Why or why not?

d If you owned this business, what would you do first to improve the financial outlook?

5 Faiza makes and sells earrings. They cost $15 per pair to make, and she sells them at a markup of 200%. On average, she sells 360 pairs of earrings each month. She pays $255 per day to rent the pop-up stall in the shopping centre and runs the stall 6 days per week for 4 weeks in a month. She pays herself $2000 per month in wages and has other expenses of approximately $750 per month.

a Create a simple monthly income (P&L) statement for Faiza's business.

b Does she make a net profit?

c Are there other expenses Faiza should also consider and include?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6 A small business owner is not very neat with paperwork. These are a month's worth of receipts and invoices that were all jumbled up in a drawer.

Receipt from Unity cars $5,100	Receipt for ink cartridge $110.20
Invoice from Fred's bakery $1,680	Invoice for event hosting $24,250
Total sales June $94,000	Receipt for new monitors $3,560
Receipt for fixing air conditioning $4,700	Invoice from York printing $2,600
Invoice for new chairs $990	Receipt for refurbishing office $31,500
Invoice for taxis $820	Invoice for First Aid training $790
Receipt for office rent $4,500	Receipt for phone and internet $150

a Create a cash receipts statement and include GST.

b Create a cash payment statement and include GST.

c Did they make a profit or loss in relation to their cash flow according to this documentation?

Mathematical literacy

7 Match each financial term on the left with its meaning on the right.

Term	Meaning
a Assets	**A** A report of where the business's money is coming from, and where it's going
b Balance sheet	**B** Total amount of money flowing into a business
c Cash flow sheet	**C** The amount of money put into the business by the owner
d Owner's equity	**D** Statement of the business's assets, liabilities and owner's equity
e Expenses	**E** The legal debts of the business
f Profit and loss statement	**F** The resources of value to the business
g Liabilities	**G** Money flowing out of a business for goods or services
h Revenue	**H** A report showing the business's revenue, expenses and profitability over a period of time

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Application tasks

8 Below is a partially completed profit and loss statement for *Nicki's Handicrafts* for the December quarter 2024. *Nicki's Handicrafts* is a small, personal business where Nicki makes her own crafts and sells them at different markets.

Profit and loss for Nicki's Handicrafts: December Quarter 2024

	October	November	December	Total
Income				
Sales	4,575	5,985	7,450	**18,010**
Less cost of goods sold	1,601	2,095	2,607	**6,303**
Less Returns	343	449	558	**1,350**
Gross profit/net sales				
Expenses				
Advertising and marketing	75	80	250	**405**
Bank fees and charges	68	90	112	**270**
Telephone	24	29	37	**90**
Stationery and printing	57	60	98	**215**
Insurance	42	42	42	**126**
Superannuation	173	173	173	**519**
Wages (including PAYG)	1,500	1,500	1,500	**4,500**
Market and stall fees	155	175	260	**590**
Total expenses	**2,094**	**2,149**	**2,472**	**6,715**
NET PROFIT (net income)				

a Use this P&L statement to complete the missing entries in the cells highlighted in green to find the gross profit and net profit for October, November and December, and the total for the quarter.

b Is Nicki's business likely to be registered for GST? Why or why not?

c Do you think this is a successful business for Nicki? Explain why or why not?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9 Here is a list of both revenue and expenses for a food van enterprise for one month.

Item	Value
Advertising and marketing	$250
Bank fees and charges	$265
Cost of goods sold (permit fees)	$558
Cost of goods sold (supplies)	$5,920
Event catering revenue	$890
Income tax	$1,144
Insurance	$225
Lease of van	$1,125
Maintenance	$300
Parking fees	$260
Sales of street food	$16,590
Superannuation	$598
Telephone	$94
Wages (including PAYG)	$5,200

a Create a P&L statement for the business for this month. Include the gross profit and net profit.

b Calculate the gross profit margin.

c Calculate the net profit margin.

d Is the business operating at a profit level that indicates it is viable?

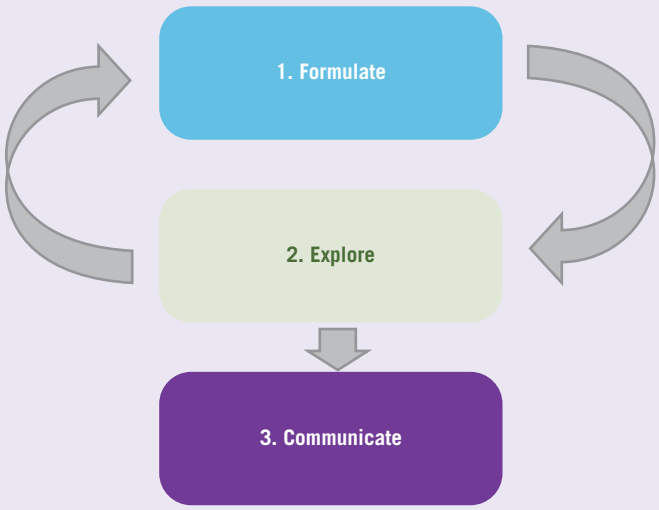
e What could this business do if the gross profit or the net profit are not high enough to make good enough profits?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Investigations

When undertaking your investigations, remember the problem-solving cycle steps:

- **Formulate** – Sort out and plan what you need to know and need to do to solve the problem.
- **Explore** – Use and apply the mathematics required to solve the problem.
- **Communicate** – Record and write up your results.



1 What a business can do to identify if it is profitable

Your task is to investigate what could be done to help ensure that a specific business is profitable.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key background business details:

The business sells ice creams from a shop at a popular summer holiday venue in Victoria.

The business is run by a sole trader.

- Last year's gross income was $170,000.
- Last year's expenses included:
  - Rent: $1,120 per month
  - Utilities: $4,560 per quarter
  - Ingredients and supplies: $90,000.

Formulate

To identify if a business is profitable, all the expenses of the business must be determined.

a Develop a plan for determining all the expenses of the business.

You could consider some of the following questions.

- Are there business legal requirements that have not been included in the expenses? How could you find out what these are, and how much each costs?
- Are there business running costs that have not been included in the expenses? How could you find out what these are, and how much each costs?
- Are there business infrastructure costs that have not been included in the expenses?
- Are there any other aspects of the business that have not been included in the expenses? What are these, and what does each cost?
- How will you ensure that the sites you use for information are current and reliable?
- What technological tool will you use to record the information you collect?

Explore

b Conduct research to gather the data to answer your questions. Use a table to record these sources, the information they have provided and the hyperlinks.

c Use a spreadsheet to create an income statement for this business.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

d Use this data to create an appropriate graphical representation of the state of the business.

e What adjustments could be made to make this business profitable? Adjust these figures reasonably so that the business becomes profitable.

f Create an appropriate graphical representation of this new business outlook.

Communicate

g Write up and present the findings of your investigation into the profitability of a business. You can choose the format of your presentation.

You should:

- include the questions that you asked, and what you found
- list the sources of the data that you used, including the hyperlinks
- include two sets of spreadsheets and graphs
- explain the mathematical skills you used in analysing your data
- provide a summary of how to ensure that a business meets its obligations and is profitable
- reflect on how technology was used to conduct the investigation and present the results
- consider what you would change, and why, if you were to do this investigation again.

2 Fundraising for a charity

Your task is to investigate a fundraising activity to raise money for a charity of your choice. You might want to undertake this investigation as a pair or as a member of a small group.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Formulate

a In a small group or as a class, conduct a brainstorm to identify possible fundraising activities to raise money for a charity of your choice.

b From the ideas identified in your brainstorm, select an activity that you and your group would like to run.

c Develop a plan for running the activity that you have selected. Things to consider include:

- How would you run the activity?
- What would you need?
- What will your costs be?
- Are there any other issues that you need to address?

Explore

d Research and record all costs involved in running your activity in a spreadsheet.

e Calculate the unit price and break-even point.

f Construct a break-even graph using technology (if you need a refresher on how to do this, look back at Chapter 4 about finding a break-even point using simultaneous equations).

g What could your group do if the profit is too low, or the expenses are too high?

Communicate

If you conducted this investigation as a member of a pair or a small group, each of you needs to submit your report.

h Write up and present the findings of your investigation. You can choose the form of your presentation.

You should:

- include the questions that you asked, and what you found
- include the spreadsheet and break-even graphs
- explain the mathematical skills you used in analysing your financial calculations
- reflect on the technologies that have been used to collect the data initially and what technology was used to collate, present and analyse the data
- consider what you would change, and why, if you were to do this investigation again.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key concepts

- **Revenue** (also called income) is the money paid to a business for products or services. All companies need to generate revenue so that they have money to pay their **expenses** such as tax, rent, wages, superannuation etc.
- There are specific rules and requirements related to the **goods and services tax (GST)** when running a business. This includes that people must register for GST when:
  - their annual GST turnover (gross income from all businesses minus GST) is $75,000 or more (this is the GST threshold).
  - they expect their turnover to reach the GST threshold (or more) in the first year of operation.
  - a non-profit organisation has a GST turnover of $150,000 per year or more.
- Before registering for GST, companies or individuals need to have an **Australian business number (ABN)**.
- Most businesses will need to be able to create and generate **invoices**. A tax invoice should include the following:
  - The words 'Tax invoice'
  - Seller's identity
  - Australian business number (ABN)
  - The date when the invoice was created
  - Description of goods or service
  - GST amount: either specify the amount of GST to be paid, or, if all the goods or services include GST, it can state, 'Total price includes GST.'
  - Total amount payable.
- If the business or individual does **not** meet the GST threshold, then the invoice does not need to state the GST amounts, but in that case it should not say 'Tax invoice', but simply 'Invoice'.
- Business expenses are extensive, and the key ones include:
  - salaries and wages, and related costs such as taxation, superannuation and leave entitlements
  - purchases of goods and products to on sell or to create goods or services with
  - operating expenses such as utility bills, rent etc.
  - insurances such as WorkCover.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- **Leave entitlements** are set by the industry award, and include annual leave, sick leave, parental leave and more. To check your leave entitlements, visit the Australian Government Fair Work Ombudsman site.
- A **business activity statement (BAS)** is a form used to report and pay various tax obligations to the Australian Taxation Office (ATO), especially GST and taxes deducted from an employee's pay. Businesses are required to submit it on a regular basis, typically quarterly.
- A business is **insolvent** when the income is not enough to cover the expenses.
- It is essential to have a budget (called a **financial plan**) for a business. It is prepared in advance to show the expected expenses and income of the business. There are three main financial statements that companies use to track their financial performance:
  - Balance sheet
  - Cash flow statement
  - Income statement
- **Gross profit margin** is calculated by dividing gross profit by total revenue. We can express this margin as a percentage by multiplying by 100.

$$\text{Gross profit margin} = \frac{\text{gross profit}}{\text{total revenue}} \times 100\%$$

- **Net profit margin** is calculated by dividing net profit by total revenue. We can express this margin as a percentage by multiplying by 100.

$$\text{Net profit margin} = \frac{\text{net profit}}{\text{total revenue}} \times 100\%$$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Success criteria and review questions

☐ I can make currency exchange rate conversions.

1 Use an online currency converter to convert the following amounts between Australian dollars (AUD) and the foreign currency.

Australian Dollars	Foreign currency amount	Exchange rate
a 50.00 AUD	_____ Chinese yuan	
b _____	1,000 € (euro)	
c 7,665.00 AUD	_____ Indonesian rupiah	
d _____	£375 (UK pound)	

☐ I can calculate a GST amount.

2 Calculate the GST that has been:
- **a** added to an item with a wholesale price of $764.50
- **b** included in price of an item sold for $480.50.

☐ I can determine whether a business is required to register for GST or not.

3 A local café caravan operator has an average gross income of about $5,250 per month. Do they need to pay GST for their business?

☐ I can work out a GST credit or payment.

4 For a business, the total amount of GST collected from customers is $12,805 and the total amount of GST paid to suppliers is $6,173. What is the total amount owing to the ATO?

☐ I can calculate annual leave entitlement.

5 A shift worker is entitled to 5 weeks annual leave which starts to accumulate from when a job is commenced. Adam has worked for the company for 15 weeks. Approximately how many days of annual leave has Adam accumulated if he hasn't taken any annual leave so far?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

☐ I can calculate income and revenue.

6 Kala offers two dog services: dog minding and dog walking. The table shows the rates charged for these two services and the number of jobs in one week.

a What is Kala's total income for that week?

b If this weekly income is maintained over a whole year, and Kala works for 48 weeks in the year, what would be Kala's annual income, based on that weekly amount?

c The prices are GST inclusive. How much GST would have been included in the above charges?

Dog minding	**Number of jobs**
Per day: $55.00	5
Dog walking	
30-minute walk: $25.00	10
45-minute walk: $35.00	8
60-minute walk: $45.00	12

☐ I can complete an invoice.

7 Complete the invoice (using the information from the previous question) and answer the questions that follow.

Kala 's Pet Minding Services
Tax Invoice

Invoice #: 2024 1234 **ABN: 12 345 678 910**

To:	Jim Ford 12 Third Street Four Springs VIC 3297	From:	Kala's Pet Minding Services 14 Snail Road Green Springs VIC 3298

Job:
- Mind two dogs for 5 days
- Cost per day: $50 per dog per day (excluding GST)

Task/Item	**Qty**	**Cost**	**Total cost**
		Sub total	
		GST 10%	
		Total amount owing	

Date: 11 October 2024
Invoice prepared by: Kala Green

Balance due within 14 days of the completion of work.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

a What is the invoice number?
b When was the payment due?
c What is the amount of GST?
d What is the total amount owing?

☐ I can work out a BAS amount.

8 For a business, the total amount of GST collected from customers is $24,505, the total amount of GST paid to suppliers is $10,055 and the total amount of tax withheld from wages is $21,545. What is the total amount owing to the ATO?

9 For a business, the total amount of GST collected from customers is $2,705, the total amount of GST paid to suppliers is $1,173, the total amount of tax withheld from wages is $5,445 and the PAYG instalment owing for wages is $3,445. What is the total amount owing to the ATO?

☐ I can understand and create financial statements.

10 Beza runs a business from her home. She and a friend make and sell artwork and photos. Here are their income and expenses for the previous quarter.

- Income from sales: $148,583
- Cost of the materials used (cost of goods sold): $52,000

Expenses

- Advertising and marketing: $4,341
- Bank fees: $928
- Phone: $743
- Stationery and printing: $7,774
- Postage and freight: $2,578
- Insurances: $1,040
- Superannuation: $4,282
- Utilities**:** $855
- Wages (including PAYG): $37,125
- Miscellaneous fees and expenses (e.g. stall hire): $5,868

a Create a quarterly income (P&L) statement for Beza's business.
b Do they make a net profit?
c What is their net profit margin?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mathematical toolkit

1 Reflect on the range of different calculations, technologies and tools you used throughout this chapter, and how often you used them for undertaking your work and making calculations. Indicate how often you used and worked out results and outcomes for each of these methods and tools.

Method and tools/ applications used	**How often did you use this?**
• Calculating and working in your head, and using algorithms	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using pen-and-paper	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using a calculator	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using a spreadsheet	Not at all: ☐ A little: ☐ Quite a bit: ☐
• Using measuring tools – name the tool, technology or application: _____	Not at all: ☐ A little: ☐ Quite a bit: ☐
_____	Not at all: ☐ A little: ☐ Quite a bit: ☐
• Using other technology or apps – name the technology or application: _____	Not at all: ☐ A little: ☐ Quite a bit: ☐
_____	Not at all: ☐ A little: ☐ Quite a bit: ☐

2 Did this chapter and the activities help you to better understand how you use different tools and technologies in using and applying mathematics in our lives and at work? In what areas and ways? Write down some examples.

3 In one sentence, explain something relating to tools and technologies that you learned in the unit. Write an example of what you learned.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key vocabulary

Here is a list of this chapter's key maths terms and their meanings.

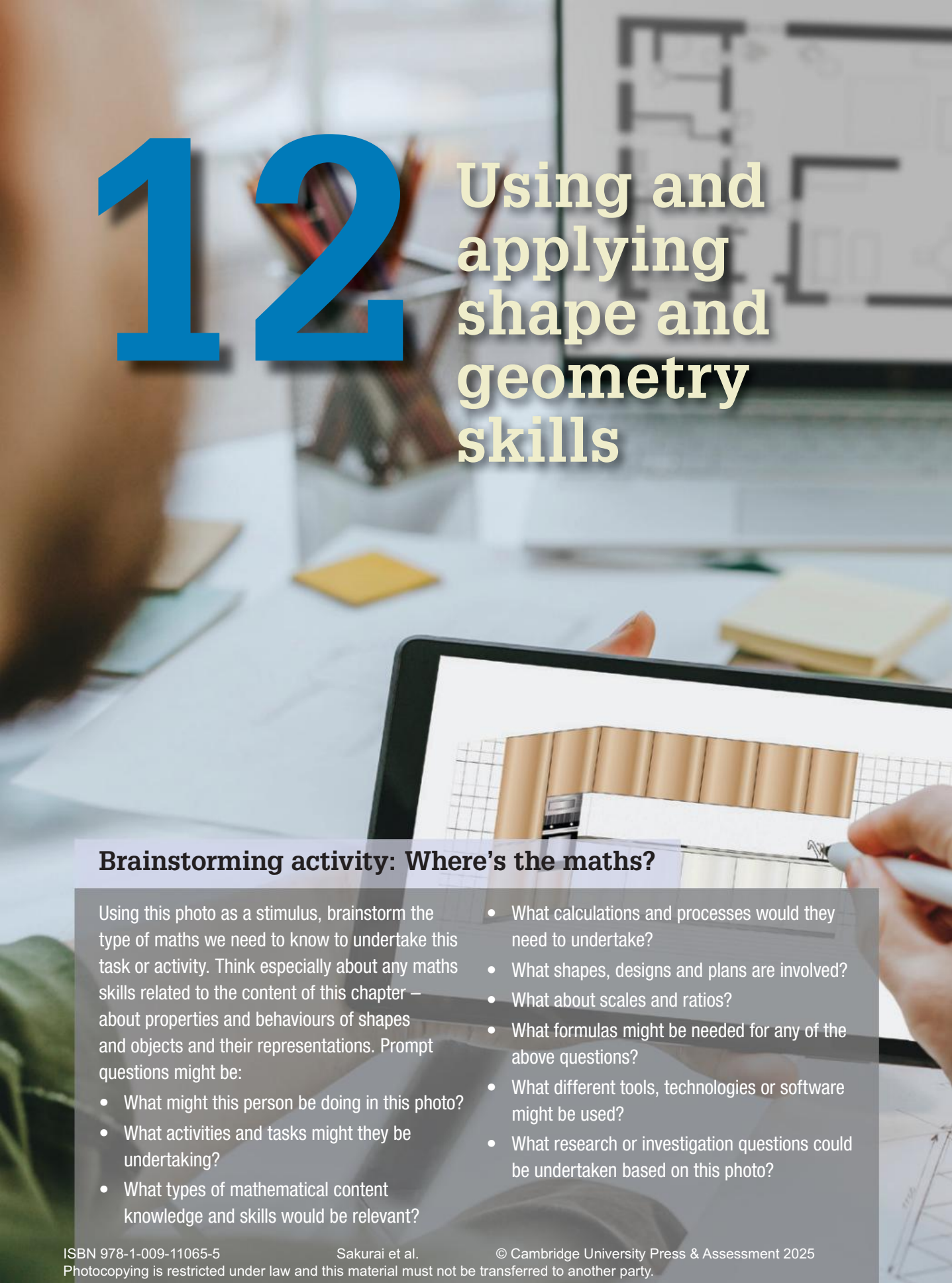
Term	Meaning
Annual leave	This is usually 4 weeks for a full-time employee.
Assets	A business asset is any item of value that the company owns.
Australian Taxation Office (ATO)	The Australian Taxation Office operates the tax collection system for businesses and private citizens.
Award	Industrial agreement that legally binds employers and employees regarding work conditions, pay and entitlements.
Balance sheet	The balance sheet provides an overview of the business assets, liabilities and the owner's equity.
Business activity statement (BAS)	The form a business uses to report its activity to the ATO on a regular time schedule, e.g. each quarter.
Capital purchase	Purchase made on a business asset such as machinery, computers, cars, cash registers, office furniture, etc.
Cash flow statement	Reports all the cash flows in and out of a business during a reporting period, categorised as operating activities, investing activities and financing activities.
Exchange rate	The value of one currency when it is being converted to a different currency.
Expenses	The costs of running a business or the money paid out by a business.
Fair Work Ombudsman	Australian Government department that oversees employment rights, responsibilities, conditions and industry *awards*.
Financial indicators	A system of percentage, ratio or rate calculations for keeping track of financial performance to help a business to running profitably.
Floating exchange rate	Movements in the currency exchange rate, in our case, the Australian dollar, are determined by the demand for, and supply of, Australian dollars in the foreign exchange market.
Goods and Services Tax (GST)	A tax added to most goods sold (except for fresh food) and to services.
Gross	The amount earned before tax is paid.
Gross profit	The amount of money you are left with after deducting the cost of goods sold from revenue.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Term	Meaning
GST threshold	The minimum gross income (minus GST) that needs to be met for when companies or individuals must register for GST. It is currently set at $75,000.
Income statement	An overview of the revenue, expenses, income and earnings of a business during a reporting period (usually monthly, quarterly or annually). Also called a profit and loss (P&L) statement.
Insolvent	This is when a business can't generate enough income to pay its debts.
Invoice	An itemised bill for goods or services provided by a business to a customer.
Leave entitlements	What employees are entitled to have as set out by Victorian and Australian law, and their industry award.
Liabilities	The amounts a business owes to its suppliers; total liabilities + equity must equal the total assets.
Loss	A business's operations are not profitable and that changes need to be made to increase *revenues*, decrease costs, or both.
Net	The amount retained after tax is paid on *gross* earnings.
Net profit	The amount of money you are left with after having paid all your allowable business expenses.
Non-capital purchase	Business purchase that may include normal running expenses, such as rent, stationery, insurances and repairs.
Owner's equity	The business owner's equity is the residual amount of the assets after liabilities are deducted.
Profit	The difference between *revenue* and *expenses*.
Profit and loss (P&L) statement	See *Income statement*.
Pro rata	This is a proportionate allocation. For example, if an employee is hired to work half the hours of a full-time employee, their pro rata leave entitlement is half that of a full-time employee.
Revenue	The money earned by a business from sales of its products or services.
Sole trader	A self-employed person who owns and runs their business as an individual. The individual is legally responsible for all aspects of the business, including debts and losses.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

12 Using and applying shape and geometry skills



Brainstorming activity: Where's the maths?

Using this photo as a stimulus, brainstorm the type of maths we need to know to undertake this task or activity. Think especially about any maths skills related to the content of this chapter – about properties and behaviours of shapes and objects and their representations. Prompt questions might be:

- What might this person be doing in this photo?
- What activities and tasks might they be undertaking?
- What types of mathematical content knowledge and skills would be relevant?
- What calculations and processes would they need to undertake?
- What shapes, designs and plans are involved?
- What about scales and ratios?
- What formulas might be needed for any of the above questions?
- What different tools, technologies or software might be used?
- What research or investigation questions could be undertaken based on this photo?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter contents

Chapter overview and Spotlight

12A Starting activities
12B Tuning in
12C Shapes and objects in the world
12D Transforming shapes
12E Angle properties
12F Using maps and map applications
12G Reading and working with plans
12H Creating 3D from 2D
Investigations
Chapter review

From the Study Design

In this chapter, you will learn how to:

- interpret and describe shapes and objects and their representations using geometric and spatial language and conventions
- explain and apply transformations, including similarity and symmetry of shapes
- create and modify diagrams, plans, maps or designs using drawing equipment and packages/applications, including undertaking standard transformations

(Units 3 and 4, Area of Study 4)

© Victorian Curriculum and Assessment Authority 2022

ISBN 978-1-009-11065-5 Sakurai et al.

© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter overview

Introduction

Shapes and objects surround us. The study and understanding of these is essential to many occupations and trades, and in our lives. One of the main reasons that most buildings are rectangular in shape is that they are easier to engineer and more cost effective to build. Traditional building materials can be easily utilised with the potential of less waste than with other shapes. Triangles have been used for centuries to strengthen or support structures and buildings. A 90° angle is one of the most secure angles in construction. Semicircles and circles can be found in many historic buildings such as places of worship.

Geometric transformations are an everyday experience. In the use and production of photographs or images, you are seeing a dilation. When you move and travel, you are applying translation. Did you check that your clothes were right this morning by looking in a mirror? This is reflection.

In this chapter, we will deep dive into two-dimensional (2D) shapes, how to transform them and what these transformations do to shapes. We will look at three-dimensional (3D) objects and relate them to the real world, exploring connections between the ideas of geometry and their application to industry.

Learning intentions

By the end of this chapter, you will be able to:

- identify the names and properties of shapes and objects
- sketch and accurately draw shapes and objects
- undertake transformations, identify symmetry, and use similarity and common angle properties
- use the language, symbols and drawing conventions for diagrams, maps, plans and models
- describe shapes and objects using geometric and spatial language and conventions
- create and modify diagrams, plans, maps or designs using drawing equipment and technology.

ISBN 978-1-009-11065-5
© Sakurai et al. 2024
Cambridge University Press
Photocopying is restricted under law and this material must not be transferred to another party.

Spotlight: Ciaran Begley

An interview with an art technician

Tell us about your job and some of the work that you do.

I work as an art technician who installs exhibitions in art galleries. I also help post-graduate university students install their artwork. Both situations are similar, but the larger art galleries involve a lot more occupational health and safety concerns, whereas the student exhibitions allow us to be a bit more experimental and creative in the installation process. I install a lot of paintings and sculptures, but these days my work involves a lot more installation of audiovisual components. I am also an artist myself, and my main focus is light-based installations that use technology that we use to see the world.

What maths do you use regularly in your work?

I use a lot of basic arithmetic and drawing up plans in my installation process. Say I am hanging three paintings on a wall. I need to measure the length of the wall, then the lengths of each painting, and then subtract the painting lengths from the wall length. There are four spaces on a wall to hang three paintings, so I then need to divide the whole space (that is, the wall dimensions) by four. There's also a lot of measuring of angles, and I often have to make sure things are nicely squared off. With more complex audiovisual installations, I actually use a lot of Pythagoras' theorem. For example, a standard TV screen is in a 16 : 9 ratio with a hypotenuse of 25, which is an expansion of the 3 : 4 : 5 triangle. I need to consider this ratio when moving and arranging things like a TV screen in a space. Also, as a freelancer technician, I do a lot of bookkeeping for invoices and receipts.

What is the most useful maths-related tool or piece of technology in your work?

When I am dealing with a sculpture, I use a software called *Sketch Up 3D*. It allows me to build a three-dimensional model of the exhibit, which I can then easily move around in the virtual world before having to physically install it. I use this 3D plan as a guide but I still redo all the calculations and measurements on the floor to ensure everything is accurate. Also, for my bookkeeping, I use an Excel spreadsheet. The 'Autosum' feature has saved me many times from making typos by hand for thousands of dollars.

What was your attitude towards maths in school? Has this attitude changed over time?

I really loved maths in school; it was actually a choice between art and maths for me, but in the end art won out. I don't think my attitude towards maths has changed over time. I use a lot of much simpler maths in my work, but I will always choose to take the mathematical approach even if I could just lay something out by eye. I enjoy the process of being accurate, and the mathematical approach gives me a sense of security.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

12A Starting activities

Activity 1: Shapes in designs

Consider this image of a lead-light panel.

1 How many different shapes (of all sizes) are in this image?

2 Classify the shapes of the images according to the types of the shapes. Provide a rationale for your classification.

3 Classify the angles in the images according to the types of the angles. Provide a rationale for your classification.

4 Find some objects (such as other windows or buildings) near you or your school or community that have interesting combinations of shapes and design. Take photos of them and classify the shapes and angles according to the classification schemes you used above.

Activity 2: Tiling a community space

The management committee of the local community centre has a new entry foyer which they would like to tile with an interesting pattern. As they want this space to be an attractive work of art, they have created a competition for the design.

The committee has provided these specifications.

- The space is 9 m by 6 m in size.
- The entire floor space must be covered.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

1 You need to create some drawings for the committee to consider and provide background information to the committee. You also need to address the following requirements.

   a Provide two hand-drawn sketches (not to scale) to show possible patterns that you might use for tiling.

   b Name the shapes that you have used.

   c Explain if you have tessellations and provide reason(s) why you think that the shape(s) that you have chosen tessellate.

   d Name the shapes that you have used.

   e Decide on the size of each tile.

   f Provide a scale drawing for the floor and demonstrate how many tiles will be required. Consider the edges and how these might also be covered. (You can use technology for this.)

Discussion questions

The Dutch artist Maurits Cornelis Escher made artworks based around mathematical concepts, especially tessellations, in the 1930s. Search for and investigate his artworks.

1 What artworks of his do you like? Are all his artworks tessellations? What other ideas and perceptions about maths and shape did he use?

2 List the different types of shapes that he used to create tessellations.

3 Create a classifications system (it could be more than one) for his different types of shapes and illustrations.

4 Give explanations and reasons for which of Escher's shapes tessellate and why.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

12B Tuning in

Epic Success: Federation Square

Federation Square in Melbourne was opened in 2002. Although the design was the result of an international competition, initially it was unpopular. Over time, Melbournians and visitors have embraced its controversial design and now Federation Square is rated as one of the top 10 public squares in the world.

Over 100 million people have visited the square. It has hosted many public events, and is the youngest heritage listed site in the world.

Discussion questions

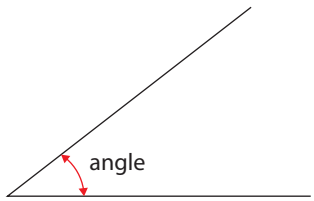
Find more photos or images of Federation Square.

- What shapes can you see in the building and the surrounds?
- What is the predominant shape used in the design of the exteriors of the Federation Square buildings?
- Does the design use tessellation?
- Do you like the design? Why or why not?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Angles

Understanding about lines and angles is one of the underpinning concepts of geometry. A line is defined as a set of points, while an angle is made when two lines intersect. When two lines originate from a common point, the inclination of one line to the other is called an **angle**.



In the use and application of angles as part of geometry and space and shape, there are three main ways to measure angles.

- **Degrees**: The most common unit for measuring angles is degrees. A protractor, which is a semicircular instrument with markings from 0° to 180°, is typically used to measure angles in degrees.
- **Radians**: Another unit of measurement for angles is radians. Radians are used in trigonometry and calculus. They provide a more natural way to express angles in terms of the radius of a circle. One full revolution (360°) is equivalent to 2π radians.
- **Revolutions**: Angles can also be measured in revolutions. A full revolution corresponds to a complete circle (360° or 2π radians). This unit is less common but is occasionally used in specific contexts.

However, in our use of angles in most of our lives and work, we usually measure angles using **degrees**. You are probably familiar with a full circle being 360°. Designers, graphic artists, real estate agents, landscapers, health professionals, engineers, scientists, urban planners, sports coaches and emergency workers all use degrees to measure angles.

The other measures, radians and revolutions, are used where circular motion and rotations are more critical. This can occur in specific professions such as mechanics, wheel aligners, and engineers in transport. Revolutions can be used as a rate. For example, in a car the speed of an engine is measured in revolutions per minute (RPM). Astronomers use revolutions to express the orbits of planets around the Sun.

In this chapter, we will focus on the main and common measure of angles – degrees.

Equipment

Usually when we draw shapes and related plans and diagrams, we use instruments such as a protractor, a pair of compasses and a set square.

But are you familiar with measurement apps on your smart device? A number of free apps for mobile devices are available that act as protractors and can be used to measure angles. These can be downloaded for use. Some examples include *Angle Meter Pro*, *Angle Pro*, *Bubble Level*, *Spirit Level Pro*, *Smart Protractor*, *Protractor+* and *Angle Meter 360*.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

There are also many tools that tradespeople use such as digital inclinometers, digital spirit levels with inclinometers built in, digital angle finder rulers and protractors.

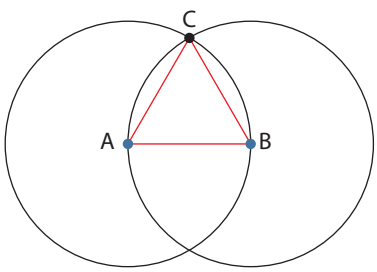
Practice questions

1 Use the internet to find at least five different tools or applications that measure angles.

- **a** Provide a screenshot of each tool.
- **b** State what unit of measurement each tool uses.
- **c** For each tool, provide one example of where it may be used.

2 You are going to construct an equilateral triangle using geometric principles.

- **a** Draw a straight line on your page (not too long).
- **b** Placing the point of a pair of compasses on either end of the line, draw two circles.
- **c** Draw lines connecting the centre of the two circles with the intersection of the two circles.



- **d** Measure the sides of the triangles and describe your findings.

3 Using an angle-measuring device such as a protractor or digital protractor, draw and label the following angles.

a 90° **b** 270° **c** 125° **d** 30°

4 Using an angle-measuring device, such as a protractor or digital protractor, measure the number of degrees in the different angles shown in the photo of Federation Square below. You should be able to find at least five different angles.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

12C Shapes and objects in the world

Understanding about the geometry of different shapes and objects is important for several reasons.

- It helps us analyse and describe the fundamental properties of the physical world. By understanding shapes, angles and spatial relationships, we can solve real-world problems. For instance, architects use geometry to design buildings, engineers apply it to construct bridges, and artists create visually appealing compositions using geometric principles.
- Fields such as physics, astronomy and computer graphics heavily rely on geometrical knowledge and understandings. Understanding the shape and movement of celestial bodies, analysing fluid dynamics, and modelling complex systems all involve geometric principles. Computer-aided design (CAD) software uses geometry to create 3D models for various applications.

- Geometry has influenced art and aesthetics throughout history, from ancient architecture to modern abstract paintings, artists use geometric shapes, symmetry and proportions to convey meaning and evoke emotions. The golden ratio, for example, appears in famous artworks and natural patterns, demonstrating the harmony between mathematics and aesthetics.
- Shape and geometry enhance our spatial awareness, allowing us to visualise objects in different orientations, understand distances, and navigate our surroundings. Whether reading a map, arranging furniture, or parking a car, spatial reasoning based on geometric principles underpins our actions.
- How food is packaged is all about three-dimensional shapes. What the packaging is for a particular product will partly depend on the food. It would be stupid to put maple syrup in a box, or potato crisps in a bottle. But a producer, and the supermarkets, also have to consider the type of packaging that makes the best and efficient use of the shelf space.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

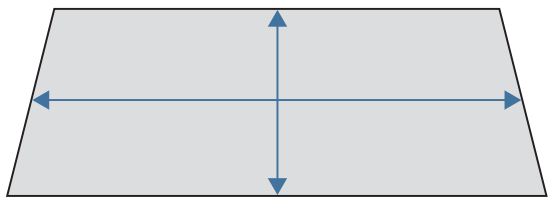
In Chapter 10 of the Units 1 & 2 textbook, the underpinning mathematical ideas related to shapes and objects were covered comprehensively. Please refer back to that chapter if you need to refresh your skills. In this current chapter, you will learn about working with more complex ideas to do with both two-dimensional and three-dimensional shapes and objects.

Understanding two-dimensional and three-dimensional shapes

Two-dimensional (2D) shapes are flat and have no thickness; for example, a drawing of the top of your desk would be a rectangle with width and length.

Three-dimensional (3D) shapes are like real objects; for example, your actual desk is an object in space. It has a width, length and height.

Two-dimensional shapes



Plane geometry is about 2D shapes. These shapes are flat and are known as **planar** shapes.

You are probably very familiar with many of these 2D shapes. For any you don't know, look up their meanings.

Curved

Circle

Ellipse

Crescent

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Triangles

Right-angled triangle

Equilateral triangle

Obtuse-angled triangle

Isosceles triangle

Acute-angled triangle

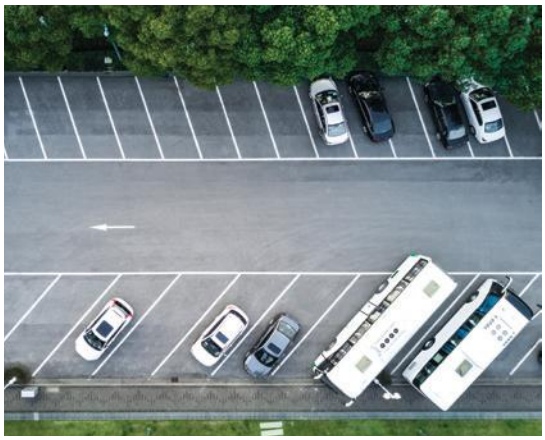
Scalene triangle

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

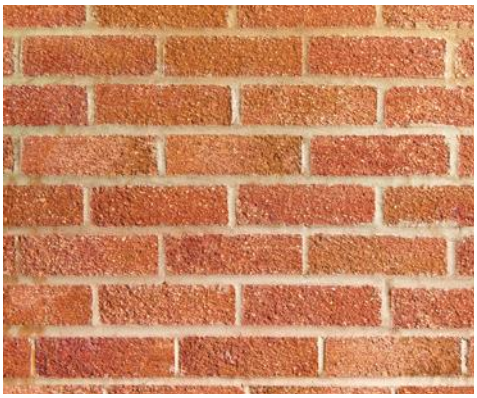
Quadrilaterals

Square

Parallelogram



Rectangle



Trapezium

Rhombus

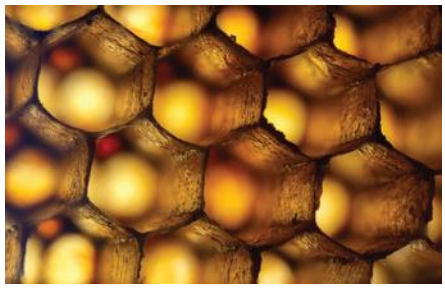
Kite

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

For **polygons** (a two-dimensional figure with straight sides) with more than four sides, we use the following prefixes.

- 5 sides – pent – pentagon

- 6 sides – hex – hexagon



- 7 sides – hept – heptagon

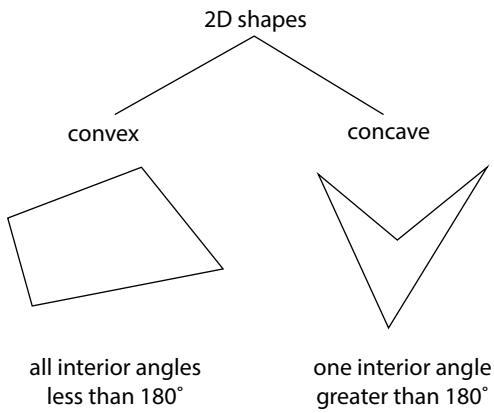
- 8 sides – oct – octagon

- 9 sides – non – nonagon

- 10 sides – dec – decagon

Convex or concave shapes

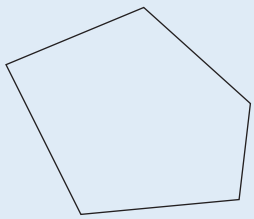
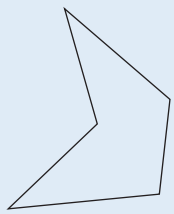
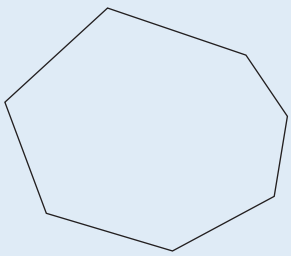
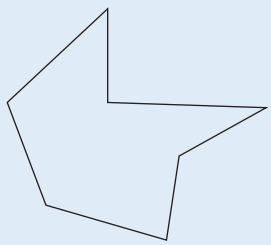
Two-dimensional shapes can be broadly classified into two types: **convex** or **concave**.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

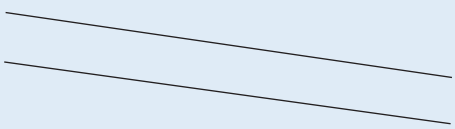
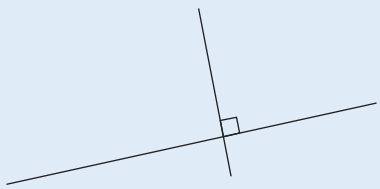
Convex polygons have all vertices pointing outwards, whereas non-convex (or concave) polygons have at least one vertex pointing inwards.

For example:

Convex pentagon 	Concave pentagon 
Convex heptagon 	Concave heptagon 

Other terms about lines and angles

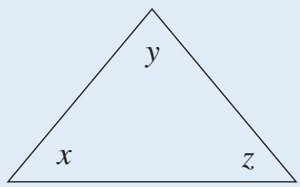
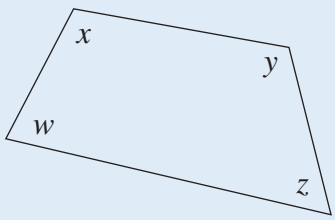
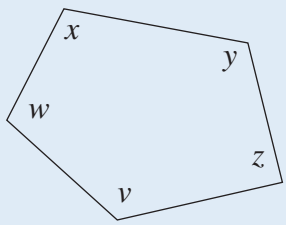
Some other words are important when we talk about shapes and objects. These are words like parallel, perpendicular, horizontal and vertical.

Parallel means two or more lines are running in exactly the same direction, so should never meet.  These two lines are parallel.	Perpendicular means meeting at right angles (at 90° to each other).  These two lines are perpendicular.
Horizontal means parallel to the horizon. This line is horizontal.	Vertical means at right angles or perpendicular to the horizon. This line is vertical.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Interior angles

The **interior angles** of a shape can be measured or calculated.

In a triangle, the sum of the interior angles is 180°.	In a quadrilateral, the sum of the interior angles is 360°(a diagonal forms two triangles).	In a pentagon, the sum of the interior angles is 540° (two diagonals from a vertex form three triangles).
 $x + y + z = 180°$	 $w + x + y + z = 360°$	 $v + w + x + y + z = 540°$

Can you see a pattern? Each time an extra side is added, the sum of interior angles increases by 180°.

The formula to find the sum of the interior angles of a polygon with n sides is:

$$\text{Sum of angles} = (n - 2) \times 180°$$

Regular polygons have all sides the same length, so each interior angle is the same size. You just divide the sum of the angles by the number of sides.

Example 1 Finding the size of an interior angle of a regular polygon

Find the size of the interior angle in a regular heptagon.

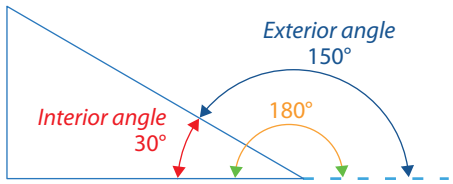
THINKING	WORKING
STEP 1	
Find the sum of all interior angles. A heptagon has 7 sides.	$n = 7$ Sum of angles $= (n - 2) \times 180°$ $= (7 - 2) \times 180°$ $= 5 \times 180°$ $= 900°$
STEP 2	
Next, divide the total sum of all interior angles by the number of angles.	There are 7 interior angles. The sum of all interior angles is 900°. $900° \div 7 = 128.5714 \ldots °$
STEP 3	
Interpret the result and write your answer.	Each interior angle in a regular heptagon is 128.57° (to 2 decimal places).

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Exterior angles

The exterior angle is the angle between any side of a shape, and a line extended from the next side.

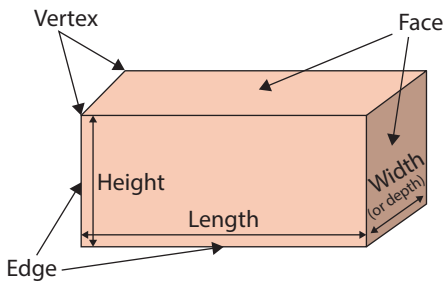
When we add the interior angle and exterior angle we get a straight-line angle of 180°.



Three-dimensional shapes

Three-dimensional objects have length, width and height; and they also have:

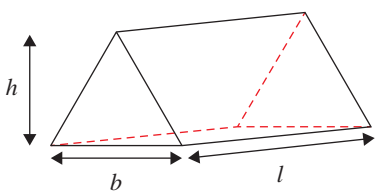
- **faces** – the two-dimensional shapes that make up the outer surfaces
- **edges** – the line segment along the boundary of two faces
- **vertices (singular vertex)** – the points where edges meet.



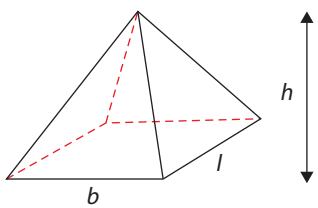
Three-dimensional objects often take their name from the names of their faces.

Objects may fall into broad categories, but keep in mind that there are many different ways to classify objects.

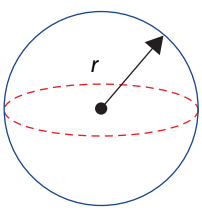
Prisms have two identical shapes at either end and flat sides.



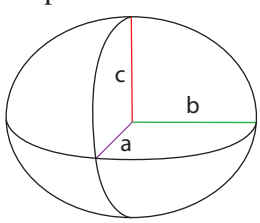
Pyramids have a polygon at the base and the sloping sides meet at a single vertex.



Spheres are round solid objects with each point on the surface the same distance from the centre.



Ellipsoids are like slightly flattened spheres – Earth is approximately an ellipsoid.



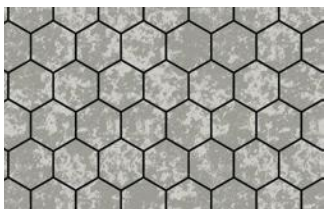
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Tessellations

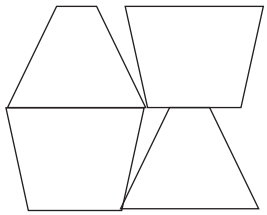
Tessellations are patterns of repeating polygons which cover a surface without any gaps. The shapes cannot overlap each other.

Regular tessellations are patterns made by repeating a **regular** polygon.

For example, this tessellation pattern is made by repeating regular hexagons.

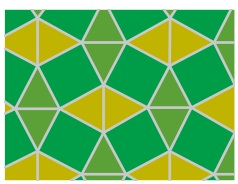


These irregular shapes do not tessellate as they leave a gap when joined together.

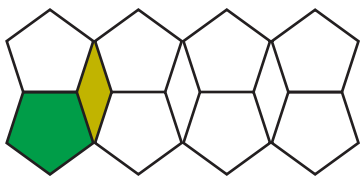


Can you think of another regular polygon that can make a tessellation? (*Hint*: There are two others.) Research more to find out which shapes tesselate by themselves, and which do not.

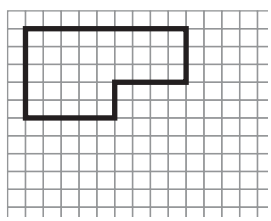
A **semi-regular tessellation** is made from combining **two or more** different polygons that fit together without any gaps.



This tessellation uses a pentagon and a diamond to make a tessellation:



Think about how you can start with one shape, and then using graph paper, play with how you can tessellate it. If it will not tesselate by itself, work out if there is a second shape that would enable it to tessellate. For example, copy this shape on to graph paper and make it tessellate.



12C Tasks and questions

Thinking task

1 Do some research and thinking about food packaging. Browse some different supermarket shelves. Think about which 3D shapes are good examples of food packaging? Which ones are not so good? Why or why not? Think about:

- Which shapes pack tightly with minimal loss of space?
- Which shaped packages are most common? How do they vary? Why?

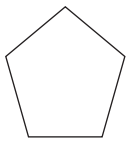
Share and compare your findings with your classmates.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

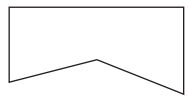
Skills questions

2 Identify each 2D shape as concave or convex.

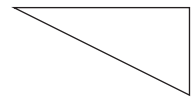
a



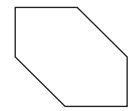
b



c



d



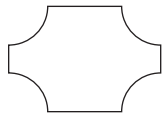
3 For each 2D shape shown below:

i determine if it is a polygon

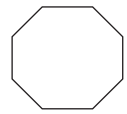
ii if it is a polygon, name it and state whether it is regular or not and whether it is concave or convex.

a

b

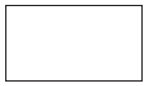


c

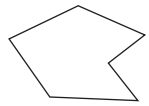


d

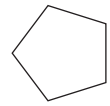
e



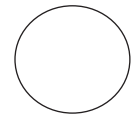
f



g

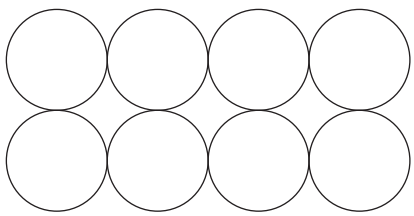


h

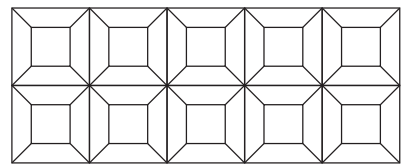


4 Which of the following patterns are tessellations?

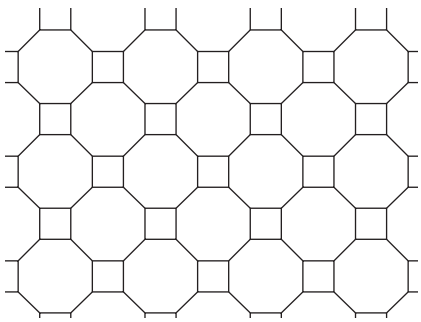
a



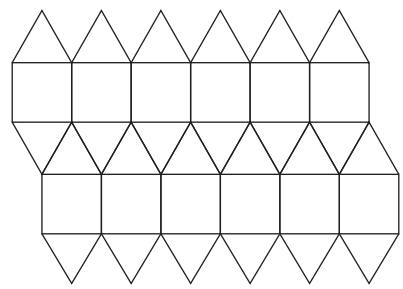
b



c



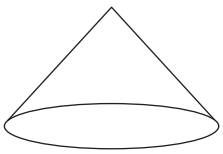
d



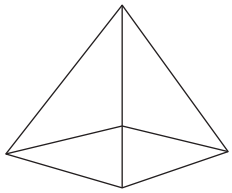
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

5 Name all of the objects in the table below. Sketch and label them in your notebook.

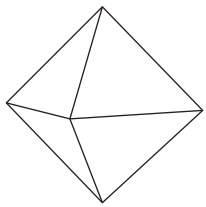
a



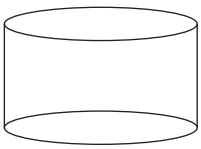
b



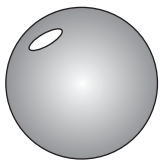
c



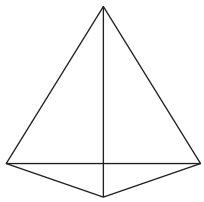
d



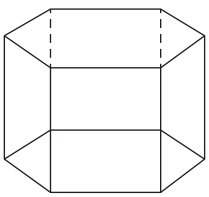
e



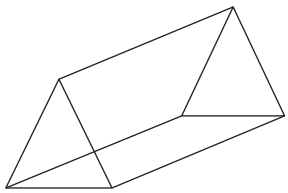
f



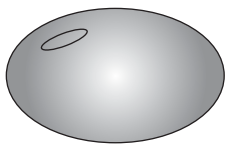
g



h



i



6 How many faces, vertices and edges do each of the following objects have?

a cube

b triangular pyramid

c pentagonal prism

d sphere

7 For the following **regular** shapes, find:

i the sum of the interior angles

ii the size of one angle.

a triangle

b hexagon

c octagon

d pentagon

Mixed practice

8 How many angles and sides has an octagon?

9 What is the size of each angle in an equilateral triangle?

10 What is the name of a 5-sided polygon?

11 Which of the following shapes produce regular tessellations by themselves?

a circle

b octagon

c rectangle

d triangle

e hexagon

12 What is the third angle in a right-angled triangle if one angle is 60°?

13 What is the name of a 3D object with two triangles joined by rectangles?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

14 What is the sum of the interior angles of a hexagon?

15 How many faces does a decahedron have?

Mathematical literacy

16 Match each term on the left with its definition on the right.

Geometric term	Definition
a Acute angle	**A** A 2D shape or 3D object where all sides and angles are equal
b Concave 2D shape	**B** An angle between 90 and 180 degrees
c Convex 2D shape	**C** A 3D object where all sides are triangles that meet at the apex
d Horizontal line	**D** Lines that are at 90 degrees to each other
e Obtuse angle	**E** A corner on a 3D object
f Perpendicular lines	**F** A 2D shape where one interior angle is greater than 180 degrees
g Prism	**G** An angle that is less than 90 degrees
h Pyramid	**H** A 2D shape where all interior angles are less than 180 degrees
i Regular	**I** A 3D object that has two identical shapes at either end
j Vertex	**J** A line that is parallel to the ground or the horizon

Application tasks

17 If a supermarket shelf is 1200 mm wide, 550 mm deep and 450 mm high, calculate how many of these products you could fit into the space.

Shape and dimensions of product	Example of product	Number of these that you can get into the shelf space
a A cuboid 23 cm × 12 cm × 15 cm		
b A cylinder 18 cm tall, radius 3 cm		
c A triangular prism 20 cm long × 5 cm wide × 4 cm tall		
b A tetrahedron sides 8 cm		

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

18 *Note*: For this activity you will need a device to take photographs.

This is the innovative RMIT Building 80 Swanston Academic Building (SAB).

Search to find more information about it and its design. Then work your way through the following questions.

- **a** Who was the designer of the RMIT Building 80? What are some of its design features? What shapes have been utilised in its design and structure?
- **b** Walk around your school grounds or your local community. Take photographs of 2D shapes and 3D objects. Capture as many images of different shapes and objects as you can.
- **c** In the classroom, categorise your shapes and objects and label each shape and object that you identify. Note some images will have multiple shapes/objects.
- **d** Create a digital poster which may be printed with your images for display.

19 Take a piece of string that is 24 cm in length. Create as many triangles as you can with this one length of string. Make the side lengths a whole number of centimetres.

- **a** Draw each triangle including the length of each side.
- **b** Label each triangle as equilateral, scalene, isosceles, right-angled, acute-angled or obtuse-angled.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

12D Transforming shapes

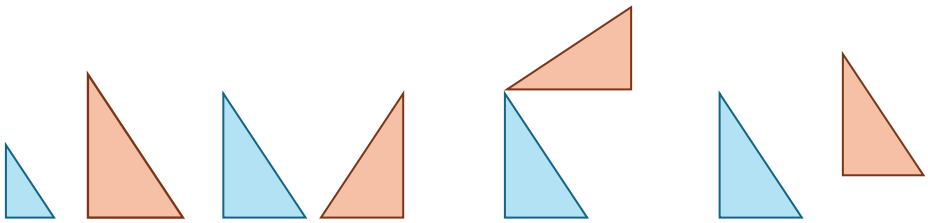
Objects can be transformed or manipulated and moved in different ways. When you enlarge or blow up a photo, this is an example of a dilation. Reflection is another transformation – for example, when you use a mirror. When you are driving a car, the wheels and the steering wheel rotate. Moving where an item of furniture is in a room is an example of translation.

Transformations of shapes can involve the processes of:

- dilation
- reflection
- rotation
- translation.

When an object is transformed, the new object that is created is called the image.

Below is an outline of what each one means.



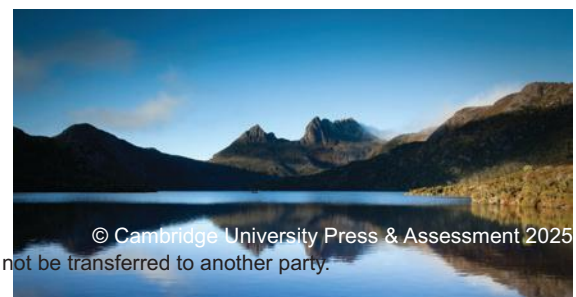
Dilation

Dilations involve changing the size of an object, but not the shape or the angles.

When a shape is dilated, the image is **similar** to the original object. Similar shapes have the same proportions and angles but are different sizes. This is often applied when we enlarge or reduce photos. Scale model cars are another example of a dilation.

When the size of an object is doubled we say that it is being dilated or enlarged by a factor of 2. This means that each side length in the object is multiplied by 2. On the other hand, if the size is reduced, like with scale model cars, it might be stated as a fraction of the original size, such as $\frac{1}{43}$, which is quite a popular dilation used.

Reflection

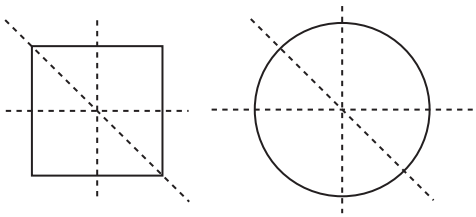


Reflections involve flipping a shape over a line of reflection, creating a **mirror image**.

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

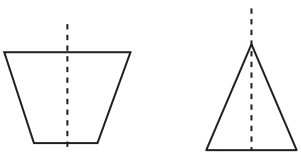
Symmetry

Some shapes can be **symmetrical**. This means they have the same shape on either side of a line – like having an identical reflection.

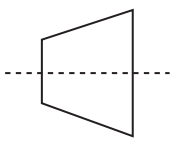


For example, shapes like squares and circles are symmetrical in a number of ways, so there are a number of lines you can put that they are symmetrical about. These lines are called an **axis of symmetry.**

Even shapes like the trapezium and isosceles triangle are symmetrical, but only around a vertical line.

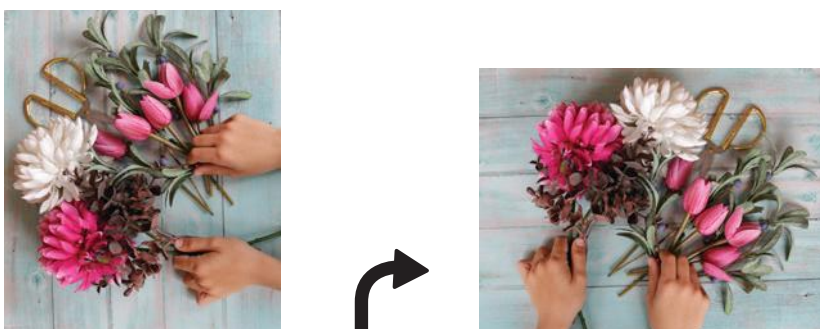


Some will be symmetrical only around a horizontal line.



Rotation

Rotations involve moving an object in a circular path around a fixed point. The point may be on or in the shape or anywhere outside the shape. We usually measure this using angles. We often also use clockwise or anticlockwise when talking about rotation. For example, rotating clockwise by 90° as seen in the example below.



Translations

Translations involve moving each point in a figure the same distance in the same direction, sliding the whole figure without dilation, reflection or rotation – like moving a piece of artwork on a wall.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Congruent shapes

When a shape is reflected, rotated or translated, the original shape and its image are the same shapes, they have just been moved. They are called **congruent** shapes. Congruent shapes are exactly the same size and shape.

Two congruent figures

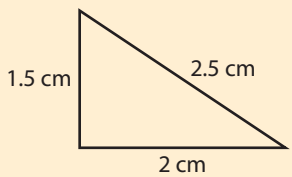
Two congruent figures with one rotated

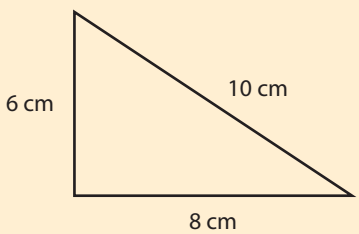
Two congruent figures with one translated

Two congruent figures with one reflected

Example 2 Dilating a shape

A triangle has side lengths 1.5 cm, 2 cm and 2.5 cm. What will be the side lengths of the image after the triangle is dilated by a factor of 4? Sketch the image of the triangle.

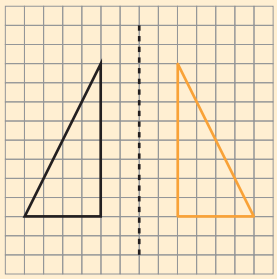
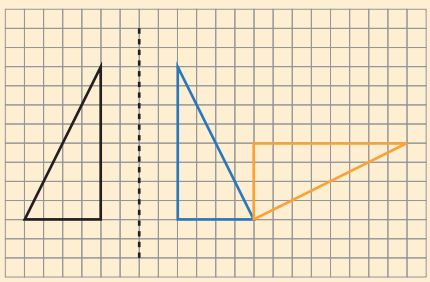


THINKING	WORKING
STEP 1 Dilating by a factor of 4 means that each side length of the triangle will be multiplied by 4. All the angles will stay the same.	New side lengths are: 1.5 cm × 4 = 6 cm 2 cm × 4 = 8 cm 2.5 cm × 4 = 10 cm
STEP 2 Redraw the triangle with exactly the same shape but enlarged with new side lengths.	

Example 3 Combining transformations

Using a grid, reflect this shape over a vertical line and then rotate it 90° clockwise from the bottom right-hand corner.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 1 Draw the original shape on a grid. Reflect the shape over a vertical line by taking the corners (vertices) and reflecting them to corresponding points on the right side of the vertical line to form the reflected shape.	
STEP 2 Rotate the reflected shape 90° clockwise. Keep the right-hand corner fixed and move the other two corners to corresponding points on the grid.	

12D Tasks and questions

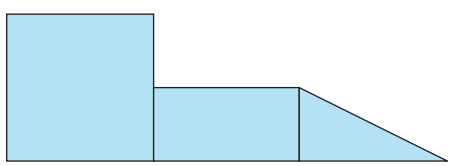
Thinking task

1 Find and give examples of a dilation, a reflection, a translation, and a rotation in the real world. Take a screenshot to record each of them. Share and compare these with your classmates. As part of this, see if you can find examples of:

a similar triangles
b congruent triangles
c similar prisms
d congruent prisms.

Skills questions

2 Consider this shape. Will the image be congruent or similar to the original shape after each of the following transformations?



a Doubled in size
b Rotated 90° clockwise
c Reflected across a horizontal line through the base
d Translated 10 cm to the right.
e Rotated 180° anticlockwise, and then halved in size

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

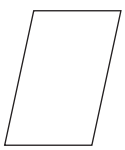
3 Use grid or graph paper for the following questions.

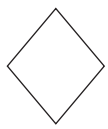
- **a** Draw two similar triangles making sure the lengths are proportional, so that the angles stay the same size.
- **b** Draw two congruent triangles. When they are placed adjacent to each other along equal edges, what is the new compound shape called?
- **c** Draw a circle and dilate by a factor of two.
- **d** Draw two congruent pentagons.
- **e** Draw a hexagon and dilate by a factor of one-half.
- **f** Draw two similar ellipses.

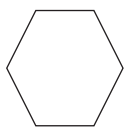
4 Use grid or isometric dot paper for the following questions.

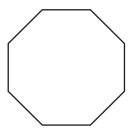
- **a** Draw a cube and translate by 10 squares to the left.
- **b** Draw a triangular prism and dilate by a factor of 3.
- **c** Draw a cylinder and rotate by 90° anticlockwise.
- **d** Draw two cubes of different size.
- **e** Draw two congruent pentagonal prisms.
- **f** Draw a square-based pyramid and translate by 4 squares to the left then reflect it vertically.

5 Are each of these shapes symmetrical? If so, draw in an axis of symmetry.

a 

b 

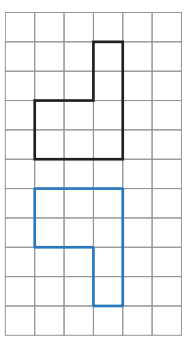
c 

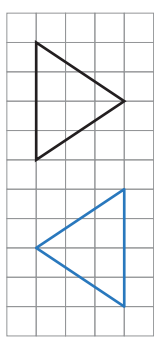
d 

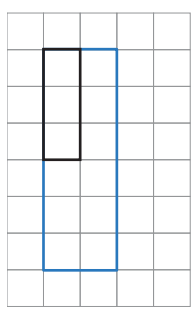
Mixed practice

6 For each shape shown in black and its image shown in blue:

- **i** identify the transformation/s that have taken place (there may be more than one)
- **ii** identify if they are congruent or similar.

a 

b 

c 

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mathematical literacy

7 Use the words in the box to complete the sentences.

rotated	congruent	translated	dilated	symmetrical	reflected

a When a shape is _____, its size but not its shape is changed.

b When a shape is _____, it is the same size. This creates a _____ mirror image.

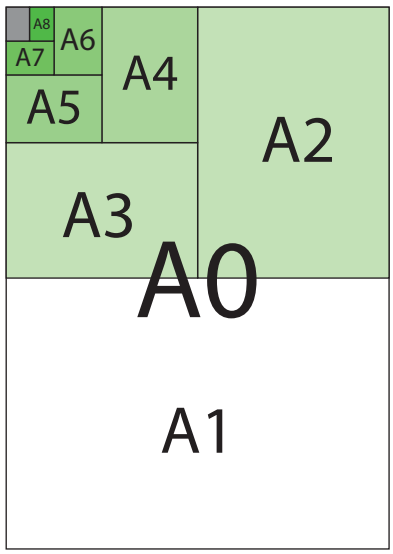
c When a shape is _____, it is the same size but moved to a different position without dilation.

d When a shape is _____, it is moved in a circular path around a central point.

e Translated, rotated or reflected shapes are _____.

Application tasks

8 Printers and photocopiers have enlargement and reduction (shrink) functions. These functions are the same as dilations.



a Research to find the size in millimetres for the following common paper sizes: A5, A4, A3, A2, A1, A0.

b The area of an A0 sheet is exactly 1 square metre. What happens to the area from an A0 sheet to A1? Does this pattern continue with smaller sizes?

c What percentage enlargement or reduction would you select on the printer or photocopier to:

i make A4 half size

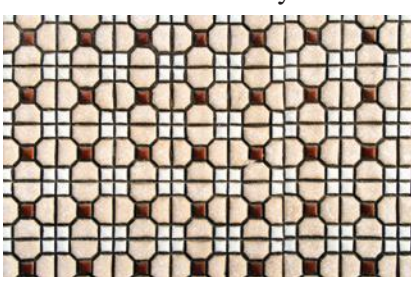
ii make A4 double size

iii enlarge A4 to A3

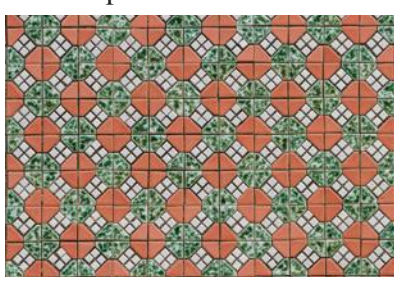
iv reduce A2 to A4.

9 For the following tile tessellations, describe the basic shape or shapes that are used and describe how they have been applied to make the pattern.

a

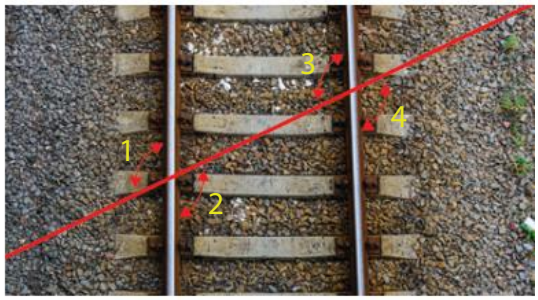


b



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

12E Angle properties



We see the application of angle properties every day. For example, engineers building a new train line need to ensure that the train tracks are parallel. One way to check this is to use angle properties and measure the angles that a line (transverse) makes across the train tracks. If a pair of corresponding angles are equal then the tracks are parallel.

Angles 1 and 3 are a pair of corresponding angles that are equal, so the two railway track lines are parallel. (Angles 2 and 4 are another pair of corresponding angles that are equal. Are there other pairs of corresponding angles?)

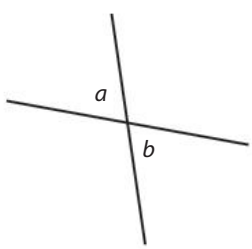
Road engineers, surveyors, architects and landscapers use geometry, algebra and trigonometry when designing buildings and spaces. Such professionals and tradespeople need to interpret and implement these designs.

There are **common angle properties** that are used to determine angles and placement of materials and structures.

Property 1: Vertically opposite angles are equal.

In the image shown, two roads (Baker Rd and McIntyres Rd) cross to form two pairs of vertically opposite angles.

Use your protractor to measure the vertically opposite angles marked a and b on the image to confirm that they are equal. Can you identify the other pair of vertically opposite angles in the image?

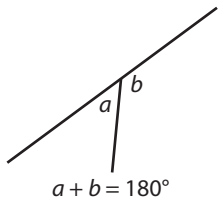


$a = b$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

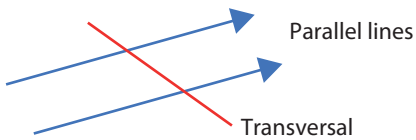
Property 2: Adjacent angles on a straight line add to 180°.

In this photo of a glass rooftop skylight, two adjacent angles have been labelled a and b. Together they form a straight angle of 180°.



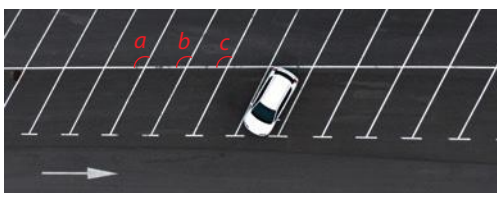
Parallel lines

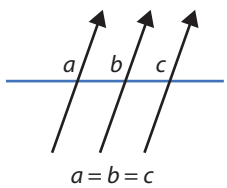
Parallel lines are lines that are always the same distance apart and never touch. When a line crosses parallel lines it is called a transversal and the angles around this line have special properties.



Property 3: Corresponding angles are equal.

In some carparks, the outlines of the parking bays create parallel lines with a transversal, and you can see that the corresponding angles will be the same. In this case, three corresponding angles have been labelled as a, b and c. Can you identify more?

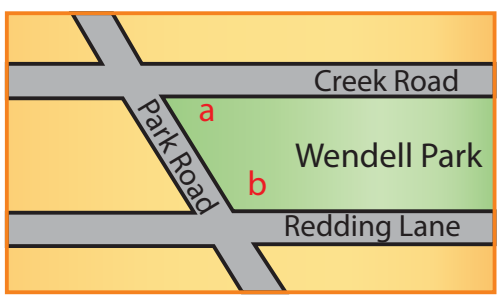


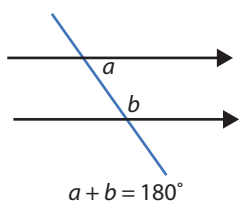


Property 4: Co-interior angles add to 180°.

When you have a transversal crossing a pair of parallel lines, the two interior angles will add to 180°.

For example, the image shows two parallel lines (Creek Road and Redding Lane) crossed by a transversal (Park Road). The two co-interior angles a and b (in Wendell Park) will add to 180°. Check this for yourself.

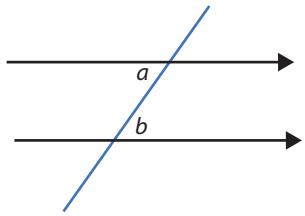




ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

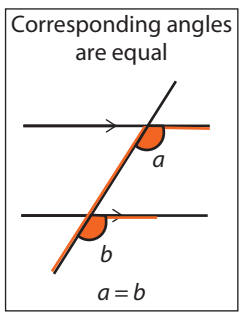
Property 5: Alternate angles are equal.

Another example of parallel lines crossed by a transversal can be seen in this photo of a gate. The alternate angles labelled a and b are equal to each other.

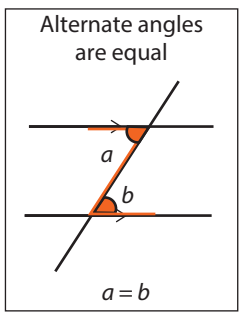


$a = b$

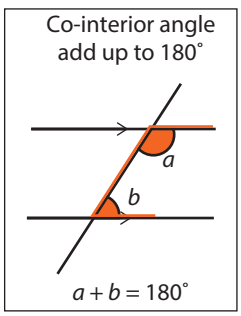
We use the letters F, Z and C to remember these properties of angles around parallel lines, as illustrated below.



Look for an F-shape



Look for a Z-shape



Look for a C- or U-shape

Activity

With a partner, look at the photo of a gate shown in Property 5.

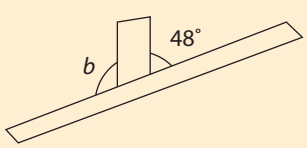
1 Draw a quick sketch of the gate and label the parallel lines and a transversal.

2 On your sketch, locate and label an example of each of the following:

- **a** a pair of vertically opposite angles
- **b** a pair of adjacent angles
- **c** a pair of corresponding angles
- **d** a pair of co-interior angles
- **e** another pair of alternate angles
- **f** another pair of adjacent angles

Example 4 Using angle properties

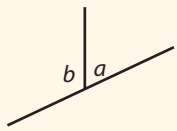
You are checking the placement of a diagonal beam on a building site. The smaller angle between the beams should be 48°. You verify this by measuring angle b.



a Which angle property are you applying?

b What should be the measurement of angle b?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 1	
Consider which property relates to angles on a straight line (property 2).	**a** The angle property that can be applied is: adjacent angles on a straight line add to 180°. $a + b = 180°$ 
STEP 2	
Substitute 48° for a in the angle relationship and solve to find the value of b.	**b** $48° + b = 180°$ $b = 180° - 48°$ $b = 132°$ Angle b should be 132°.

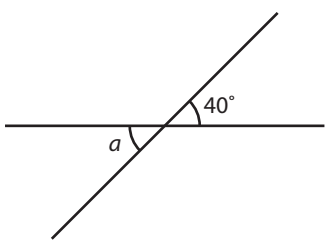
12E Tasks and questions

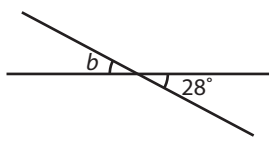
Thinking task

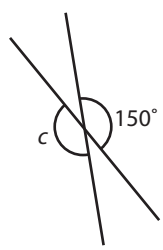
1 Look around your school. Can you find different applications and examples of the angle properties you have met in this section? Look for angles in shapes on, or in, different buildings (look at doors, windows, gates etc.), or even on different sports fields and their markings and lines. You can take some photos and share these with your classmates.

Skills questions

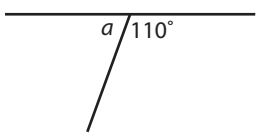
2 Find the size of the following unknown angles labelled with pronumerals by using Property 1: Vertically opposite angles are equal.

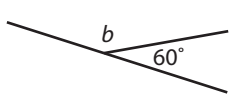
a 

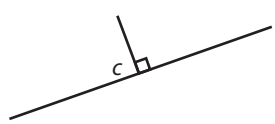
b 

c 

3 Find the size of the following unknown angles labelled with pronumerals by using Property 2: Adjacent angles on a straight line add to 180°.

a 

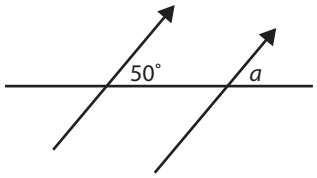
b 

c 

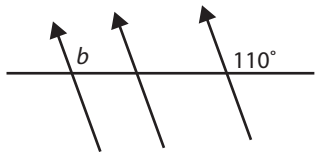
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4 Find the size of the following unknown angles labelled with pronumerals by using Property 3: Corresponding angles are equal.

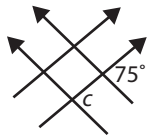
a



b

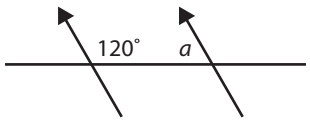


c

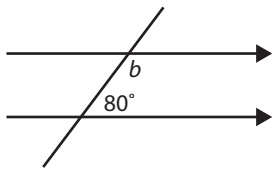


5 Find the size of the following unknown angles labelled with pronumerals by using Property 4: Co-interior angles add to 180°.

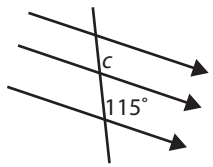
a



b

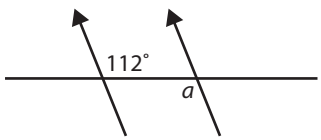


c

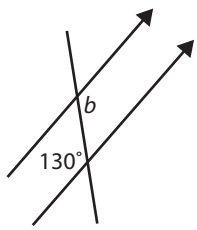


6 Find the size of the following unknown angles labelled with pronumerals by using Property 5: Alternate angles are equal.

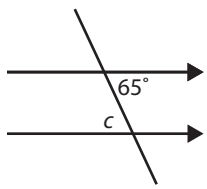
a



b

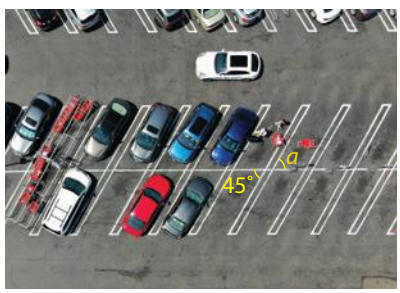


c



7 Find the size of the following unknown angles labelled with pronumerals. State which angle property you used in each case.

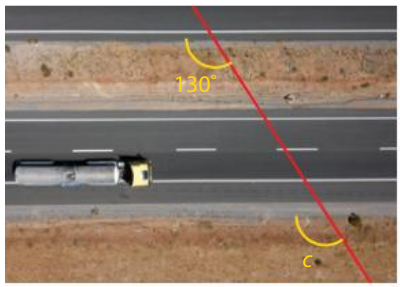
a



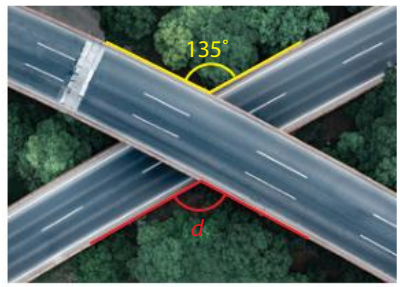
b

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

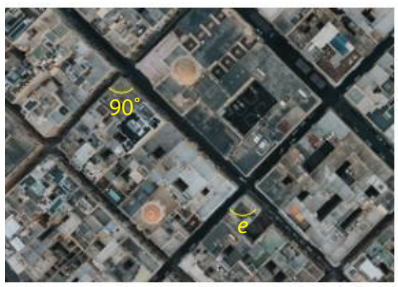
c



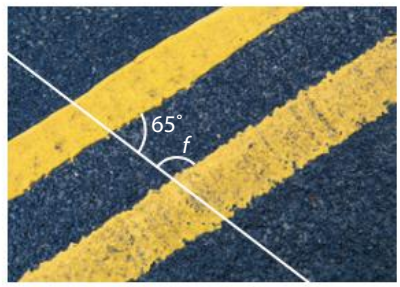
d



e



f



g

h

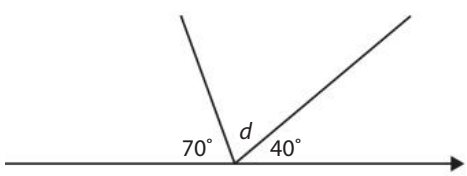
i

j

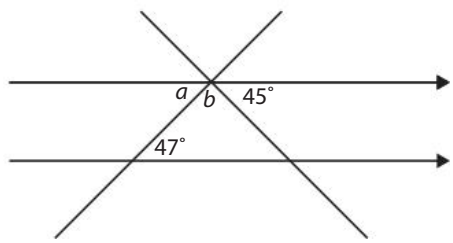
Mixed practice

8 Find the size of the angles labelled with a pronumeral.

a

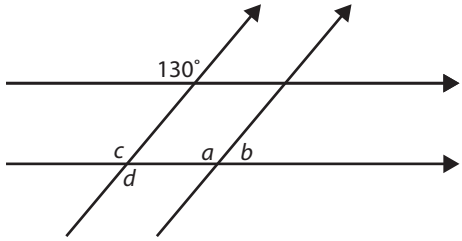


b

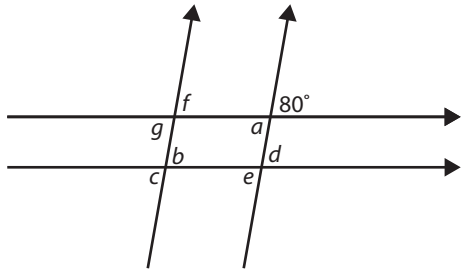


ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

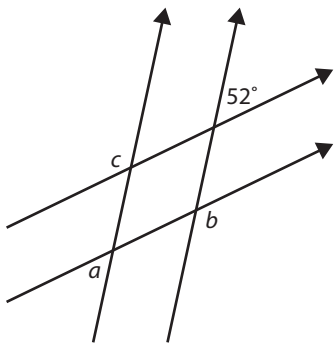
c



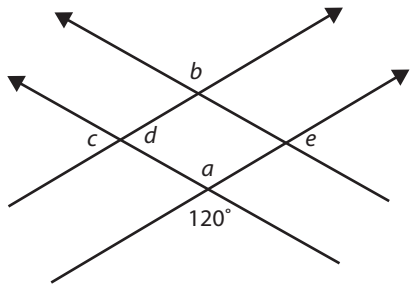
d



e



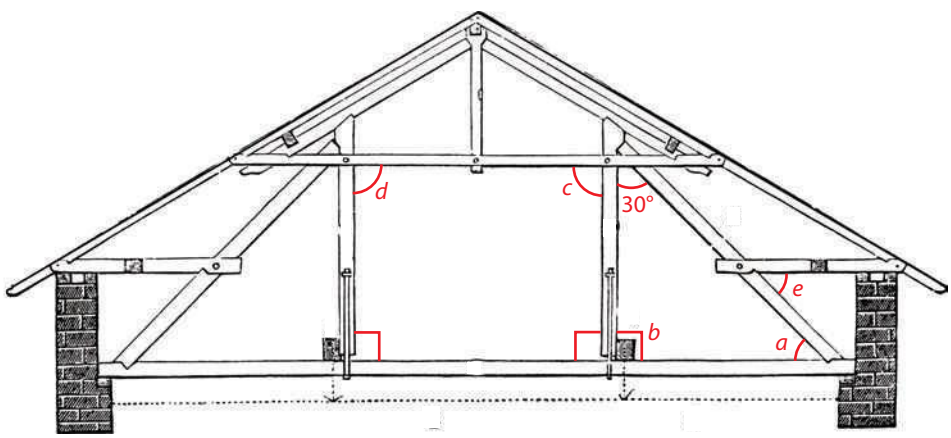
f



Application task

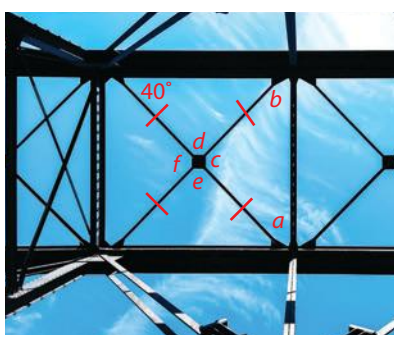
9 For the following trusses, determine the size of the unknown angles labelled with pronumerals.

a



b

c



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

12F Using maps and map applications

We use maps all the time: to get to a mate's place, to get to a job interview, to meet up with friends at a venue. Can you think of other situations where you've used a map?

We're going to examine the features of maps that help us find our way around:

- using road maps to find distances and directions
- using map apps.
- using the PTV app
- looking at international travel

Features of maps

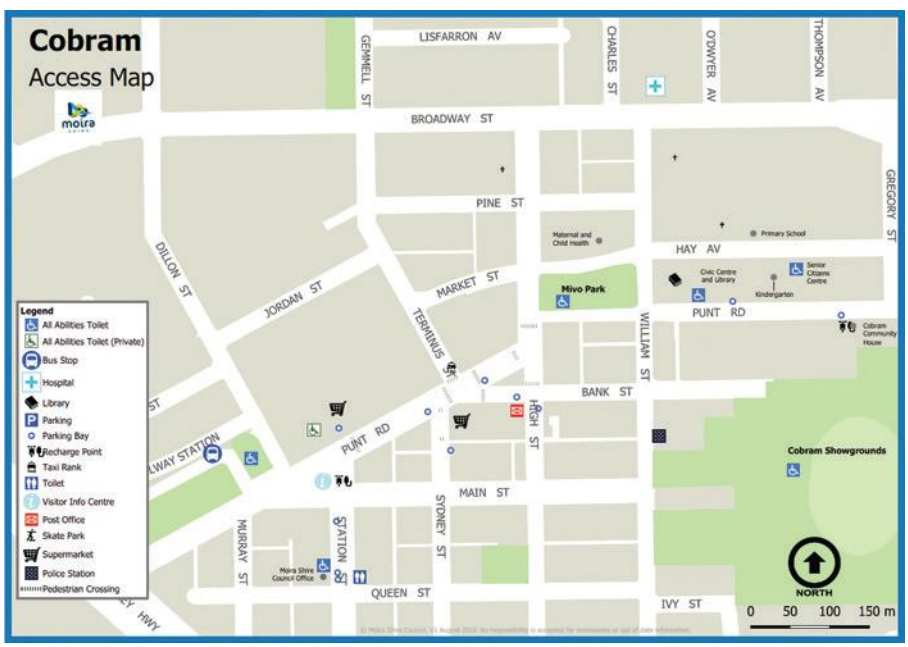
In Chapter 12 of the Units 1 & 2 textbook, the underpinning mathematical ideas related to understanding, interpreting and using maps were covered comprehensively. Please refer back to that chapter if you need to refresh your skills.

In this current chapter, you will learn a bit more about working with maps, including looking at international travel.

A good map has:

- north
- street names or route numbers
- a scale that is the same for every user.
- landmarks
- legend

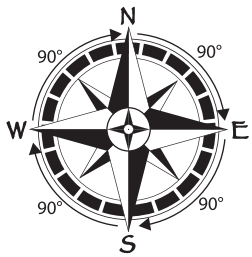
Below is an example of a map that has these features.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Directions

A map usually indicates where North is using a simple **compass** or **compass rose** or a **direction indicator**. For example:



On a map, north is usually shown as pointing towards the top, but as you can see in the Melbourne map on the previous page, this is not always the case.

Map scales

A scale is the ratio of the length on the drawing (or map) to the actual length.

On the map on the previous page, the scale of the map is presented as a line that is 4 cm long which represents 1 km. That is, 4 cm : 1 km or 4 cm : 100 000 cm (since we need to write ratios with the same units).

Scale = 4 : 100 000.

Then we need to simplify the ratio by dividing both sides of the ratio by the highest common factor (HCF). In this case, HCF = 4.

Scale = 1: 25 000 (so 1 cm on the map represents an actual length of 25 000 cm)

This could also be written as a fraction or scale factor: $\frac{1}{25\,000}$

The scale factor can be calculated using the formula:

$$\text{Scale factor} = \frac{\text{length on the map}}{\text{actual length}}$$

We can use this formula to calculate the actual length that is represented on a map by rearranging the formula to become:

$$\text{Actual length} = \frac{\text{length on the map}}{\text{scale factor}}$$

Example 5 Determining a length using a scale factor

Selina is using a hiking map to determine the distance from her campsite to the top of a mountain. The scale on the map is written as 1 : 300 000 and the distance from the campsite to the mountain top on the map is approximately 5.5 cm. What is the actual distance?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 1 Write the scale as a scale factor.	$\text{Scale factor} = \frac{1}{300\ 000}$
STEP 2 Use the formula to calculate the actual length.	$\text{Actual length} = \frac{\text{length on the map}}{\text{scale factor}}$ $\text{Actual length} = \frac{5.5 \text{ cm}}{\frac{1}{300\ 000}}$ $= 1\,650\,000 \text{ cm}$
STEP 3 Convert the length to a more reasonable unit and write your answer.	1 650 000 cm ÷ 100 000 = 16.5 km The actual distance from the campsite to the mountain top is 16.5 km.

Using a map application

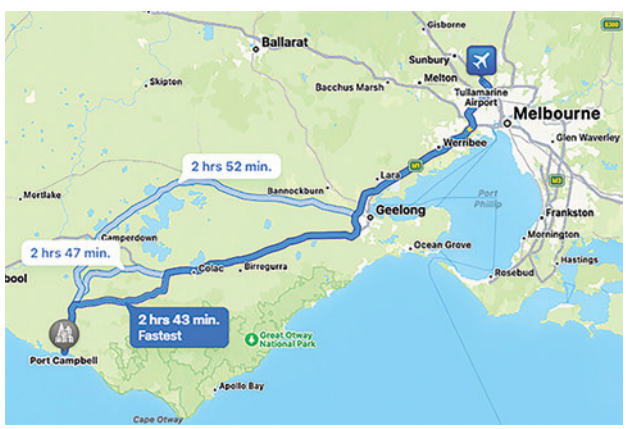
One of the advantages of using a map app is that the road and traffic conditions are live. Remember that when we zoom in or out, the scale changes.

Using a map app to plan a journey is a skill that we all need to be able to do.

When we're using a map app, we are often offered alternative routes.

Here is a map showing two routes from Tullamarine airport to Port Campbell.

One route is significantly longer in driving time than the other. This map also shows the types of roads: M1 is a major road, while C164 is a minor road.

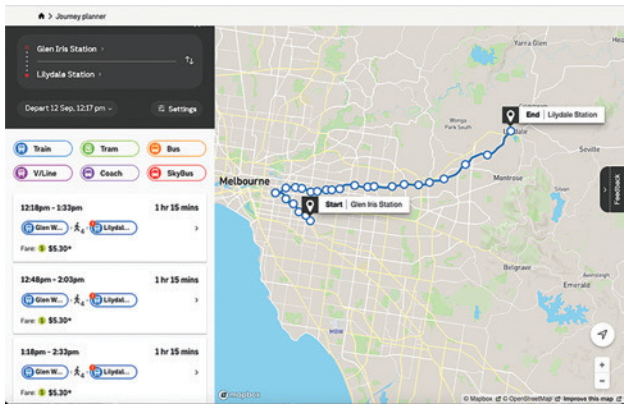


ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Getting around using the PTV journey planner app

Look up the PTV site, and go to the Journey Planner tab.

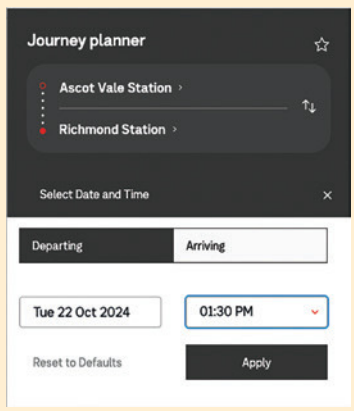
The PTV app is live, so you need to set the day, time and direction to get your journey right. These are the steps to follow.



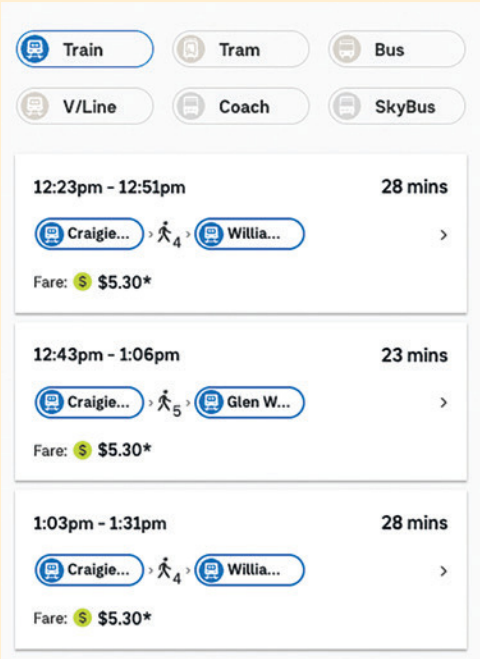
1. Choose a starting point.
2. Put your destination in.
3. Choose the mode of transport.
4. Select whether you want to work out when you're departing, or when you're arriving.
5. Select the date of travel.
6. Select the time of travel.
7. Click the Apply button.
8. Now you see your journey options, with durations, and the fare.

Example 6 Using the *PTV Journey Planner* app

Jin lives in Ascot Vale, near the railway station. Next Tuesday, at 1:30 p.m., he has a job interview at *Super Bikes*, which is a short walk from Richmond station. Plan his journey so that he gets to his interview a little early.

THINKING	WORKING
STEP 1 Locate the *PTV Journey Planner* (on the PTV phone app or the PTV website) and enter the starting point and destination. **STEP 2** Click to select **Arriving**. Select a suitable date and arrival time for Richmond station and click the **Apply** button.	

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 3 Select the type of transport he will use. (Click on 'Train' in this case.)	Jin prefers to travel by train.
STEP 4 Select a suitable journey from the list presented.	 Jin could catch the 12:43 p.m. train from Ascot Vale and arrive at Richmond station at 1:06 p.m., giving him more than 20 minutes to walk to the interview.

International travel

Because Australia is an island, when travelling overseas, this usually means flying.

When you're flying to London, for example, which journey and flights you make will depend on your reason for travelling, and your budget. If you're travelling for a specific purpose, you probably want to minimise the stopovers because hanging around in airports is boring and expensive. But if you're having a holiday, you might want to do some stopovers and spend a bit of time in each country.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

12F Tasks and questions

Thinking task

1 Research and think about how our everyday use of maps, and organising and managing our travel has changed over this century.

- When was there a significant move from using hard copy maps and street directories, like the *Melways*, to using digitally based GPS maps such as Google Maps and other apps such as the PTV app?
- How has this changed how people decide what routes to take and how?
- Has it changed how people organise their travel plans for holidays (and work)? In what ways?
- Do people still use hard copies of maps – in what ways might they still be useful?
- Does the reason for an overseas trip affect the map or tool that we use?

Share your thoughts and findings with other students.

Skills questions

2 Use this map to estimate the distance between the places listed below.

a Hospital to the Police station

b Moira Shire Council Office to the Recharge Point

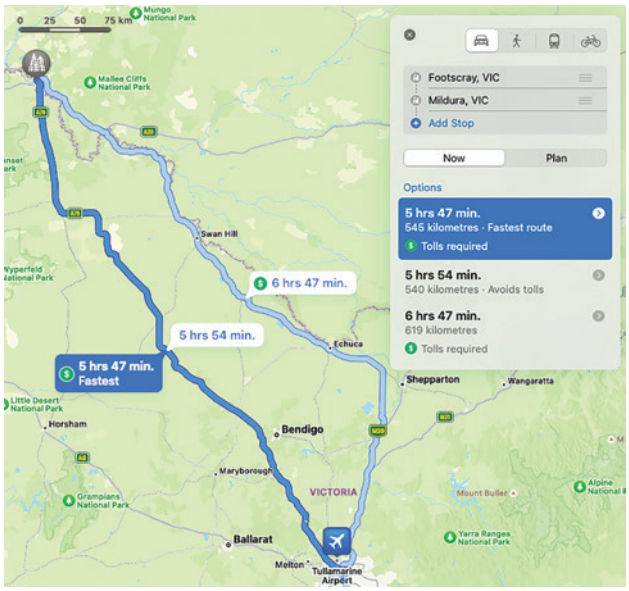
c Post Office to Broadway Street

d Primary School to the Maternal and Child Health centre

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3 Estimate the compass direction for each of the trips in question **2**.

4 This is a map app image of the possible routes to drive from Footscray to Mildura.



a What is the time difference between the shortest distance route and the longest distance route?

b What is the percentage difference in the distance between the shortest and longest routes compared to the distance travelled for the longest route? Round your answer to the nearest whole per cent.

c Based on the times and distances shown on the GPS map for the routes, what is the average travelling speed, in kilometres per hour (km/h), for the shortest route? Round your answer to the nearest km/h.

d Since it is such a long journey, you have decided to allow 20 minutes as a morning break, 45 minutes as a lunch break, and another 20 minutes for an afternoon break. If you have to be in Mildura by 6 p.m. and use the fastest route, what time should you leave Footscray?

e The car has an average fuel consumption on the open road of 7.5 litres per 100 km. Based on this fuel consumption rate, about how much petrol would be needed for travelling both ways on the longest route? Round your answer to the nearest litre.

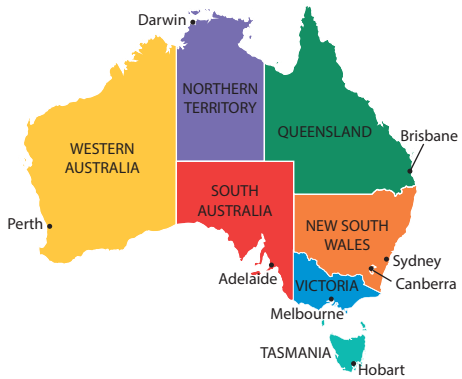
f The fuel tank of the car has a capacity of 80 litres. How many tanks of fuel would be needed for the total road trip going the longest way?

5 Jamil lives in Broadmeadows within walking distance of the station. He has a job interview at *JobsRus* next Monday at 2 p.m. *JobsRus* is close to Parliament station. Use the PTV journey planner to find the best train for him to catch. What would be the best back-up option if there is a delay, or trains are cancelled?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6 The flight distances from Melbourne's Tullamarine airport to the airports of the state capital cities are shown in this table.

Airport	Distances
Adelaide	643 km
Brisbane	1377 km
Canberra	468 km
Darwin	3135 km
Hobart	617 km
Perth	2701 km
Sydney	706 km



a Arrange the distances from the least to the greatest.

b Calculate each distance as a percentage of the largest distance.

c Approximately, how many times further away is the most distant airport from Tullamarine compared with the airport that is closest to Tullamarine airport?

d Sianne lives in Melbourne, her parents live in Perth and her brother lives in Brisbane. In one year, Sianne flew from Tullamarine airport to Perth three times, and flew twice to visit her brother in Brisbane. Based on the distances in the table, what is the total distance Sianne travelled on those five trips?

Application tasks

7 A friend who lives next door to your school wants to come over to your place on the weekend but has no idea where you live or how to get there.

a Draw a sketch map of the route from the school to your place.

b Include any bus or train travel, if applicable.

c Include the names of main roads.

d Include any landmarks.

e Give an indication of the time it will take for each part of the journey.

8 You are planning a full day excursion with your mates in the Melbourne CBD. Use the internet to find a good map of the CBD and print off a copy. Make sure it has a scale on it.

a Use the internet to research at least five places of interest that you would visit.

b Mark these places on your map.

c Use the PTV journey planner to make sure that you're at Flinders Street station by 9:30 a.m.

d Plan your route to visit each place, starting and finishing at Flinders Street station.

e Use the scale on your map to work out the distance that you would travel while visiting each place.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

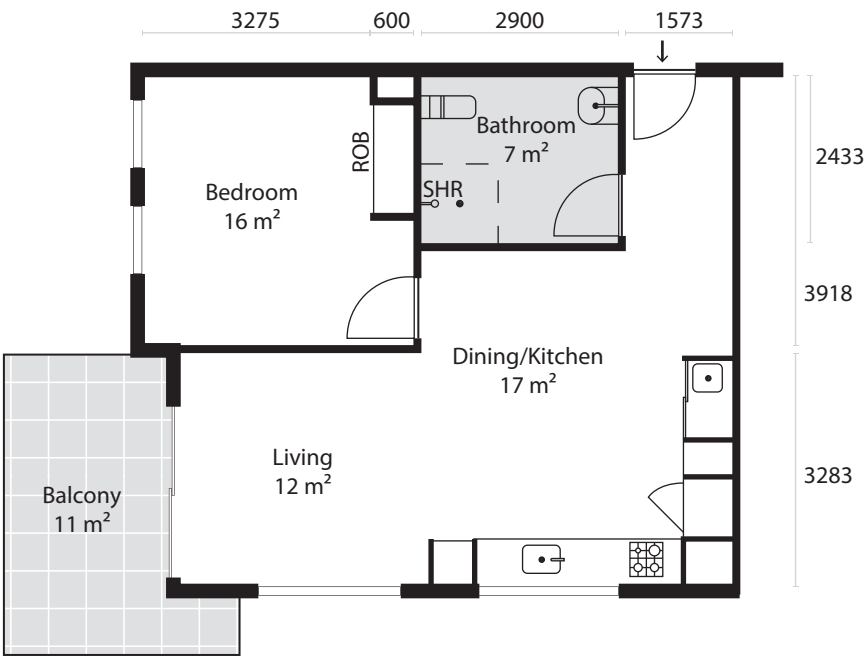
12G Reading and working with plans

Plans are two-dimensional drawings which provide detailed information about the design, shape and measurements of an item or object. Any product that is to be made, whether it's a car part, a house or a dress, will have a detailed plan to be followed.

Being able to read and work with plans is an essential skill in many occupations.

House plans

Here is an example of the floor plan of an apartment to be sold *off the plan* (meaning prior to being built).



This plan includes important features and their measurements.

By convention, the exterior walls are dark, and indicate the roofline of the building.

Sometimes abbreviations and/or symbols are used to represent items in the plan. What do you think these represent in the plan above?

1

2 SHR

Measurements

Length measurements are often represented on plans using arrows or straight lines.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

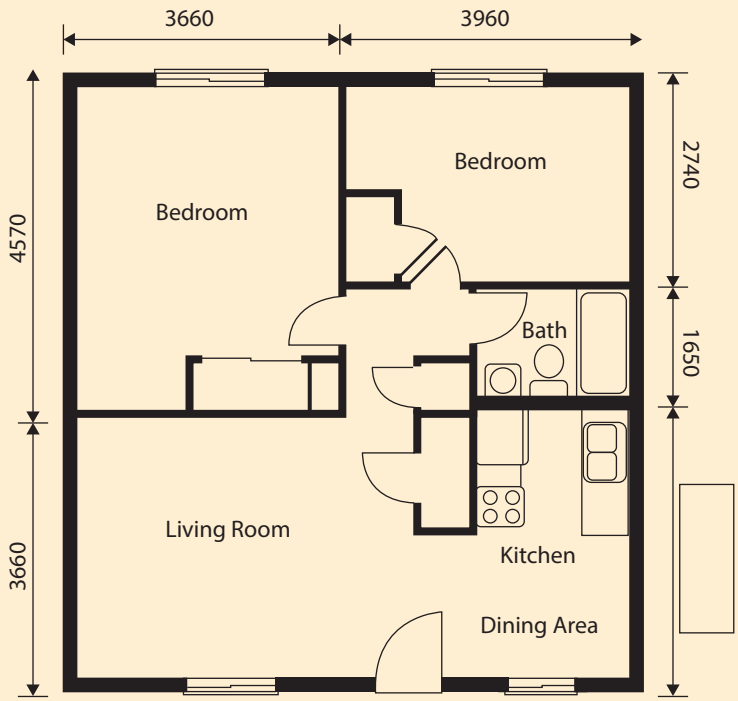
The most common unit used on building plans is millimetres (mm); however, metres (m) and centimetres (cm) are sometimes used.

Remember the conversions for length are:

1 m = 1000 mm 1 m = 100 cm 1 cm = 10 mm

Example 7 Reading floor plans

Consider the following floor plan. Measurements are in millimetres (mm).



a Calculate the lengths of the outside walls. Answer in mm.

b Calculate the value of the missing wall length that should be shown in the box at the right-hand side of the plan.

c What symbol is used to represent the kitchen sink?

d For this apartment to be built, the council requires that there should be a minimum floor area of 50 m^2. Does this apartment comply with this requirement?

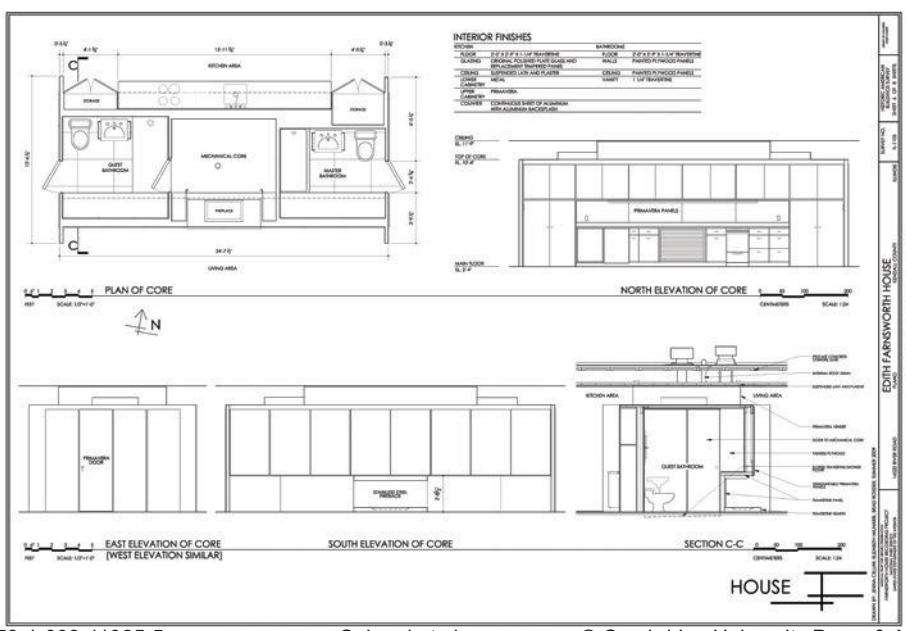
THINKING	WORKING
STEP 1	
Add part-lengths to determine the length of each outside wall.	**a** 3660 + 4570 = 8230 mm (for left and right walls in plan) 3660 + 3960 = 7620 mm (for top and bottom walls in plan) Outside walls of apartment are 8230 mm and 7620 mm.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 2	
Use the wall length along the right side of the plan to determine the unknown length.	**b** Unknown length = 8230 – 1650 – 2740 = 3840 mm The missing value is 3840 mm.
STEP 3	
Identify the symbol used for the kitchen sink.	**c** The symbol used in the kitchen for a sink looks like this.
STEP 4	
Calculate the floor area of the house using the outside wall lengths. Convert each length measurement to metres so the area is in m^2.	**d** Area of rectangle = length × width Length of apartment = 8230 mm = 8.23 m Width of apartment = 7620 mm = 7.62 m Floor area = 8.23 m × 7.62 m = 62.7126 m^2
STEP 5	
Compare to the council's requirement of at least 50 m^2 and write your answer.	The floor area is more than the minimum area of 50 m^2, so it complies with the council's requirement.

Elevations and virtual viewing

Elevations show the house from each side so that you get a better idea of what the finished house will look like.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Many people struggle to visualise what a house will look like from plans and elevations. Sometimes there is an artistic sketch that shows what is called a perspective view of how the house (or another) object looks in reality. However, a perspective view cannot show accurate dimensions.

There are many housing companies that offer **virtual tours** of their *off the plan* houses. And many real estate agents offer virtual tours of the houses they're selling.

There are also quite a few websites that let you virtually build a room or a house.

12G Tasks and questions

Thinking task

1 Here are two different styles of possible house constructions in Australia.

a Explain at least three design/construction features of houses in Australia that consider the environmental conditions of where the house is to be built.

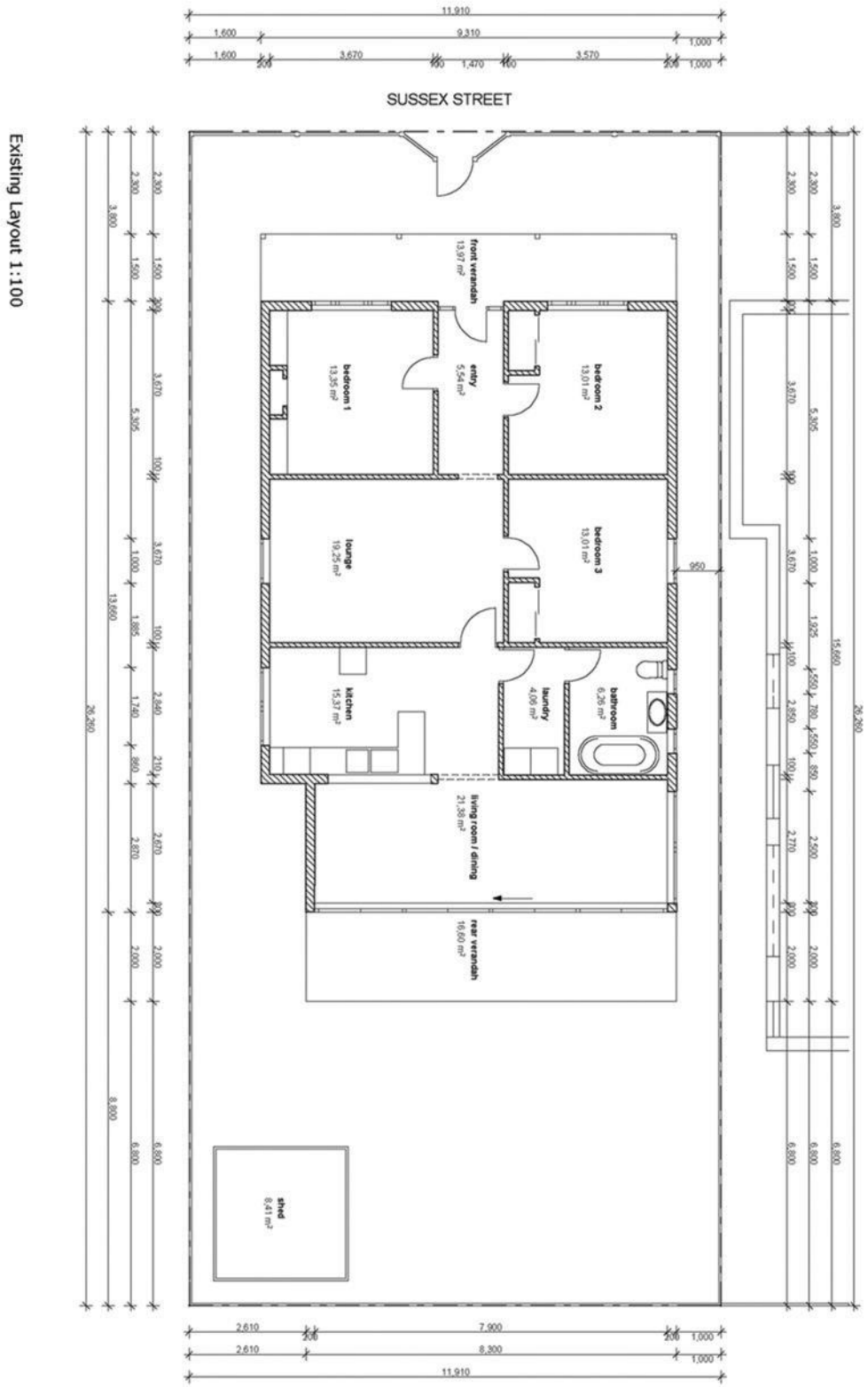
b Why are they used? What aspects of dimensions, shape and space do they build on and use?

Share and compare these with your classmates.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Skills questions

2 Use this house plan to answer the following questions.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

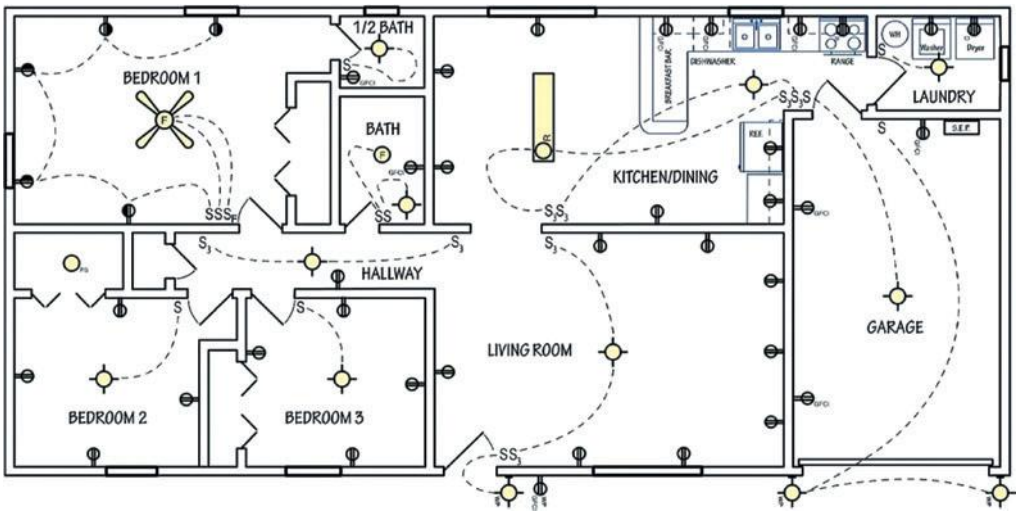
a What is the width of the main front section of the house?

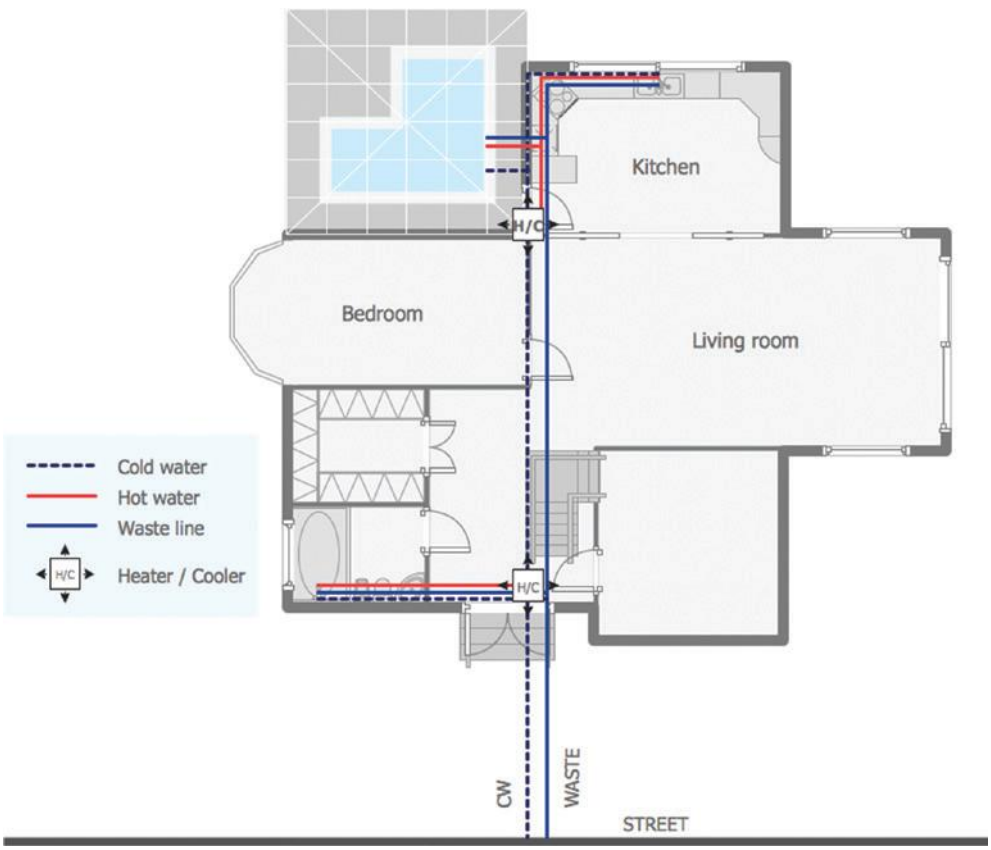
b What are the dimensions and the area of the block, in square metres?

c What are the dimensions and the area of bedroom 1?

d What are the dimensions and the area of the lounge room?

3 As well as plans for the builders, there are usually additional plans needed for electrical wiring and for plumbing facilities.





ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

a Make a list of some special symbols that are used on these plans.

b Comment on how important it is for different people on a building site to be able to understand plans from each other's trades.

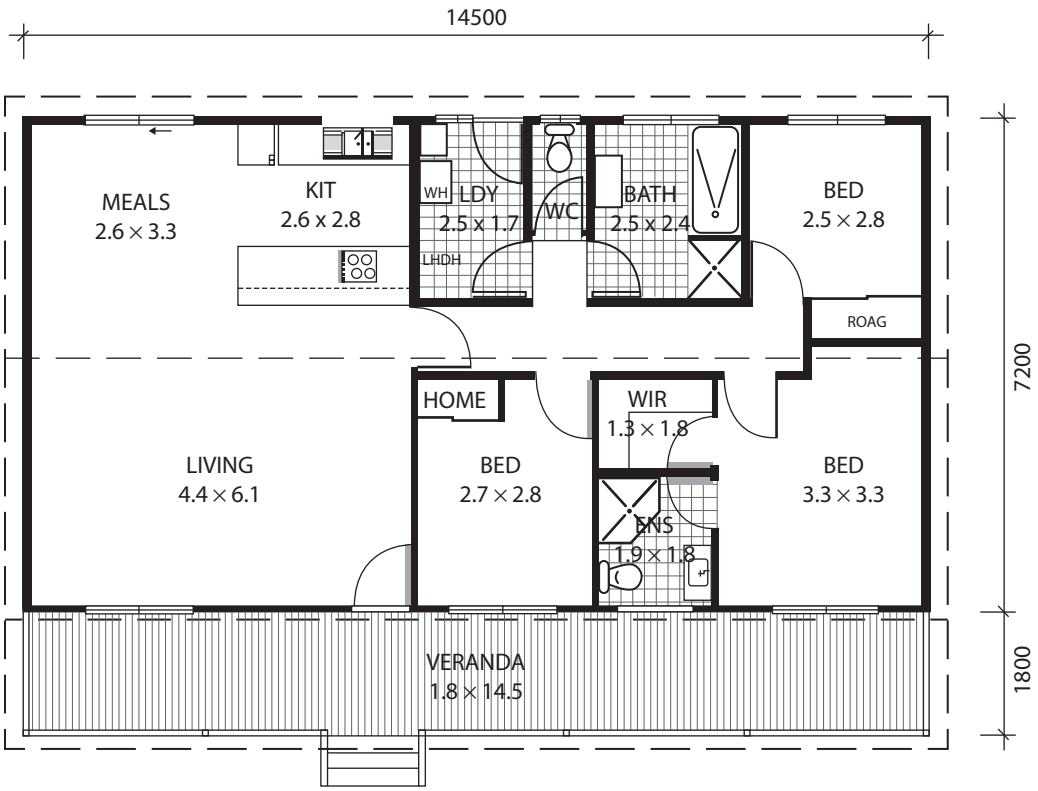
4 Draw, either by hand or computer, a front and side elevation view of these houses.

a

b

Application tasks

5 Use this house plan to answer the following questions.



a Draw the symbols used on house plans to represent:

i a door

ii a toilet

iii a wardrobe

iv a window.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

b Explain how you know whether the veranda is under the roofline.

c Is the veranda to be included in the area of the house?

d Calculate the area of the house in m^2.

e A building 'square' is 9 m^2. Calculate the number of building squares, to 1 decimal place.

f If a building square costs $18,000, calculate the cost of building this house.

g The laundry, bathroom and ensuite are to be tiled. Calculate the total area to be tiled, to 1 decimal place.

h If tiling costs $105 per square metre (which includes materials and labour), calculate the cost of tiling these areas, rounding up to the nearest dollar.

i The living room and the bedrooms are to be carpeted. Calculate the total area to be carpeted.

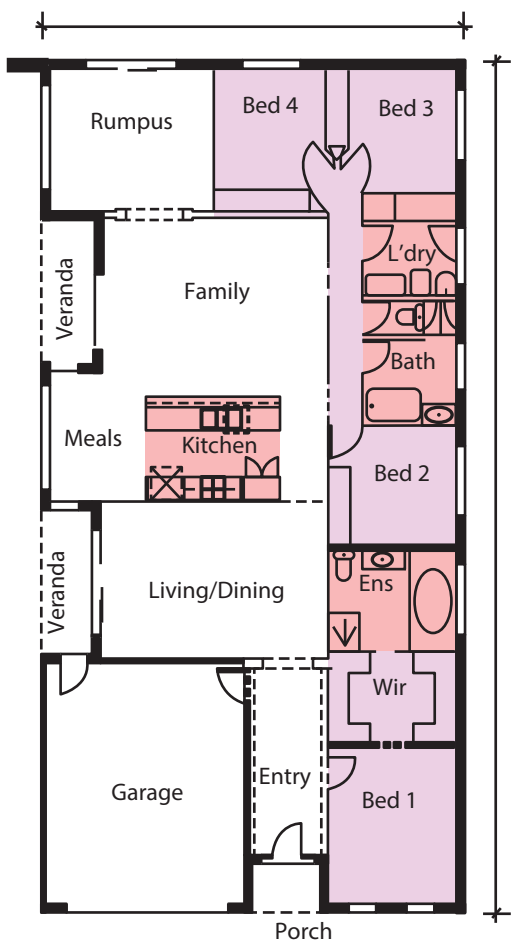
j If the carpeting costs $95 per square metre (which includes materials and labour), calculate the cost of carpeting these areas, rounding up to the nearest dollar.

6 Use the house plan shown to answer the following questions.

a Explain whether this would be a good design if the family's three children are less than 5 years old.

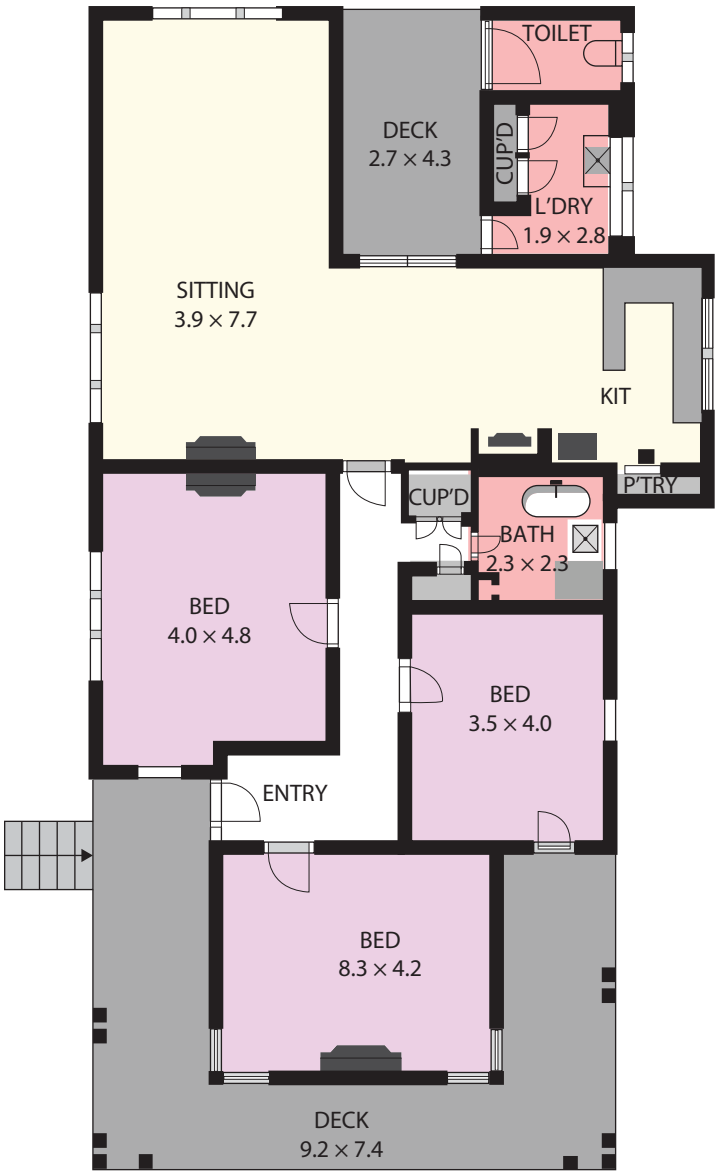
b Explain whether this would be a good design if the family has three teenagers.

c What modifications would you make to this house plan to suit different ages of children?



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

7 Examine the house plan shown.



a What design flaws are evident in this house plan?

b Redesign the house plan so that it still has three bedrooms. You can make minor adjustments to exterior walls if you feel that this is necessary.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

12H Creating 3D from 2D

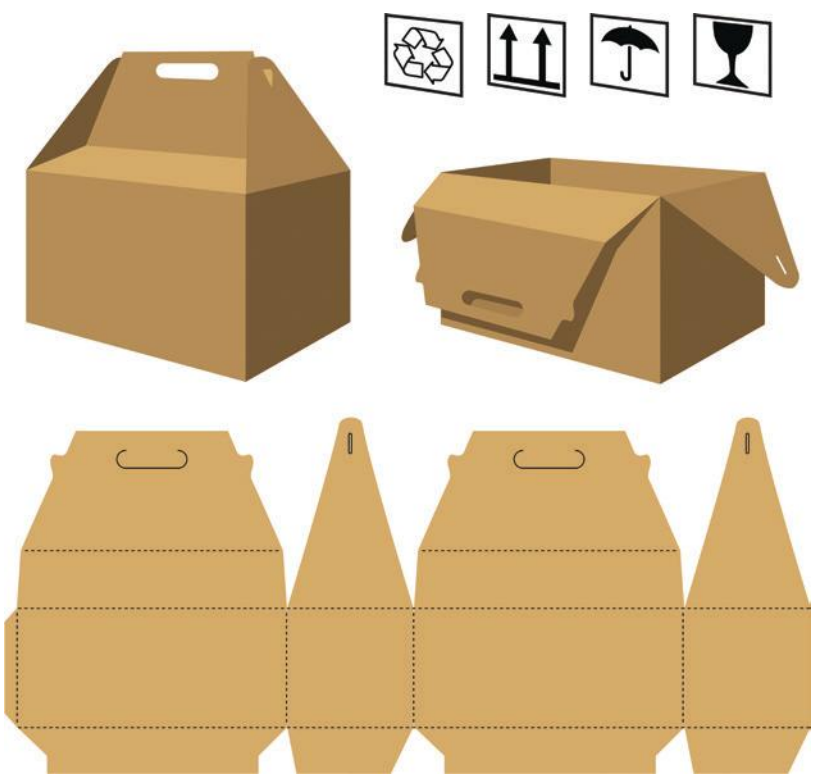
In many areas of life and work when constructing or making just about anything, concept sketches may be required before a more accurate plan is drawn.

In the 21st century, many jobs require using technology to create templates, models or plans to construct or make real-life objects. This is now very true with the development of 3D printers.

Using software applications to create two-dimensional drawings of three-dimensional objects requires an understanding of shape and geometry, and measurement skills.

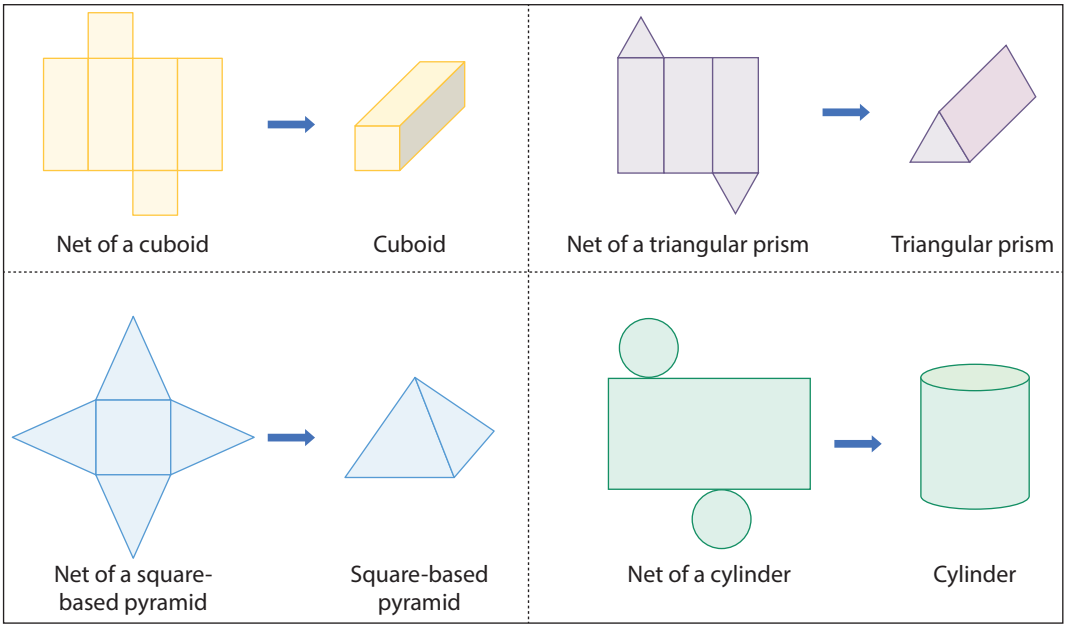
Before investigating the different ways that we can use technology, let's first revisit making 3D objects from 2D shapes.

The 2D plans (**nets**) for 3D objects (**solids**) are plans that when folded make the required object. They may include flaps for construction purposes.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Here are some nets for constructing familiar 3D objects.



Orthogonal drawings

When we looked at house plans and designs earlier, we talked about and had examples of different views of houses. These different illustrations show the house from each side so that you get a better idea of what the finished house will look like.

Formally in design, architecture and engineering etc., **orthogonal drawings** were used, which are scaled, multi-view drawings of a three-dimensional object to show each view separately, in a series of two-dimensional drawings.

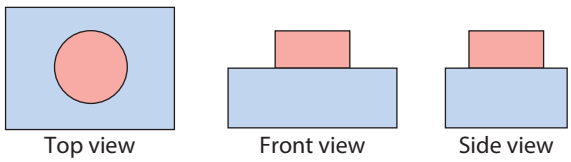
Typically, in Australia, there are three views shown (called **third angle orthogonal drawing**):

- Front view: The front view provides a direct representation of the object as seen from the front. It shows the primary features and dimensions of the object.
- Right side view: The side view displays the object from the right. It complements the front view by revealing additional details, such as hidden edges and features not visible in the front view.
- Plan (top) view: The plan view presents the object as seen from directly above. It provides information about the object's layout, dimensions and overall shape.

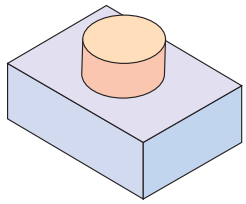
This is often compared to a three-dimensional drawing of the same object – called an **isometric drawing** where all dimensions are shown to scale and where the horizonal edges are shown at an angle of 30° from the corner. The illustration on the next page compares the two.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Two-dimensional orthographic projection



Three-dimensional isometric projection



Industry and professionals, such as engineers, architects and designers, rely on **orthogonal** drawings and these views to communicate precise information about objects, structures and components. Orthogonal drawings usually include measurements on each view and are used to develop lists of material requirements.

Producing scale drawings

Scale drawings may be drawn by hand or drawn using software programs.

Hand-drawing equipment may include:

- drawing boards which have a grid and provide horizonal and vertical lines
- T-square is used for measuring 90° angles
- set square for drawing 30° and 45° angles.

Software programs may include:

- *Computer aided design (CAD)* programs work by using Cartesian coordinates. They are now used in many industries such as logistics transport, engineering, 3D printing, drafting, architecture, car design. Some available programs in Australia include *MicroStation*, *AutoCad* and *FreeCAD*.
- Software that may be available for you to use in school; for example, *Sketch Up, Draft it, tinkercad* and *QCAD*.
- Image manipulation and creation software includes programs such as *Design*, *Photoshop* and *Adobe Illustrator*. This software works through using pixels. In these software packages you can either create your own or manipulate another image.
- Common software apps such as Word or PowerPoint also have quite good drawing tools that can be used. One advantage of a program like PowerPoint is that you can **export** your drawings or designs as images – either as .png or .jpeg files.

Using these software tools, you can undertake standard transformations such as:

- moving between 2D and 3D
- rotations
- reflections
- translations.

Note: You could use one of these special design digital programs to create some of your drawings or plans for this section. But please make sure you ask your teacher (or your fellow students who have used the apps before) for help and advice.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

12H Tasks and questions

Thinking task

1 Use the internet to find drawing apps and software that could be used for:

- drawing building plans
- designing a bike
- mapping
- fashion design.

a Include the hyperlink for each example of the drawing app or software.

b Provide one advantage and one disadvantage for each.

Skills questions

2 Draw, by hand, a net for each of the following three-dimensional objects. Include flaps to assist in their construction. Cut out each to make the three-dimensional object.

a Rectangular prism with length 4 cm, height 3 cm and depth 8 cm

b Cylinder with a radius of 4 cm and height of 5 cm

c Pentagonal prism with sides 4 cm and depth of 3 cm

d Pyramidal object of your choice

3 Use technology to create scale drawings showing different views of the following three-dimensional objects.

a Cube with side length 4 cm

b Cylinder with a radius of 5 cm and length of 8 cm

c Triangular prism with length 3 cm, height 5 cm and depth 4 cm

d Prism of your choice

Application tasks

4 Design a rectangular-sided package with the following dimensions for each view of the box.

Top view: 270 mm × 110 mm
Front view: 110 mm × 90 mm
Side view: 270 mm × 90 mm

a What is the geometric name for this object?

b By hand, sketch a two-dimensional net for this object.

c Use technology to create an accurate scale drawing of this net.

d Use technology to create a three-dimensional image of this object to scale.

5 A manufacturer wants to create a plan to mass produce this toy. The height of the toy is to be 25 cm.

a Sketch the toy by hand.

b Use technology to create a plan of the toy.

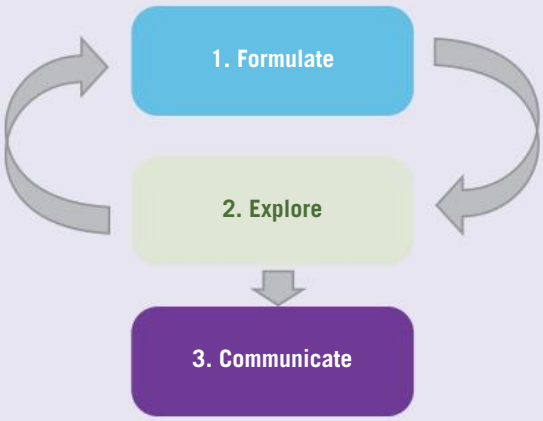
c Design a package for this toy.

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Investigations

When undertaking your investigations, remember the problem-solving cycle steps:

- **Formulate** – Sort out and plan what you need to know and need to do to solve the problem.
- **Explore –** Use and apply the mathematics required to solve the problem.
- **Communicate** – Record and write up your results.



1 Design a child's paper construction toy kit

Your task is to design a child's paper construction toy kit.

This is the design brief:

The constructions that are to be included in the kit are the **nets** for:

1 a cuboid, length 10 cm, height 4 cm, depth 5 cm

2 a second cuboid scaled to half the dimensions of the first cuboid

3 a cube, sides 2 cm

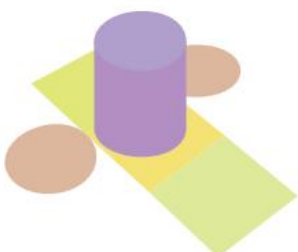
4 a second cube scaled to four times the dimension of the first cube

5 a cylinder, radius 9 cm, height 12 cm

6 a second cylinder scaled to one-third of the dimensions of the first cylinder

7 a square-based pyramid, base length 6 cm, vertical height 4 cm

8 a second square-based pyramid, scaled to double the dimensions of the first square-based pyramid



9 an open cuboid large enough to store the constructed three-dimensional objects.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Formulate

a Plan how you will create the toy kit. Some of the questions that you could consider are:

- What materials and tools will you use to construct the shapes?
- What does each three-dimensional object look like on paper?
- What scale will I need to accurately draw each three-dimensional object?
- How will I sketch each net of the three-dimensional objects?
- Do I need to sketch each net?
- What scale will I need to accurately draw each net?
- How will I arrange the constructed three-dimensional objects in the open cuboid storage container?
- What will be the dimensions of the open cuboid storage container?
- What scale will I need to accurately draw the net for this storage container?

Explore

b Create the nets and construct the three-dimensional shapes for the toy kit.

Communicate

c Write up and present the results of your investigation. You can choose the format of your presentation.

You should:

- include accurately drawn two-dimensional representations of each object in the design brief
- have accurately constructed all the nets of the three-dimensional objects in the design brief
- explain the mathematical skills that you have applied to this investigation
- reflect on how technology was used to conduct the investigation and present the results
- consider what you would change, and why, if you were to do this investigation again.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

2 Design a bedroom

Your task is to design a bedroom for a teenager.

You need to decide on the dimensions of the room – think about bedrooms at home as a possible starting point.

It must have a standard door opening, and at least one window.

Formulate

a In a small group or as a class, conduct a brainstorm to identify elements that need to be included in the design.

Some of the questions that you could consider are:

- What furniture needs to be included in the design?
- Where would you position the window/s, power points and light switches?

b What tool will you use to construct the scale drawing of your plan?

Explore

c Do a few hand-drawn sketches to explore the different layouts of the bedroom.

d Research the dimensions of every item that is to be part of the design.

e Construct an accurate scale drawing of the bedroom plan.

Communicate

f Write up and present the results of your investigation. You can choose the form of your presentation.

You should:

- explain the questions that you asked, and your reasons for your design decisions
- explain the mathematics that you used in your design
- reflect on how technology was used to conduct the investigation and present the results
- consider what you would change, and why, if you were to do this investigation again.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key concepts

- **Common angles**
  - Acute: an angle that is less than 90°
  - Right angle: an angle of 90° (a perfect corner)
  - Obtuse: an angle that is greater than 90° but less than 180°
  - Straight: an angle of 180° (a straight line)
  - Reflex: an angle greater than 180° but less than 360°
  - Exterior angle: an angle that is outside a polygon when a side is extended
- **Common terms**
  - Parallel: two or more lines running in exactly the same direction
  - Perpendicular: when lines are at 90° to each other
  - Horizontal: parallel to the horizon
  - Vertical: at right angles or perpendicular to the horizon
- **Names and properties of shapes and objects and their representations**
  - 2D convex shapes have all interior angles less than 180°.
  - 2D concave shapes have one or more interior angle greater than 180° (reflex).
  - 3D objects can have faces, edges and vertices.
  - Prisms have two identical shapes at either end, and their sides are flat.
  - Pyramids have one polygon at the base and the sloping sides meet a single vertex.
  - Ellipsoids are like flattened spheres.
- **Transforming shapes**
  - Dilation is changing the size by either enlarging or reducing a shape; these images are similar.
  - Reflection is flipping an image along a line creating a symmetrical 'mirror' image.
  - Rotation is moving a shape in a circular path around a fixed point.
  - Translation is sliding a shape without dilation, rotation or reflection; these shapes are congruent.
- **Angle properties**
  - Vertically opposite angles are equal.
  - Corresponding angles are equal.
  - Alternate angles are equal.
  - Adjacent angles add to 180°.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- **The things that we need on most maps**
  - Title
  - North
  - Scale
  - Street names and/or route numbers
  - Legend/explanation of symbols
  - Landmarks
- **Reading and working with plans**
  - Most plans are in millimetres (mm) and use common conventional symbols, e.g. for doors and windows.

Doors Windows

- **Creating 3D from 2D**
  - Nets: 2D plans to make the 3D objects
  - Orthogonal drawings: accurate 2D plans and diagrams
  - Isometric drawings: drawn to scale, horizontal edges are 30° from the corner

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Success criteria and review questions

☐ I can use a protractor to construct angles.

1 Use a protractor to draw these angles.

a 8° **b** 205°

☐ I can identify the faces, vertices and edges of a 3D object.

2 List the number of faces, vertices and edges of these objects.

a A pentagonal prism **b** A cuboid

☐ I can classify objects as planar, pyramidal, prismatic or ellipsoidal.

3 Classify each of these objects as planar, pyramidal, prismatic or ellipsoidal.

a A Toblerone packet of chocolate
b The surface of Earth
c The glass structure outside the Louvre Museum in Paris
d An image on a page from a book

☐ I can draw shapes and objects, and can apply dilation, reflection, translation and rotation.

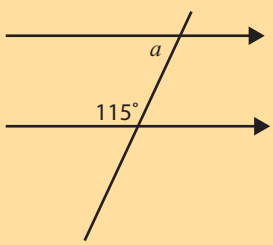
4 Using grid paper, undertake the following transformations.

a Draw a pentagon. Apply a dilation factor of 2.
b Draw a hexagon. Apply a reflection.
c Draw a right-angled triangle. Translate it 3 grid squares up and 5 grid squares to the right.
d Draw an ellipse. Rotate it around a vertical axis through 90°.

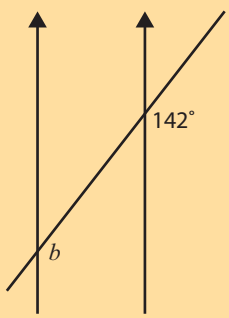
☐ I can use the properties of angles to calculate unknown angles.

5 Find the size of the unknown marked angles.

a

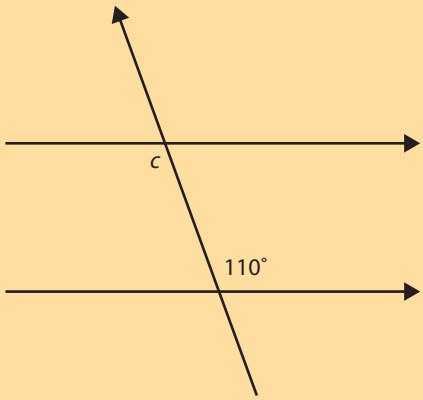


b

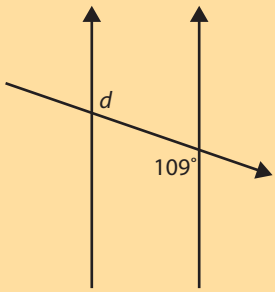


ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

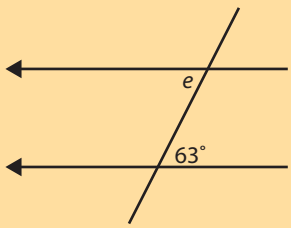
c



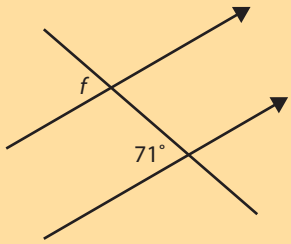
d



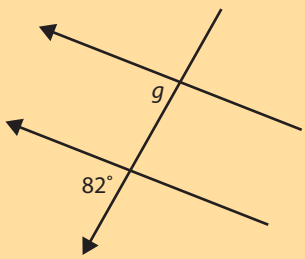
e



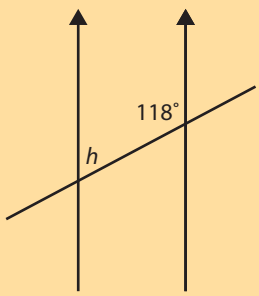
f



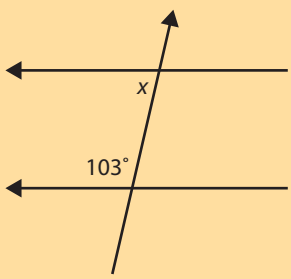
g



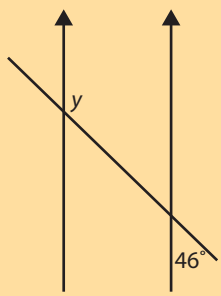
h



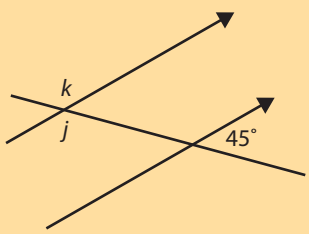
i



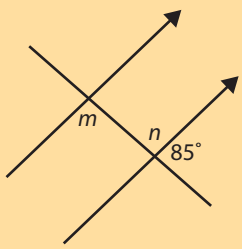
j



k



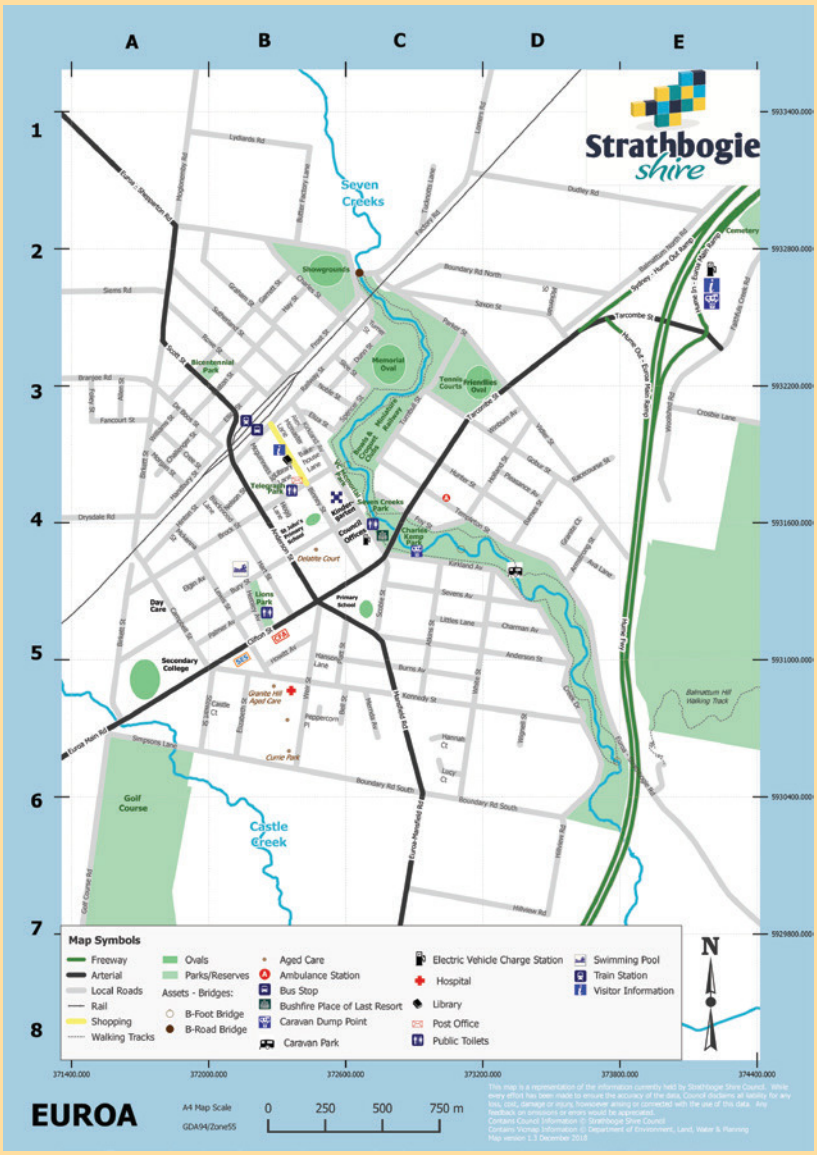
l



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

I can interpret and use maps.

6 Use the map below to answer the questions that follow.



a Using the scale, what is the distance between the Post Office and the Ambulance Station?

b Using the legend, what is the symbol for a hospital?

c In what direction do you go to get from the Kindergarten to the Swimming Pool?

d What colour is used on the map to indicate local roads?

e What does the yellow line on the map indicate?

f How do you get to the Tennis Courts from the Showgrounds?

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

☐ I can interpret a map application.

7 Avery is planning a family holiday trip from their home in Cranbourne to Broome in north-west Western Australia. They will use their large SUV for this trip.
They want to travel via Perth. There are two possible routes to follow.

- One route goes via Carnarvon and along the coast north of Perth, as shown in the first map. The distance going this way is a total of 5820 km.
- The other option is to travel inland from Perth, as shown in the second map. In this case, the total road distance is 5964 km.

a How much further in distance is it to go via the inland route?
b How much quicker is it to go via the coast road?
c Based on the time and distance shown on the GPS map for the trip via the coast road, what is the average travelling speed, in kilometres per hour (km/h)? Round your answer to the nearest 5 km/h.

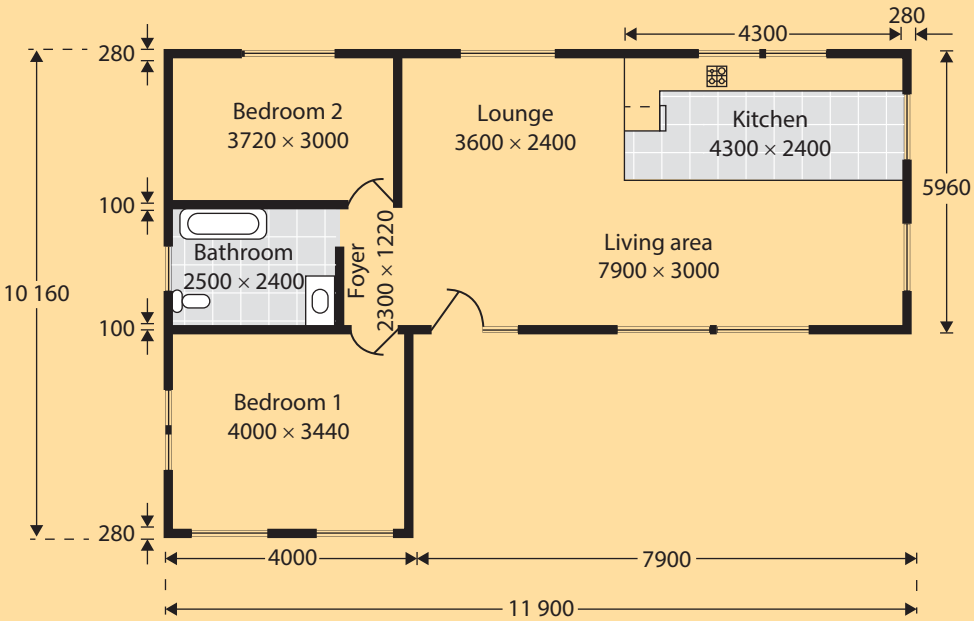
☐ I can use the PTV Journey Planner.

8 Kin lives in Collingwood, not too far from the train station. His class has an excursion to *Scienceworks* next Friday at 9:30 a.m.
a Use the PTV Journey Planner to find the right train/s for him to catch.
b About how long will this journey take?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

I can interpret and calculate using house plans.

9 Use the house plan of this flat to answer the following questions.



All measurements represent millimetres

a List one structural object that is missing from this plan.
b Calculate the area of the flat.
c Calculate the number of building squares, to 2 decimal places.
d If a building square costs $21,000, calculate the cost to build this flat.
e Calculate the cost if all the areas except the bathroom and kitchen are to be carpeted at a cost of $95 per m^2.

I can construct scale drawings by hand.

10 Create scale drawings of the following objects by hand.
a A net of a triangular prism, base 4 cm, height 3.5 cm, depth 6 cm
b A scale drawing with side and top-down views of a rectangular prism, base 7 cm, height 5 cm, depth 4 cm

I can use appropriate software to create scale drawings.

11 Create scale drawings of the following objects using software.
a A cuboid with base 6 cm, height 4 cm, depth 3 cm
b Side and top-down views of a cylinder with radius 2 cm, height 8 cm

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mathematical toolkit

1 Reflect on the range of different calculations, technologies and tools you used throughout this chapter, and how often you used them for undertaking your work and making calculations. Indicate how often you used and worked out results and outcomes for each of these methods and tools.

Method and tools/ applications used	**How often did you use this?**
• Calculating and working in your head, and using algorithms	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using pen-and-paper	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using a calculator	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using a spreadsheet	Not at all: ☐ A little: ☐ Quite a bit: ☐
• Using measuring tools – name the tool, technology or application: _____ _____	Not at all: ☐ A little: ☐ Quite a bit: ☐ Not at all: ☐ A little: ☐ Quite a bit: ☐
• Using other technology or apps – name the technology or application: _____ _____	Not at all: ☐ A little: ☐ Quite a bit: ☐ Not at all: ☐ A little: ☐ Quite a bit: ☐

2 Did this chapter and the activities help you to better understand how you use different tools and technologies in using and applying mathematics in our lives and at work? In what areas and ways? Write down some examples.

3 In one sentence, explain something relating to tools and technologies that you learned in the unit. Write an example of what you learned.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key vocabulary

Here is a list of this chapter's key maths terms and their meanings.

Term	Meaning
Concave	2D shapes that have one interior angle greater than 180° (reflex).
Congruent	2D shapes that are exactly the same size and shape.
Convex	2D shapes that have all interior angles less than 180°.
Degree	A unit for measuring angles where 360° is a full circle and 90° is a right angle etc.
Dilation	A transformation that involves an enlargement or reduction in the size of an image by a set ratio; this creates a *similar* figure.
Elevation	A view from the front, back or sides of an object or building.
Isometric	Drawing with dimensions shown to scale. The horizontal edges are shown at an angle of 30° from the corner.
Net	The 2D plans that when folded make a 3D object. They may include flaps for construction purposes.
Orthogonal	Two-dimensional plans and diagrams drawn to specifications to make accurate three-dimensional objects.
Perspective	An artistic sketch that shows how an object looks in reality. However, a perspective view cannot show accurate dimensions.
Planar	Lying in a plane or 2D surface, e.g. a rectangle is a planar shape.
Reflection	A transformation that involves flipping a shape over a line of reflection, creating a mirror image.
Regular	A regular 2D shape has all sides equal and all angles equal.
Revolution	A unit for measuring angles, e.g. car engines where revolutions per minute (RPM) is a measure of the speed at which the engine is operating.
Rotation	A transformation that involves moving an object in a circular path around a fixed point that may be on or outside the shape.
Similar	Figures with the same shape (angles) but the side lengths show a *dilation*.
Tessellation	Repeated use of shapes without gaps or overlapping to cover a surface.
Three-dimensional (3D)	Objects that have length, width and height.
Translation	A transformation that involves moving each point in a figure the same distance in the same direction.
Two-dimensional (2D)	Shapes that have length and width.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

13 Using and applying measurement skills

Brainstorming activity: Where's the maths?

Using this photo as a stimulus, brainstorm the type of maths we need to know to undertake this task or activity. Think especially about any maths skills related to the content of this chapter on measurement. Prompt questions might be:

- What activities and tasks are being undertaken?
- What types of mathematical content knowledge and skills would be relevant?
- What measurements and calculations would they need to undertake?
- What materials would they need for this job?
- What about costs and charges?
- What about times and schedules?
- What formulas might be needed for any of the above questions?
- What about scales and ratios?
- What different tools, technologies or software might be used?
- What research or investigation questions could be undertaken based on this photo?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter contents

Chapter overview and Spotlight

13A Starting activities

13B Tuning in

13C Measuring

13D Converting units

13E Calculating length and area

13F Calculating volume, capacity and density

13G Measurement error, accuracy, precision and tolerance

Investigations

Chapter review

From the Study Design

In this chapter, you will learn how to:

- use triangles and other polygons to solve problems
- estimate and accurately measure different quantities using appropriate measurement tools using metric and routine non-metric measures
- convert between a range of metric units, including derived and routine non-metric measures
- calculate and interpret area, surface area, volume, capacity and density of routine, including compound, shapes and objects
- calculate and make informal considerations of errors in measurement in relation to specified or appropriate tolerances, accuracy and precision
- (Units 3 and 4, Area of Study 4)

© Victorian Curriculum and Assessment Authority 2022

ISBN 978-1-009-11065-5 Sakurai et al.

© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter overview

Introduction

Measurement is the backbone of many trades and industries. In the building industry, measurement is used by carpenters, builders, surveyors, drafts people, architects, painters, plumbers, electricians, stumpers, bricklayers, tilers, bathroom and kitchen designers and installers, roof tilers, landscape designers, and more!

Each of these trades use measurement in slightly different ways. There are specialised tools and measuring equipment which are needed, from drone technology to laser equipment to digital levels and old-fashioned tape measures and T-squares.

Measurement is used in every industry. Hairdressers measure out chemicals. Fitness coaches measure performance and time. Nurses use measurement to deliver the correct amount of medicines. The automotive industry uses measurement in production and in performance.

But measurements also play an important role throughout our daily life, for example, during a medical check-up, a sports competition, when gardening, when controlling temperature in rooms or on appliances, or while cooking.

In this chapter, we will learn about different types of measurement equipment used in trade and industry, but also at home and in the community. We will practise common measurement calculations and examine the concepts of error, accuracy, precision and tolerance with measurement in industry and how these impact on results.

Learning intentions

By the end of this chapter, you will be able to:

- use a range of measuring equipment to measure accurately
- identify and use appropriate units of measurement
- convert between units of measurement
- use Pythagoras' theorem to calculate lengths of sides and to check if a triangle has a right angle
- calculate lengths, including arc lengths
- calculate the area of simple and compound 2D shapes, including circle sectors
- calculate the total surface area of simple and compound 3D objects
- calculate volume, capacity and density
- understand and identify error, accuracy, precision and tolerance in measurement.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Spotlight: Lockie Gillard

An interview with a carpenter

What is some of the work you do as a carpenter?

My work as a carpenter involves building different aspects of houses. I build the formwork and foundations of houses, such as walls and roof trusses.

What maths do you use regularly in your work?

I use a lot of simple maths like addition, multiplication and division. When building roof trusses, I use angles and rise and run (gradient) calculations to get the roof pitches right. When I have to make sure everything is 'square' and at a right angle I use Pythagoras' theorem, especially the Pythagorean triangles like the 3-4-5 triangle. I also have to read off a lot of drawing plans and interpret them to make my formwork to scale.

How important is measurement to your work?

Very important! If you don't measure things correctly, the pieces won't line up properly and the angles may be incorrect. If your measurements are wrong, you have to go back and cut pieces twice.

What maths-related tools or pieces of technology do you use in your job?

I use a calculator and a tape measure daily. I always carry a square ruler as well as a bevel to make sure all my angle measurements are correct.

What was your attitude towards maths when you were in school? Has your attitude changed over time?

I liked maths in school, and I was quite good at it, and I studied Methods in Year 11. I still really enjoy using maths in my work every day, and it's funny how Pythagoras' theorem ended up being the most useful thing I learned in school!

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

13A Starting activities

Activity 1: Chocolate manufacture

The image shows a manufacturing plant producing chocolate pieces. Think about all the measurements that are taken in a manufacturing plant.

1 Based on the manufacture of chocolate, work with another student to discuss and share your thoughts about these issues.

   a Do you think all chocolate pieces made here would be the same size?

   b How would the manufacturer check the size of the pieces? What sizes would they accept, and which pieces might they reject?

   c If the machine is making chocolate pieces that aren't the desired size, what can the manufacturer do to fix the problem?

2 Research supermarket websites or visit a store and look at the different sizes of chocolate bars and packets or containers. Consider and answer the following questions.

   a What is the range of sizes of chocolate bars and packets available? Is there any consistency?

   b For the same chocolate product, what is the price per piece, or per gram, for each of the different sizes or numbers? Is it always cheaper per unit for the larger size? By what percentage?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

c Many of the brands and types of chocolates available today would have been available when they were sold in the old imperial units of weights, such as in ounces (oz). Research to find out what some of the standard sizes were for chocolates pre-metric and find out what their equivalent metric sizes are today.

Activity 2: A packet of Smarties

To start you need to purchase or find a 50-gram packet of *Smarties* (or a similar sized and shaped lolly or sweet packet).

Do you know the mathematical name we can give to the shape of this packet? (There are some common names too.) The mathematical name is rectangular prism. Can you guess why? A rectangular prism is sometimes called a **cuboid**.

1. Write down the meaning of the two words 'rectangle' and 'prism'. Use a mathematical dictionary to help you if you can't write a description yourself.
2. Now look at the dimensions of the Smarties packet. How many dimensions does the packet have?
3. What units do you think you should use to measure the dimensions of the packet? If you answered centimetres (cm) or millimetres (mm), then you are correct. These are the most appropriate units to use to measure the length of each dimension of a packet this size.
4. How many mm are there in a cm?
5. Measure the dimensions of the packet and write your answers in both mm and cm. You will need to measure the length, width and height.
6. What do you think the volume of the packet is? Estimate this value.
7. Do you remember how to calculate the volume of a rectangular prism? Find a formula you can use to calculate the volume. Calculate the volume for your packet.
8. How close were you to your guess? Pretty close, close, or way off?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

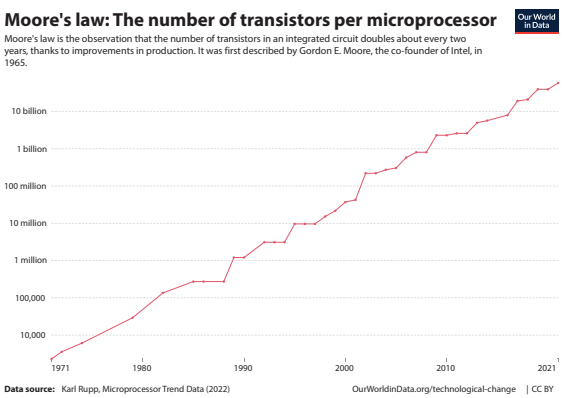
13B Tuning in

Epic Success: Precision engineering

Many of the devices and innovations that we rely on in modern society, such as phones, cars, planes and navigation systems, must be manufactured to the highest levels of precision. For example, the tiniest of imperfections in the engine of a jet plane can cause a fatal catastrophe. The ability to manufacture objects to extremely high levels of accuracy is called 'precision engineering'. Many advanced technology products depend on components being manufactured to tolerances (allowable differences) in the micrometre or even nanometre range.

Manufacturing on a very small scale is important for computer components. The performance of computers is related to the number of transistors that can fit onto a computer microprocessor (called a chip). An early manufacturer, Gordon Moore, predicted that the number of transistors that could be manufactured to fit onto a chip will double every two years. In 1971, the number of transistors per microprocessor was approximately 2300.

In 2021, it was 58.2 billion.



Discussion questions

1 Do you think that this trend in the number of transistors will continue?

2 Research the metric prefixes that make the base unit of a metre smaller for measuring very small linear dimensions of length.

- **a** What are all the prefixes that make the unit smaller?
- **b** What are they as fractions or as powers of 10?
- **c** Research and find applications of what they are used to measure.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Estimating measurements

In real life we often estimate instead of measure. In other contexts, especially work related, it is expected that you will estimate **before** you measure so that you can check if your measurement is correct or not.

An example of this is how much weight you might put in a shopping bag or your backpack so that you can carry it without breaking the bag (or injuring yourself).

Estimating isn't guessing, but using your knowledge and experience to make a judgment.

Example 1 Estimating measurements

Estimate a measurement for each of these scenarios. Include appropriate units.

a The weight of a full school bag

b The quantity of water in a drink bottle

THINKING	WORKING
STEP 1	
Think of a known weight that you are familiar with and use it to estimate the weight of a full school bag.	**a** A laptop weighs around 1.5 kg to 2 kg and a school bag could probably carry 3 or 4 of them. So an estimate of the weight of a school bag is about 5 to 7 kg.
STEP 2	
Think of a known measurement of a liquid you are familiar with. Compare this to the unknown measurement of water in a drink bottle.	**b** A bottle of soft drink contains about 600 mL of liquid. A drink bottle could be about the same size or a little bigger than the soft drink bottle. So, an estimate of the amount of water in a drink bottle could be 600 mL to 750 mL.

Practice questions

1 For each of the items listed below:

i estimate the measurement of the item, using the appropriate units

ii measure (or research) to determine the actual measurement.

a Length of a serving spoon

b Area of a laptop computer screen

c Weight of an apple

d Amount of water in a full bucket

e Temperature of water from a drinking tap

f Time it takes to walk to the school office

g Height of a door

h Width of a hair

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

13C Measuring

Measurement plays a pivotal role in our daily lives, both at home and in the workplace. Formally, measurement is the process of assigning a numerical value to an object or event; in other words, in determining how large or small a quantity is. The ability to accurately and precisely measure is critical to fields of science, engineering, technology and trades – but also in our daily lives.

Let's look at some examples that impact on us personally or as citizens.

When you're unwell, precise measurement of medication is essential. Taking too little or too much can impact its effectiveness.

In the kitchen, measurements are important too. Whether it's a pinch of salt or a cup of flour, accurate measurements ensure your recipes turn out just right.

Sports involve measurement ability and sense. Whether throwing a javelin, timing for races on foot or by bike, or in lifting weights, or in the dimensions of playing fields or swimming pools, measurement matters.

Please refer back to Chapters 10 and 11 of the Units 1 & 2 textbook if you need further information or practice relating to measurement.

Standard units of measurement

Australia, like most of the world, uses standard units of measurement (SI units). SI stands for *Systeme Internationale* from its French origins in the metric system, which is all based around powers of 10 relationships.

There are seven SI base units.

1. Length – metre (m)
2. Time – second (s)
3. Amount of substance – mole (mole)
4. Electric current – ampere (A)
5. Temperature – kelvin (K)
6. Luminous intensity – candela (cd)
7. Mass – kilogram (kg)

Our focus in this chapter will be on the common aspects of measurement that we use in our daily lives or that are often used at different workplaces.

Activity

1. Some terms for measures can be confusing. Research the meaning of 'volume' and 'capacity' and explain the difference between them.
2. We often use the words 'mass' and 'weight' interchangeably in our everyday lives. Research the meaning of each term and explain the difference between them.
3. Share and discuss your findings as a class.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Measuring length

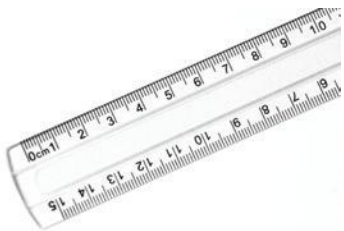
One of the most important measurements a tradesperson, designer or engineer can make is length. Incorrect measurements of length can result in misaligned or faulty constructions and products, or costly waste of materials. The message 'Measure twice, cut once' is a truism for tradespeople.

Some of the common tools used for measuring length are shown below.

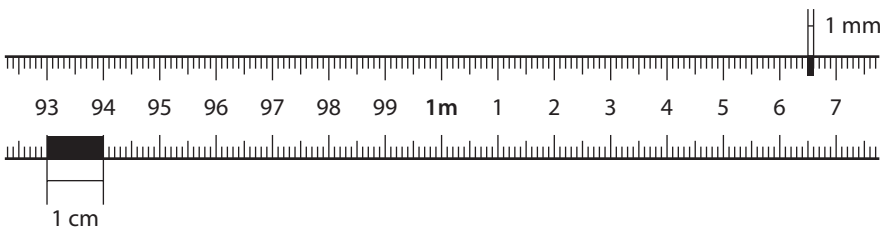
Tape measure

Laser measure

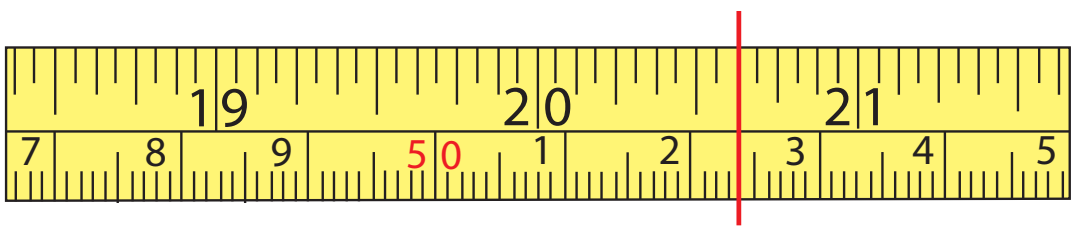
Ruler



The markings on a tape measure or ruler can vary but the most common ones show millimetres (mm) and centimetres (cm), and if longer, will also show metres. Here is part of a tape measure showing cm and mm as a reminder.



Some older or trades tape measures could look similar to the one below. This shows both imperial units of length (inches) and metric units of length (mm and cm).



On this tape, the numbers across the top represent inches and each small marking between the inches are $\frac{1}{16}$ of an inch. Along the bottom of the tape, the number in red represents the number of centimetres along the tape and the black numbers represent the centimetres between every ten centimetres. Each small marking between the centimetres are millimetres.

The line shown in the diagram marks a length of $20\frac{10}{16}$ or $20\frac{5}{8}$ inches, which is the same as 52.4 cm or 524 mm.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Measuring capacity

Capacity is the amount of fluid which a container can hold. We use 'capacity' for the volume of fluids. Chefs, chemists, nurses and engineers are just some of the occupations that need to measure capacity.

Some tools used for measuring capacity are shown below.

Jug

Measuring cup

Measuring cylinder

Measuring time

When we say that we are measuring time what we are actually doing is measuring the duration of time between two events.

Common tools used to measure the duration of time are shown below.

Digital stopwatch

Digital clock

Analogue clock

When using clocks to measure the duration, the start time and end time are recorded and the change in time is calculated by subtraction.

Example 2 Calculating duration of time

Calculate the time that has passed (duration of time) between the time shown on the first clock to the time shown on the second clock. Assume they are both showing a.m. times on the same day.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

THINKING	WORKING
STEP 1	
Determine the time on the first clock.	First clock: The large hand is past the 4 so the hour is 4. The small hand is on the 8 so the number of minutes is 40. The time is 4:40 am.
STEP 2	
Determine the time on the second clock.	Second clock: The large hand is past the 10 so the hour is 10. The small hand is on the 6 so the number of minutes is 30. The time is 6:30 am.
STEP 3	
Determine the duration of time. This can be calculated in steps.	4:40 – 5:00 = 20 minutes 5:00 – 6:00 = 1 hour 6:00 – 6:30 = 30 minutes Total time = 1 hour 50 minutes The time that has passed is 1 hour 50 minutes.

Measuring weight

Scales are used to measure the weight, sometimes referred to as the mass, of an object.

Digital scales

Analogue scales

When using digital scales, the **Tare** button can be used to reset the scale to zero. Here is an illustration of a Tare button on a digital set of scales. The image on the left shows the Tare button being used to set the scale to 0.00 grams, before weighing the amount of the ingredients, shown in the image on the right.

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

13C Tasks and questions

Thinking task

1 There are some amazing phone/tablet applications (apps) that can take measurements by using the camera of a phone. Download a measurement app, for example, *AR Ruler*, *Measure* or *Moasure* onto a smartphone or tablet.

a First, measure the length and width of your exercise book with the app and then with your ruler. How do the two sets of measurements compare?

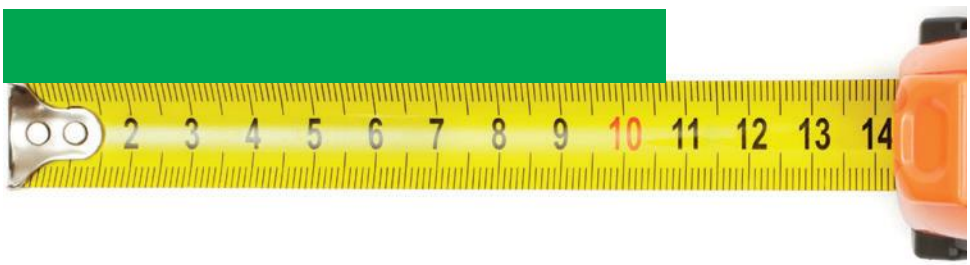
b Estimate the area of the floor in your classroom. Measure the length and width of the wall with the measurement app. Use your measurements to calculate the area of the floor. How close was your estimate?

c Explore the school grounds and take measurements of features you see; for example, the height of the basketball ring, the height of the school building, the distance from one side of the school to the other. Are there any limitations to using the measurement app? Can it measure all of these distances?

Skills questions

2 Read the quantities indicated by these measuring scales.

a



b

c

d

e

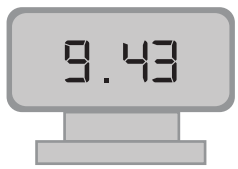
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3 Calculate the time that has passed (duration of time) between the time shown on the first clock to the time shown on the second clock. Assume they are both showing p.m. times on the same day.

a

b

c



4 For each of the following items, estimate the measurement and name the unit you used. Then undertake the actual measurement, stating the tool or app you would use. Also state how close you were in your estimate: very close, close or way off.

Item and measure	Estimate and unit used	Measurement tool or app	Actual measurement	Estimate: close or not?
a Width of the nearest corridor or hallway				
b Capacity of a large drinking glass				
c Weight of a pen				
d Temperature of a drink in a fridge				

5 The dosa[illegible] How could the follow[illegible]

ISBN 978-1-009-11065-5
[illegible]ersity Press & Assessment 2025
Photocopying is restricted und[illegible]er party.

Mixed practice

6 For each of the following, state what quantity is being measured, and the measurement with its appropriate unit.

a

b

c

d

Mathematical literacy

7 A scientific laboratory uses many different pieces of equipment to measure things. Examples of industries or institutions that have scientific labs include pharmaceutical companies, healthcare and clinical laboratories, chemical and petrochemical industries, food and beverage industry, and agricultural research. Conduct research to find and name some different measurement tools that can be found in a science lab, what they measure and the units they use.

Application tasks

8 Find these common items in your house (or online) to undertake some measurements. State what quantity is being measured, the unit being used, and its measurement value.

a Hair shampoo **b** Pet food **c** TV screen

d Kitchen kettle **e** Carpet rug **f** Height of front door

9 Find two different recipes you like online. Answer the following questions about each one or about them together.

a For each recipe, state what different measurements and quantities are used.

b What units are being used and what is the range of values for each?

c For each measure, what measuring instrument or tool would you use to make the measurements?

d Are they all standard SI units or are there variations? Or do some use non-standard metric units. If so, what are they?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

13D Converting units

If you search and find a recipe from the USA, you might find that the quantities of some ingredients listed in units such as ounces, pounds or even pints. You therefore might have to convert these measurements to equivalent metric units such as grams and litres or millilitres.

In building and construction or in engineering or manufacturing industries, there may also be non-metric units in use, especially if importing, exporting or purchasing goods, products or plans from the USA. For example, drill bits may still be stated as fractions of inches, as may the plans or diagrams for creating the items. We have to be able to convert between these different units to make sure that we are using the appropriate equivalent-sized hole or drill bit for the job that we are doing.

Before changing to the metric system in the late 1960s, Australia used the imperial system of measurement. Some of the common units used in the imperial system included inches, feet, yards, miles, pounds, gallons, tons and fluid ounces.

In this section, we will focus on conversions between metric units and non-metric (imperial) measurements. Please refer back to Chapter 11 of the Units 1 & 2 textbook if you need further practice.

Converting units of length

The SI standard unit of length is the metre. But what if we had to write down the distance to the moon or the width of a hair? Would metres be the best unit to use?

We use prefixes (letters written before the unit) to represent smaller fractions or larger multiples of the standard unit. Below are some of the most commonly used prefixes.

M	mega	× 1 000 000	× 10^{6}	million
k	kilo	× 1000	× 10^{3}	thousand
c	centi	÷ 100	× 10^{-2}	hundredth
m	milli	÷ 1000	× 10^{-3}	thousandth
μ	micro	÷ 1 000 000	× 10^{-6}	millionth
n	nano	÷ 1 000 000 000	× 10^{-9}	billionth
p	pico	÷ 1 000 000 000 000	× 10^{-12}	million millionth

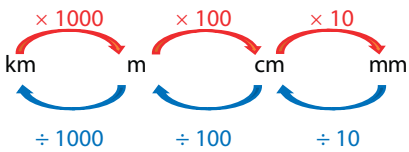
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

The main metric units of length are related as follows:

- 1 kilometre (km) = 1000 metres (m)
- 1 metre (m) = 100 centimetres (cm)
- 1 centimetre (cm) = 10 millimetres (mm)
- 1 metre (m) = 1000 millimetres (mm)

An important strategy when undertaking any conversion is to:

- multiply when converting from a **bigger to a smaller** unit (you get more of the smaller units)
- divide when converting from a **smaller to a bigger** unit (you get fewer of the smaller units)



For example, to convert 450 cm to m, we divide by 100.

450 cm = (450 ÷ 100) m = 4.5 m

Imperial units for length

Although in Australia the metric system is the accepted system for measuring length, there are still examples of the imperial units for length being used, such as for people's heights or the length of a cricket pitch (22 yards).

The table below shows some common imperial units for length and their conversions to other imperial units and to metric units.

Note: The inch and foot units may be written with single and double quotation marks as their abbreviations, e.g. 12 feet and 3 inches can be written as 12'3".

Unit	Imperial	Metric
1 inch (in,")		2.54 cm
1 foot (ft,')	12 in	0.3048 m
1 yard (yd)	3 ft	0.9144 m
1 mile (mi)	1760 yd	1.6093 km

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 3 Converting between imperial and metric units of length

Monique wants to be as tall as her favourite basketball player who is 6'5". What is this height in cm?

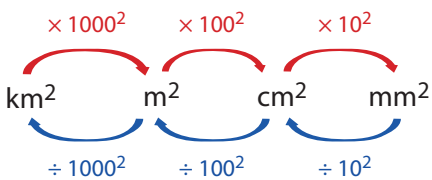
THINKING	WORKING
STEP 1	
Identify the height in imperial units of length.	6'5" = 6 feet 5 inches
STEP 2	
Convert each imperial unit separately to cm. Alternatively, convert 6 feet 5 inches to inches ($6 \times 12 + 5 = 77$ inches) and then convert to cm ($77 \times 2.54 = 195.58$ cm).	6 feet = (6×0.3048) m $= 1.8288$ m $= (1.8288 \times 100)$ cm $= 182.88$ cm 5 inches = (5×2.54) cm $= 12.7$ cm
Find the height in cm by adding the two separate lengths. Round to the nearest cm.	$182.88 + 12.7 = 195.58$ cm The height of the basketball player is 196 cm to the nearest cm.

Converting units of area

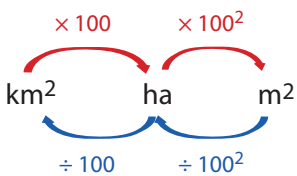
Area is calculated by multiplying one dimension by another. For example, the area of a rectangle is found by using the formula: Area = length × width

The units are squared; for example, metres squared or square metres (m^2).

To convert units of area you need to convert the length twice, once for each dimension.



Another unit of area, commonly used for measuring land area, is called the **hectare** which is the area of a square 100 m × 100 m. It is 'just the right size' for land areas, as square metres is often 'too small' a unit and square kilometres is 'too big'.



1 hectare (ha) = 10 000 m^2

Imperial unit for area

The imperial unit most commonly used for the area of land is the **acre**. The table shows its conversion to other imperial and metric units.

Unit	Imperial	Metric
1 acre (ac)	43 560 ft^2	0.405 hectare

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 4 Converting units of area

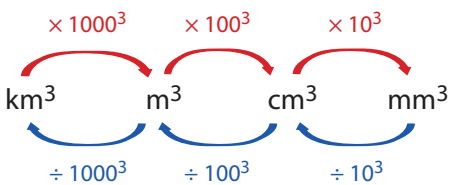
The dimensions of a field on a farm are 87.5 m by 234 m. How many hectares is this?

THINKING	WORKING
STEP 1	
To calculate the area, use the formula: Area = length × width	Area = length × width = 234 m × 87.5 m = 20 475 m^2
STEP 2	
Convert square metres to hectares by dividing by 100^2.	20 475 m^2 = (20 475 ÷ 100^2) ha = (20 475 ÷ 10 000) ha = 2.0475 ha
STEP 3	
Write your answer.	The area of the farm is about 2 hectares.

Converting units of volume

With area, we are multiplying two dimensions. Similarly for volume, we are multiplying three dimensions, so our units are cubed; for example, m^3.

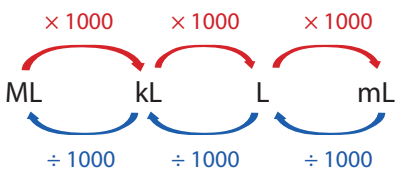
To convert units of volume you need to convert the length three times, once for each dimension.



Converting units of capacity (liquid volume)

The main metric units of capacity are related as follows:

- 1 Megalitre (ML) = 1000 kilolitres (kL)
- 1 kilolitre (kL) = 1000 litres (L)
- 1 litre (L) = 1000 millilitres (mL)



Sometimes it is necessary to calculate an object's volume in order to determine its capacity to contain fluids. The following conversions are used.

- 1 millilitre (mL) = 1 cubic centimetre (cm^3)
- 1 litre (L) = 1000 cubic centimetre (cm^3)
- 1 kilolitre (kL) = 1000 litres (L) = 1 cubic metre (m^3)

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 5 Converting between volume and capacity

An ice cream carton has a volume of 525 cm^3. What is its capacity in litres?

THINKING	WORKING
STEP 1	
Convert cm^3 to mL. (1 cm^3 = 1 mL)	525 cm^3 = 525 mL
STEP 2	
Convert mL to L by dividing by 1000.	525 mL = (525 ÷ 1000) L = 0.525 L
STEP 3	
Write your answer.	The capacity of the carton is 0.525 litres.

Imperial units for capacity

The table shows some common imperial units for capacity and their conversions to other imperial units and to metric units.

Note that the conversions listed are for units in the United States.

Unit	Imperial	Metric
1 fluid ounce (fl oz)		29.574 mL
1 cup (US measurement)	8 fl oz	236.588 mL
1 pint (pt)	2 cups	473.176 mL
1 quart (qt)	2 pt	946.353 mL
1 gallon (gal)	4 qt	3.785 L

Example 6 Converting between metric and imperial units of capacity

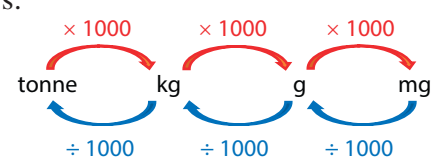
A US recipe for butter cookies requires 2 cups of butter and 3 fluid ounces of water. Convert these measurements to millilitres.

THINKING	WORKING
STEP 1	
Convert cups to millilitres. (1 cup = 236.588 mL)	2 cups = (2 × 236.588) mL = 473.176 mL
Convert fluid ounces to millilitres. (1 fl oz = 29.574 mL)	3 fl oz = (3 × 29.574) mL = 88.722 mL
Write your answer.	The recipe requires 473 mL of butter and 89 mL of water.

Converting units of mass (weight)

The main metric units of mass are related as follows:

- 1 tonne (t) = 1000 kilograms (kg)
- 1 kilogram (kg) = 1000 grams (g)
- 1 gram (g) = 1000 milligrams (mg)



ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Imperial units of mass

The table below shows some common imperial units for mass and their conversions to other imperial units and to metric units.

Unit	Imperial	Metric
1 ounce (oz)		28 g
1 pound (lb)	16 oz	453.6 g
1 stone (st)	14 lb	6.35 kg

For example, to convert half a pound of sugar to grams, we multiply by 453.6 and round to the nearest gram.

$$\frac{1}{2}\text{ lb} = \left(\frac{1}{2} \times 453.6\right)\text{ g} = 226.8\text{ g}$$

Half a pound of sugar is equivalent to 227 grams.

Converting units of time

For historical reasons a non-metric system is used for time. The main units for time are:

- 1 week = 7 days (d)
- 1 day (d) = 24 hours (h)
- 1 hour (h) = 60 minutes (min)
- 1 min (min) = 60 seconds (s)
- 1 second (s) = 1000 milliseconds (ms)

Example 7 Converting units of time

Bec's smartwatch tells her that she slept for 385 minutes last night. Write this time in hours and minutes.

THINKING	WORKING
STEP 1	
Determine the number of hours by dividing the number of minutes by 60.	385 minutes = (385 ÷ 60) hours = 6.4166 … hours There are 6 whole hours in 385 minutes.
STEP 2	
Determine the number of minutes in 6 hours by multiplying by 60.	6 hours = (6 × 60) minutes = 360 minutes
STEP 3	
Determine the number of minutes left over after 6 hours.	Number of minutes more than 6 hours = 385 – 360 = 25
STEP 4	
Write your answer.	Bec slept for 6 hours 25 minutes.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Converting units of temperature

Converting between the imperial unit of temperature, degrees Fahrenheit (°F), and the metric unit of temperature, degrees Celsius (°C), is a little more complicated than other units. Fahrenheit and Celsius are named after the scientists who worked in this area of physics.

Using C to represent the temperature in degrees Celsius and F to represent the temperature in degrees Fahrenheit, the following formulas can be used to convert between the two units.

$$C = \frac{5}{9}(F - 32)$$

$$F = \frac{9}{5}C + 32$$

You may recognise that the two formulas are equivalent – one has been algebraically transposed to become the other.

Temperature is measured using a thermometer – often an analogue one that shows both degrees Fahrenheit (°**F**) and degrees Celsius (°**C**). Or they may be digital, where you can select the measurement unit you need.

Example 8 Converting units of temperature

Aditya is planning a holiday in the USA and checks to see how hot the temperature is likely to be. The most recent maximum temperature in Los Angeles was 95°F. What is this temperature in degrees Celsius?

THINKING	WORKING
STEP 1 Convert 95°F to °C using the conversion formula. Substitute 95 for F to calculate C.	$C = \frac{5}{9}(F - 32)$ $= \frac{5}{9}(95 - 32)$ $= \frac{5}{9} \times 63$ $= 35$
STEP 2 Write your answer.	The temperature of 95°F is equivalent to a temperature of 35°C.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

13D Tasks and questions

Thinking task

1 Is a dollar a unit of measurement? Why or why not? Share and compare your thinking with your classmates.

Skills questions

Where appropriate, round answers to 1 decimal place.

2 What would be the appropriate unit of length to use for these measurements?

a Length of a bridge
b Distance from Melbourne to Sydney
c Length of a pencil
d Length of an ant

3 Convert each length measurement to the unit shown in the brackets.

a 2.5 m (cm)
b 5 miles (km)
c 12 in (cm)
d 100 m (yd)
e 6 ft (m)
f 1.75 m (mm)

4 Convert each area measurement to the unit shown in the brackets.

a 5 m^2 (cm^2)
b 15 ha (m^2)
c 25.5 mm^2 (cm^2)
d 1.2 km^2 (m^2)
e 54.5 acres (ha)
f 280 ha (km^2)

5 Convert each volume and capacity measurement to the unit shown in the brackets.

a 1.2 m^3 (mm^3)
b 250 cm^3 (m^3)
c 1200 m^3 (kL)
d 7.5 cm^3 (mm^3)
e 600 mL (cm^3)
f 500 fl oz (mL)

6 Convert each mass (weight) measurement to the unit shown in the brackets.

a 65 kg (g)
b 1200 mg (kg)
c 298 lb (kg)
d 650 g (mg)
e 125 oz (g)
f 11 stone (kg)

7 Convert each time measurement to the unit shown in the brackets.

a 1.5 hours (min)
b 16 min (s)
c 5 s (min)
d 1 h 15 min (min)
e 144 h (day)
f 6480 s (h)

8 Convert each temperature measurement to the unit shown in the brackets.

a 40°C (°F)
b 50°F (°C)
c 30°C (°F)

Mixed practice

9 Convert each measurement to the unit shown in the brackets.

a 2.34 m (mm)
b 250 g (lb)
c 3.2 km (m)
d 125 lb (kg)
e 1500 m (mi)
f 2 ha (m^2)
g 20 min (s)
h 5'6" (m)
i 2.5 t (kg)
j 32 400 L (ML)
k 2 days 6 h (min)
l 78°F (°C)

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Application tasks

10 Alexandria has been given a recipe from a friend in America for mixing her own clay to make pottery.

It includes these ingredients:

- 2.5 pounds of ball clay
- 1.5 pounds of grog (coarse sand or fired clay that has been crushed into small pieces)
- 2.0 pounds of kaolin (a type of fine-grained white clay).

Convert the measurement for each ingredient into kilograms.

11 Research the official imperial lengths of the playing pitch and the cricket stumps for cricket. Find each of the following measurements in their original units and then convert them to metric units.

a Length of the pitch from stumps to stumps

b Width across the pitch

c Height of a stump

d Width across the three stumps

12 Allegra is a furniture maker and often purchases plans for constructing her pieces from America. These plans give instructions for the size of the holes to be drilled, or the recommended drill bit sizes in American imperial units; that is, in fractional inches.

However, Allegra only has sets of metric drill bits. Allegra needs to know which sized bits of hers are the closest to the fractional inches specified. Standard metric drill bits are available in widths starting from 1.0 mm and increase in 0.5 mm widths.

A plan she has just purchased has the following imperial sizes for drill bits that she needs to use. For each one, convert to the nearest metric-sized drill bit in millimetres.

a $\frac{1}{4}$ inch **b** $\frac{1}{16}$ inch **c** $\frac{3}{8}$ inch **d** $\frac{5}{16}$ inch **e** $\frac{17}{32}$ inch

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

13E Calculating length and area

In many trades, such as building and construction, painting, carpet laying, gardening and horticulture, being able to measure and calculate different lengths and understand and use perimeter and area is an important skill.

It is also important to be able to calculate area accurately. If a mistake is made when new flooring or carpet is laid in your home, you could end up paying more money on materials than you should have, or not having enough materials to get the job done.

Hence, the ability to estimate and measure accurately and work out the required lengths, perimeters and areas is critical – at home and at work.

Pythagoras' theorem

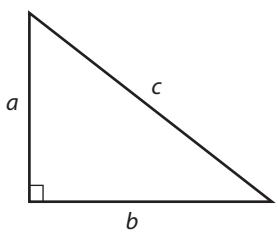
You will have met Pythagoras' theorem before. It is instrumental in enabling people like architects, engineers and builders to calculate lengths and ensure accurate measurements when constructing buildings, bridges and other structures. Sometimes you need to use and apply Pythagoras' theorem in order to work out lengths, perimeters and areas.

Some of the real-life applications of using Pythagoras' theorem include:

- finding the unknown side length of a right-angled triangle (for example, to calculate the length of a supporting strut in a building)
- checking that an angle is a right angle (for example, checking that walls are built at right angles to the floor to ensure strength and stability).

If we call the lengths of the two shortest sides a and b, and the length of the longest side c, in a right-angled triangle, then Pythagoras' theorem can be written as:

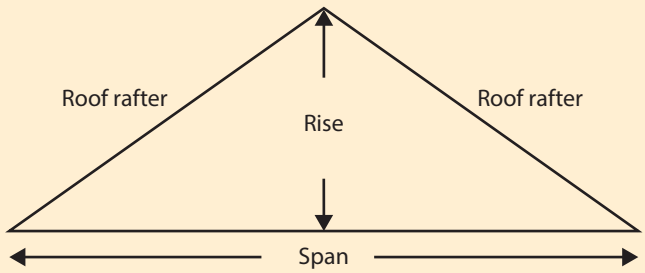
$$c^2 = a^2 + b^2$$



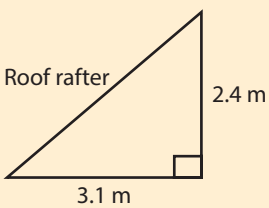
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 9 Using Pythagoras' theorem to calculate an unknown length

Carpenters need to work out the lengths of roof rafters. If they know the rise and the span, they can use Pythagoras' theorem to calculate the length of a roof rafter.



Calculate the length of each roof rafter (to 1 decimal place) for a space that has a rise of 2.4 m and a span of 6.2 m.

THINKING	WORKING
STEP 1 Identify a right-angled triangle.	
STEP 2 Identify the values for a, b and c, ensuring that c relates to the longest side.	$a = 2.4$, $b = 3.1$, $c = ?$
STEP 3 Substitute the known values into the formula for Pythagoras' theorem.	$c^2 = a^2 + b^2$ $= 2.4^2 + 3.1^2$
STEP 4 Solve for c by taking the square root of each side.	$c = \sqrt{2.4^2 + 3.2^2}$ $= 3.9204...$
STEP 5 Write your answer.	The length of each roof rafter is 3.9 m (to 1 decimal place).

Note the effect of the rounding here from 392 cm to 390 cm. That extra 2 cm might actually be important up on the roof, so always be thoughtful about rounding.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Calculating perimeter

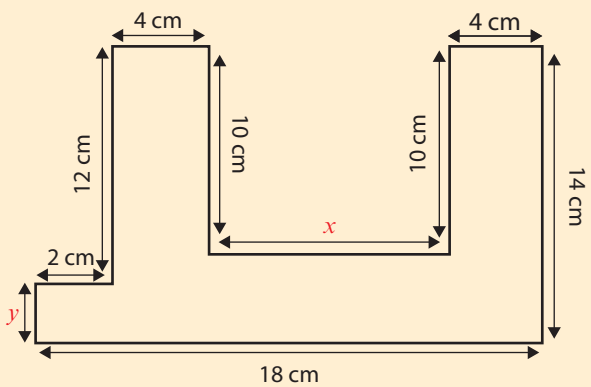
The perimeter of a shape is the total of the lengths of its sides. This requires converting the units so that they are all the same, and sometimes it involves using our knowledge of geometry to calculate any unknown lengths before we can calculate the perimeter of the shape.

Compound shapes

Compound shapes are made by combining multiple different shapes. They can also be called composite shapes as they are composed of different shapes. Tradespeople, such as landscapers, concreters, tilers and carpet layers, often need to deal with compound shapes to work with irregular shapes and sizes.

Example 10 Calculating the perimeter of a compound shape

Calculate the missing lengths and then calculate the perimeter of this shape.



THINKING	WORKING
STEP 1	
Calculate the missing length of the horizontal line labelled with x.	Missing length x: $18 - 2 - 4 - 4 = 8$ cm
STEP 2	
Calculate the missing length of the vertical line labelled with y.	Missing length y: $14 - 12 = 2$ cm
STEP 3	
Calculate the perimeter by adding all the side lengths of the shape.	$P = 18 + 2 + 2 + 12 + 4 + 10 + 8 + 10 + 4 + 14$ $= 84$ cm
STEP 4	
Write your answer.	The perimeter of the shape is 84 cm.

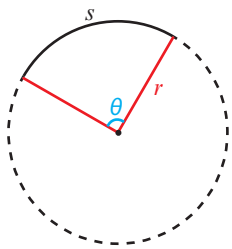
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Calculating the length of a circle arc

The formula for calculating the perimeter (commonly called the circumference) of a circle is:

$$C = 2\pi r$$

We know that a full circle has an angle at its centre of 360 degrees (360°). To calculate the length of an arc (s), we need to know the radius of the circle (r), and the angle at the centre of the circle in degrees ($\theta°$) that forms the arc.



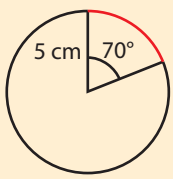
The length of an arc is a fraction $\left(\frac{\theta°}{360}\right)$ of the circumference of a circle.

The formula for calculating the length of an arc is:

$$s = 2\pi r \times \frac{\theta°}{360}$$

Example 11 Calculating the length of an arc

Calculate the length of an arc of a circle where the radius is 5 cm and the angle at the centre of the circle is 70°. Give your answer correct to 2 decimal places and include the unit.

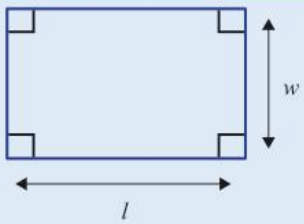
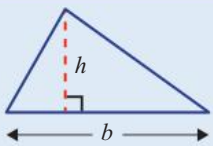
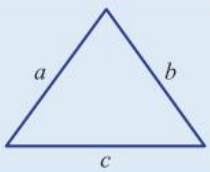
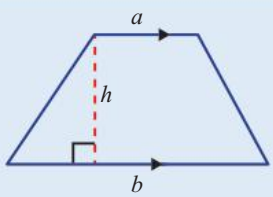
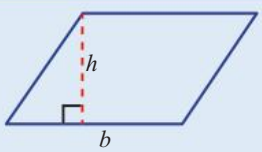
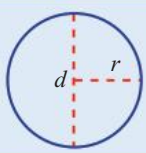
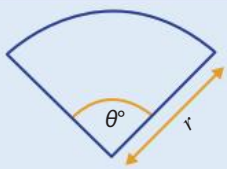
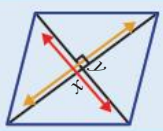


THINKING	WORKING
STEP 1	
Write the formula to calculate the length of the arc and list the known values.	$s = 2\pi r \times \frac{\theta°}{360}$ $r = 5, \theta° = 70$
STEP 2	
Substitute the known values into the formula and evaluate.	$s = 2 \times \pi \times 5 \times \frac{70}{360}$ $= 6.1086\ldots$
STEP 3	
Write your answer, correct to 2 decimal places.	The length of the arc is 6.11 cm (to 2 decimal places).

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Calculating area

Some of the key formulas used to calculate the area of 2D shapes are shown below.

Name	Shape	Area formula
Rectangle		$A = lw$
Triangle		$A = \frac{1}{2}bh$
Triangle (Heron's formula)		$A = \sqrt{s(s-a)(s-b)(s-c)}$ where $s = \frac{a+b+c}{2}$
Trapezium		$A = \frac{1}{2}(a+b)h$
Parallelogram		$A = bh$
Circle		$A = \pi r^2$
Circle sector		$A = \pi r^2 \times \frac{\theta^\circ}{360}$
Kite (rhombus)		$A = \frac{1}{2}xy$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Heron's formula

Heron's formula, named after the Greek mathematician Heron of Alexandria, calculates the area of a triangle when we are given the lengths of the three sides.

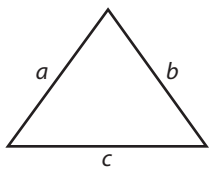
To use Heron's formula for a triangle with side lengths a, b and c:

1 Calculate s, the semi-perimeter (half the perimeter)

$$s = \frac{a+b+c}{2}$$

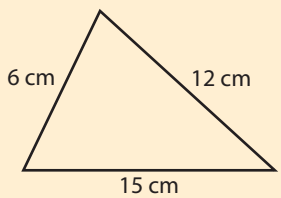
2 Substitute for s, a, b and c in the area formula

$$A = \sqrt{s(s-a)(s-b)(s-c)}$$



Example 12 Calculating the area of a triangle using Heron's formula

Calculate the area of the triangle, correct to 1 decimal place.



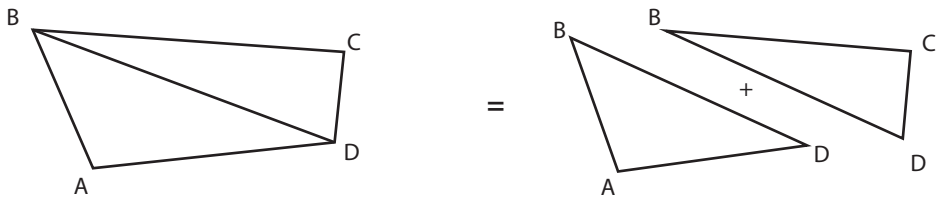
THINKING	WORKING
STEP 1	
Identify values for a, b and c. (The order does not matter.)	$a = 6$, $b = 12$, $c = 15$
STEP 2	
Calculate the semi-perimeter, s, by substituting the values for a, b and c into the appropriate formula.	$s = \frac{a+b+c}{2}$ $= \frac{6+12+15}{2}$ $= 16.5$
STEP 3	
Substitute values for s, a, b and c into Heron's formula and then evaluate to calculate the area. Use a smartphone in landscape orientation to find the $\sqrt{\ }$ key.	$A = \sqrt{s(s-a)(s-b)(s-c)}$ $= \sqrt{16.5 \times (16.5-6) \times (16.5-12) \times (16.5-15)}$ $= \sqrt{16.5 \times 10.5 \times 4.5 \times 1.5}$ $= 34.1970\ldots$
STEP 4	
Write your answer, correct to 1 decimal place.	The area of the triangle is 34.2 cm^2 (to 1 decimal place).

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Calculating the area of an irregular quadrilateral

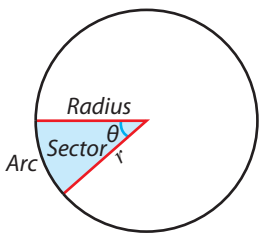
Heron's formula may also be used to calculate the area of an irregular quadrilateral if we know the lengths of each side and the length of one diagonal.

The irregular quadrilateral can be split into two triangles along the diagonal and the areas of the two triangles calculated using Heron's formula, then added together.



Calculating the area of a circle sector

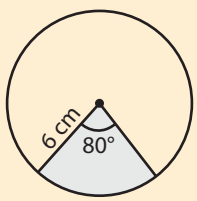
We know that to calculate the area of a circle, we use the formula $A = \pi r^2$. A sector is part of a circle – so to calculate its area we need to know the radius and the angle the sector forms at the centre of the circle.



$$A = \pi r^2 \times \frac{\theta^\circ}{360}$$

Example 13 Calculating the area of a sector

Calculate the area of the sector, correct to 1 decimal place.



THINKING	WORKING
STEP 1	
Write the formula to calculate the area of a sector and list the known values.	$A = \pi r^2 \times \frac{\theta^\circ}{360}$ where $r = 6$, $\theta^\circ = 80$
STEP 2	
Substitute the known values into the formula and then evaluate.	$A = \pi \times 6^2 \times \frac{80}{360}$ $= 25.1327\ldots$
STEP 3	
Write your answer, correct to 1 decimal place.	The area of the sector is 25.1 cm^2 (to 1 decimal place).

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

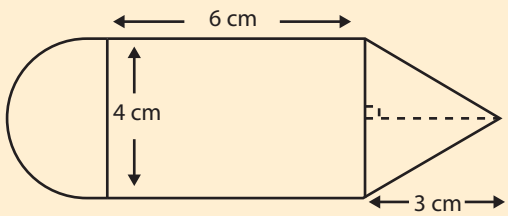
Areas of compound shapes

To calculate the area of compound shapes:

1. Identify the basic shapes that make up the compound shape.
2. Calculate the area of each basic shape.
3. Add or subtract the areas to calculate the area of the compound shape.

Example 14 Calculating the area of a compound shape

Calculate the area of the shape in cm^2, correct to 1 decimal place.



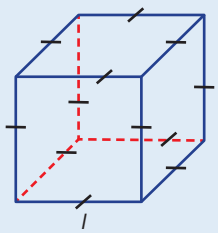
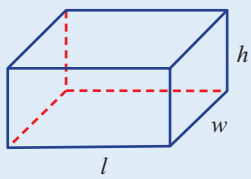
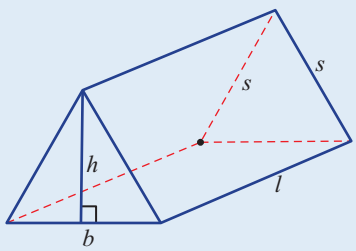
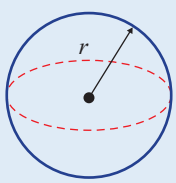
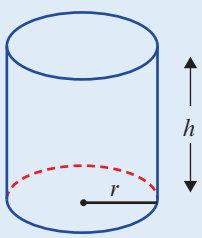
THINKING	WORKING
STEP 1	
Identify the basic shapes in the compound shape.	The compound shape is made up of a semicircle, a rectangle and a triangle.
STEP 2	
Calculate the area of each basic shape, correct to 3 decimal places where appropriate (to ensure the final answer is correct to 1 decimal place).	Area of semicircle $= \frac{1}{2}\pi r^2$ where $r = \frac{1}{2} \times 4 = 2$ cm $= \frac{1}{2} \times \pi \times 2^2$ $= 6.283$ cm^2 (to 3 decimal places) Area of rectangle $= lw$ where $l = 6$ cm, $w = 4$ cm $= 6 \times 4$ $= 24$ cm^2 Area of triangle $= \frac{1}{2}bh$ where $b = 4$ cm, $h = 3$ cm $= \frac{1}{2} \times 4 \times 3$ $= 6$ cm^2
STEP 3	
Add the areas of the basic shapes and write your answer, correct to 1 decimal place.	Total area $= 6.283 + 24 + 6$ $= 36.283$ cm^2 The area of the shape is 36.3 cm^2 (to 1 decimal place).

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Total surface area

The total surface area (TSA) of a three-dimensional object can be calculated by adding the area of each of its separate surfaces.

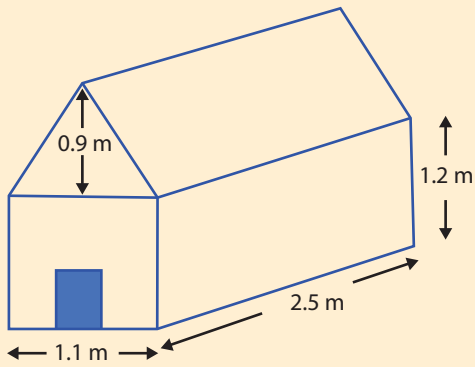
Note: Each **prism** shown here is an object where the two ends are the same size, and the sides are rectangles. A cube could also be called a square prism.

Name	Shape	Total surface area formula
Cube		There are six square surfaces. TSA = $6l^2$
Rectangular prism		There are six rectangular surfaces. TSA = $2(lh + lw + wh)$
Triangular prism		There are two triangular surfaces and three rectangular surfaces. TSA = $bh + 2ls + lb$
Sphere		The surface is all curved. TSA = $4\pi r^2$
Cylinder		There are two circles and one curved surface (or wrapped rectangle). TSA = $2\pi r^2 + 2\pi rh$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 15 Calculating the total surface area of a compound 3D object

Silvy is planning to paint the cubby house in the backyard. Only the outside of the front, back and side walls (including the door) are to be painted (not the roof or floor).
To determine how much paint is needed, calculate the total surface area of the surfaces to be painted, correct to the nearest square metre.



THINKING	WORKING
STEP 1	
Identify the basic shapes of the surfaces to be painted.	Front (and back) surface: rectangle and triangle Right (and left) surface: rectangle
STEP 2	
Calculate the area of each shape using the appropriate formula.	Area of front rectangle = lw where $l = 1.1$, $w = 1.2$ $= 1.1 \times 1.2$ $= 1.32 \text{ m}^2$ Area of front triangle $= \frac{1}{2}bh$ where $b = 1.1$, $h = 0.9$ $= \frac{1}{2} \times 1.1 \times 0.9$ $= 0.495 \text{ m}^2$ Area of side rectangle = lw where $l = 2.5$, $w = 1.2$ $= 2.5 \times 1.2$ $= 3 \text{ m}^2$
STEP 3	
Add the areas of the basic shapes to determine the total surface area.	TSA = 2 × area of front rectangle + 2 × area of front triangle + 2 × area of side rectangle. $= (2 \times 1.32) + (2 \times 0.495) + (2 \times 3)$ $= 9.63 \text{ m}^2$
STEP 4	
Write your answer, correct to the nearest square metre.	The total surface area of the surfaces to be painted is 10 m^2 (to the nearest square metre).

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

13E Tasks and questions

Thinking task

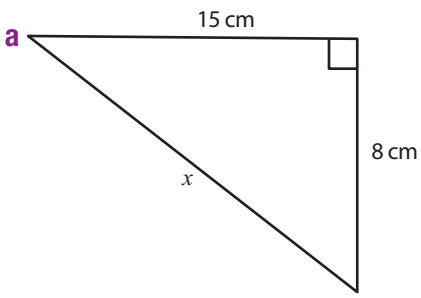
1 Consider where someone might need to calculate the area or total surface area in their work. Conduct some internet research and add the details of three more professions to the list below.

Profession	Application
Fashion design	Calculating the area of fabric required for a pattern
Carpet salesperson	Calculating the area of carpet needed to cover floors

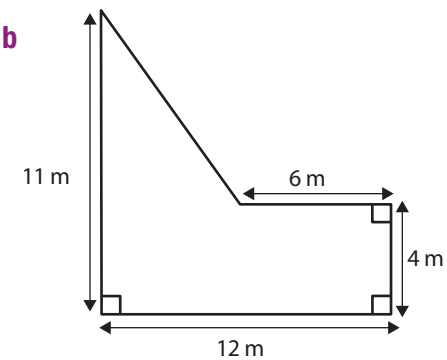
Skills questions

2 Calculate the perimeter of these 2D shapes, correct to 1 decimal place where appropriate.

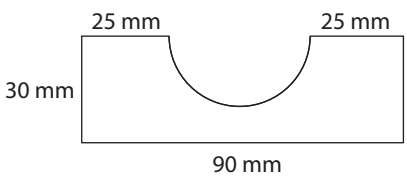
a



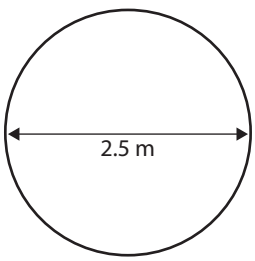
b



c

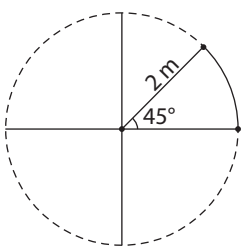


d

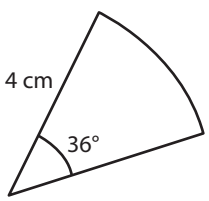


3 Calculate the length of each arc, correct to 1 decimal place where appropriate.

a



b

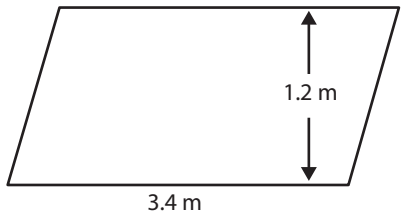


ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

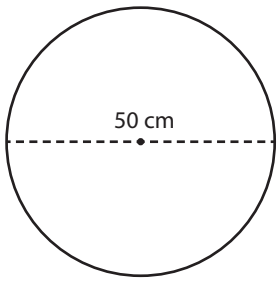
4 Calculate the area of the 2D shapes, correct to 1 decimal place where appropriate.

a

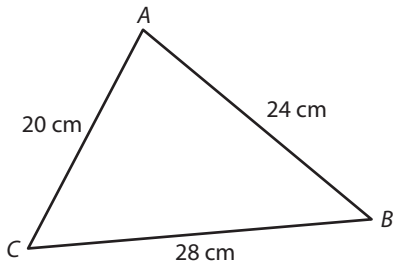
b



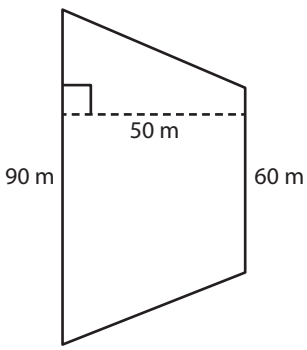
c



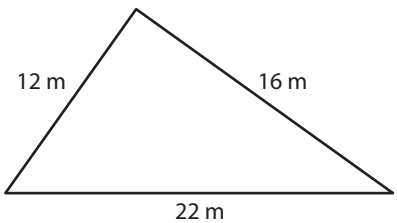
d



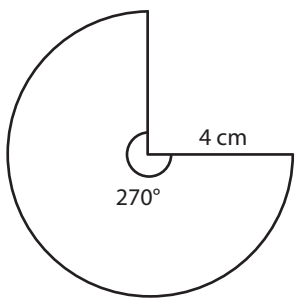
e



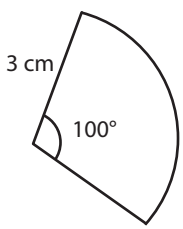
f



g

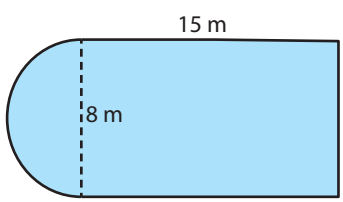


h

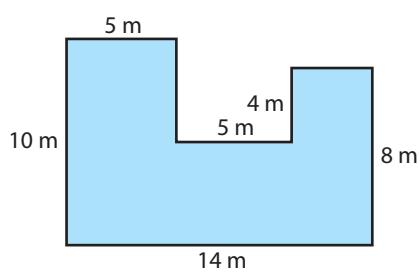


5 Calculate the area of these compound shapes shown in blue, correct to 1 decimal place where appropriate.

a

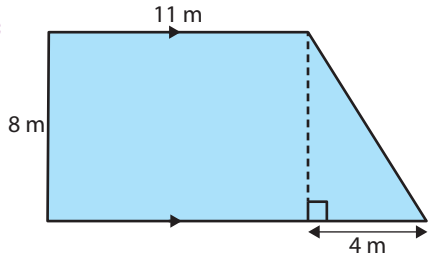


b

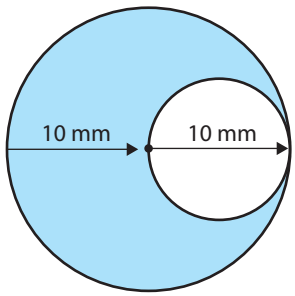


ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

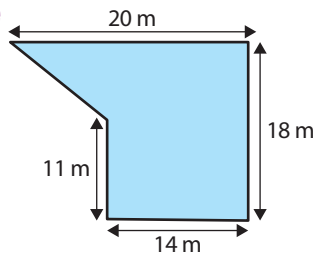
c



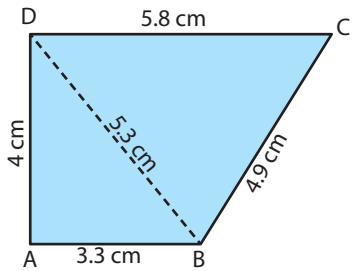
d



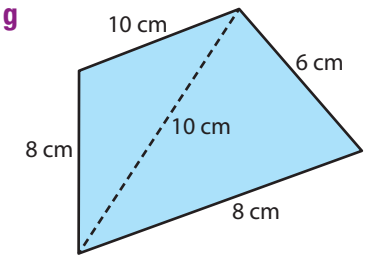
e



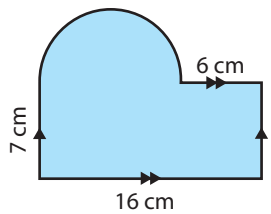
f



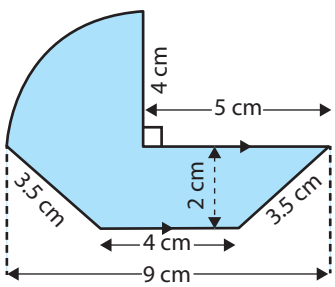
g



h



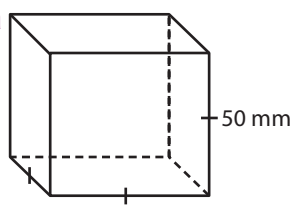
i



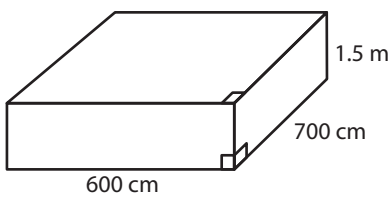
j

6 Calculate the total surface area of the 3D objects, correct to 1 decimal place where appropriate.

a

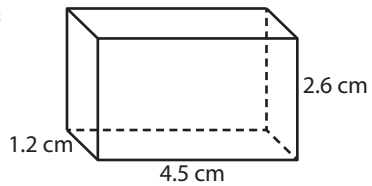


b

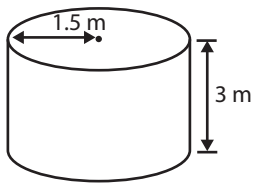


ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

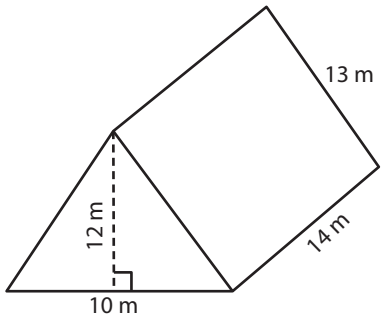
c



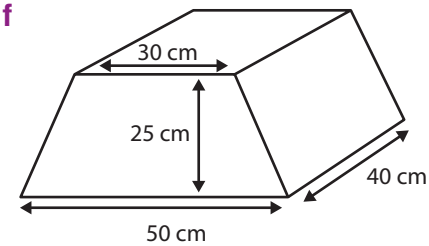
d



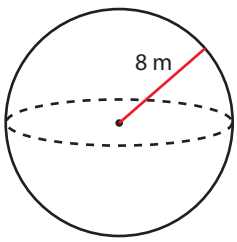
e



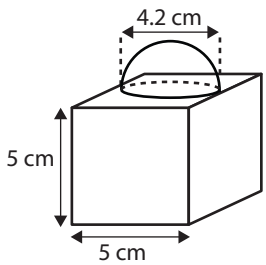
f



g



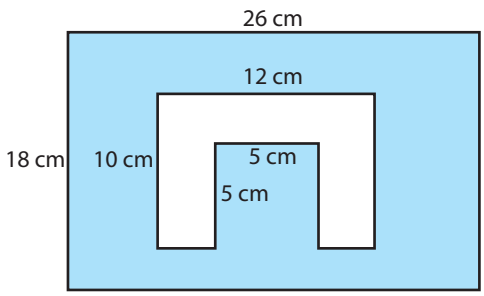
h



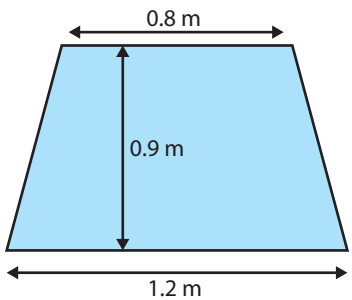
Mixed practice

7 Calculate the area shaded in blue for each of the following 2D shapes.

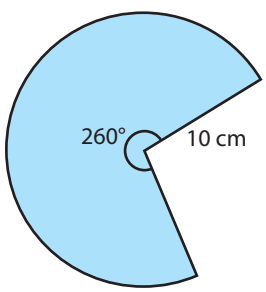
a



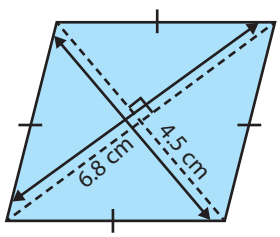
b



c



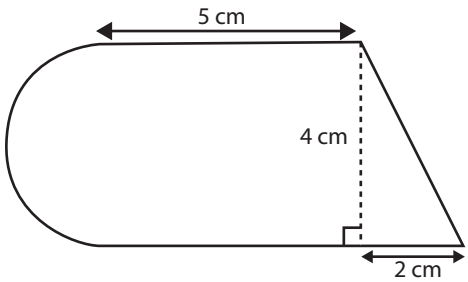
d



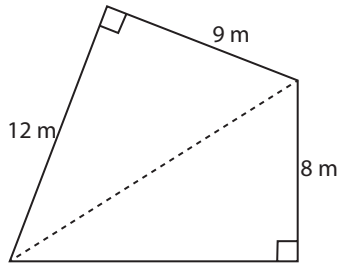
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

8 Calculate the perimeter of each shape, correct to 1 decimal place.

a

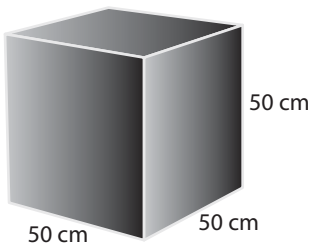


b

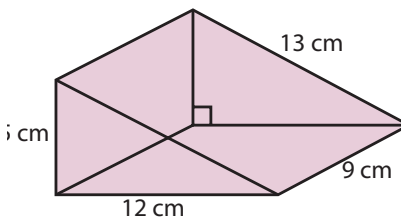


9 Calculate the total surface area of these objects, correct to 2 decimal places where appropriate.

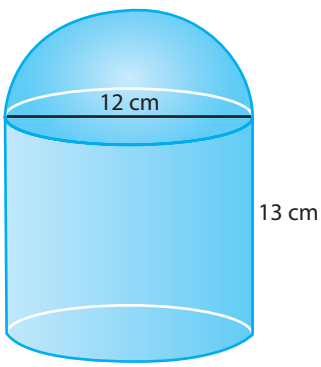
a



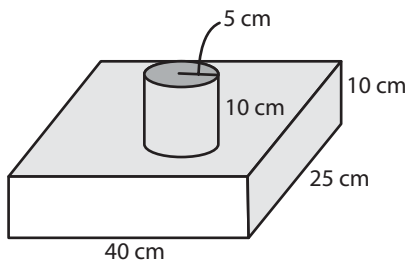
b



c

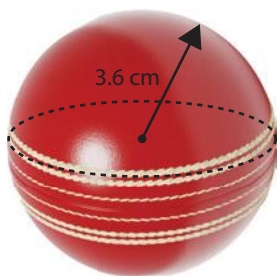


d



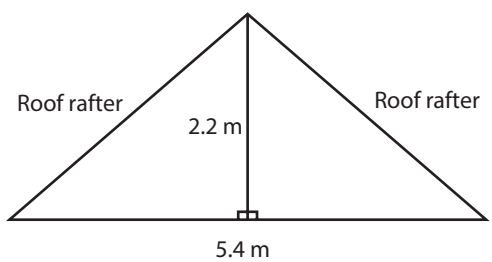
e

f



Application tasks

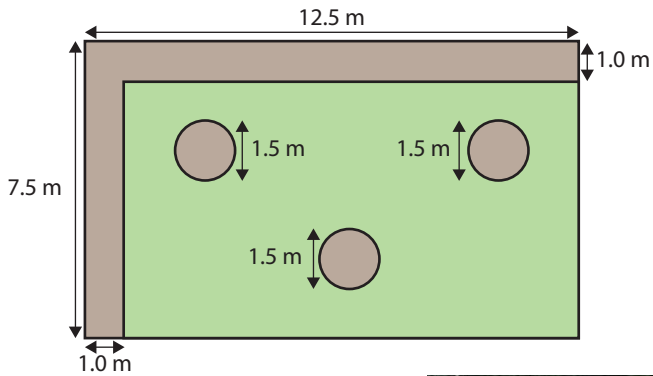
10 An architect is designing a roof space and needs to calculate the length of the roof rafters required. The space is triangular in shape with a span of 5.4 m and height of 2.2 m. What is the length of each roof rafter?



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

11 A builder measures the lengths of the sides in a rectangular shaped room and finds that the opposite sides are the same as each other. One pair of sides both measure 5.1 m and the other pair both measure 9.2 m. To determine if the corners of the room are square (right angled), he measures the length of a diagonal. If the diagonal measures 10.5 m, is the room a rectangle with the corners being square?

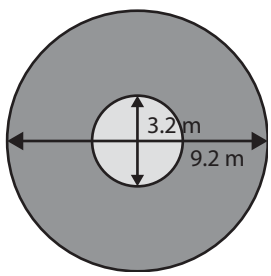
12 A gardener is fertilising a large lawn area. The area of the lawn is shown in green on the plan. It has rectangular garden beds on two sides and three circular garden beds in the lawn area as shown.



a What is the area of the lawn to be fertilised?

b If the fertiliser's rate of application is 20 g/m^2, how much fertiliser does the gardener need for fertilising this lawn?

13 A team of asphalters are asphalting a circular roadway in a court, with a central circular garden bed, as shown. In order to calculate the amount of asphalt required, they need to know the area of the road to be asphalted. What is the area to be asphalted in square metres?



14 Collect three different 3D objects, either from the classroom or at home. Examples might include boxes, cans, phones, tubs and pots. For each object, measure the relevant dimensions and calculate the total surface area.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

13F Calculating volume, capacity and density

Like length and area, being able to work out the volume or capacity of different objects or structures is critical. This is true in industries such as building and construction where working out the amount of concrete needed for a slab, foundations or a path or driveway is necessary, or in gardening and landscaping where the volume of soil or mulch is needed.

When buying different products, you need to be able to assess the volume and capacity of the different shapes to calculate which product is the best value.

When you put ice cubes into a glass of water, the ice cubes float. This is because the ice has a lower **density** than the water. Similarly, this is why people can float and swim – our density is slightly less than that of water. Wood generally floats on water (think of boats) because it is less dense than water. Whereas rocks, generally being denser, sink. Similarly, we know that a helium balloon floats in air because its density is lighter than air.

Density of a material is the amount of the substance contained in a certain volume. The knowledge about density is used in a range of industries such as engineering when comparing different materials to use in different structures, especially in aircraft and ships. It is also critical in areas such as environmental science, health and medicine.

Volume and capacity

The volume is the amount of space taken up by a 3D object. The units used for volume of a solid are m^3, cm^3, mm^3 etc. Capacity is defined as the amount of liquid a container can hold, and the units used are L, mL, kL and ML.

Volume of a prism

A prism is a three-dimensional object which has a uniform cross-sectional area; for example: rectangular prisms, cylinders and triangular prisms.

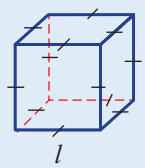
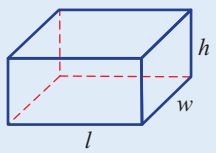
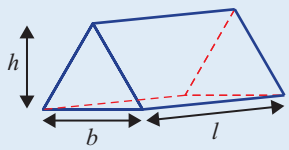
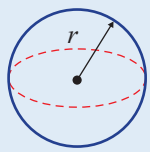
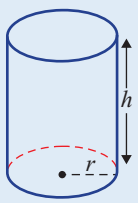
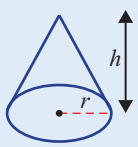
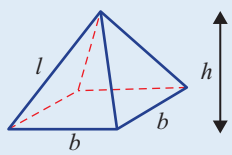
A simple way to calculate the volume of any prism is to multiply the area of the cross-section by the height (which can also be expressed as length).

$$\text{Volume} = \text{area of cross section} \times \text{height (or length)}$$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Volume formulas

There are specific formulas to calculate the volume of common 3D objects. For prisms, these formulas are based on multiplying the area of the cross-section of the prism by its length.

Name	Object	Volume
Cube		$V = l^3$
Rectangular prism		$V = lwh$
Triangular prism		$V = \frac{1}{2}bhl$
Sphere		$V = \frac{4}{3}\pi r^3$
Cylinder		$V = \pi r^2 h$
Cone		$V = \frac{1}{3}\pi r^2 h$
Square pyramid		$V = \frac{1}{3}b^2 h$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 16 Calculating the volume of a prism

The packaging for a Toblerone chocolate bar is a triangular prism as shown. Calculate the volume of the triangular prism in cm^3.

THINKING	WORKING
STEP 1	
Calculate the area of the cross-section of the prism (triangle).	$A = \frac{1}{2}bh$, where $b = 3.6$, $h = 3.1$ $= \frac{1}{2} \times 3.6 \times 3.1$ $= 5.58\ cm^2$
STEP 2	
Calculate the volume by multiplying the area of the cross-section by the height or length of the prism.	Volume = area of cross-section × length $V = 5.58 \times 21$ $= 117.18\ cm^3$
STEP 3	
Write your answer.	The volume of the triangular prism is $117.18\ cm^3$.

Note: The measurement units in this example were all in cm. If there is a mixture of different units in a question, you need to convert them all to the same unit before substituting the values into the formula.

Volume of compound objects

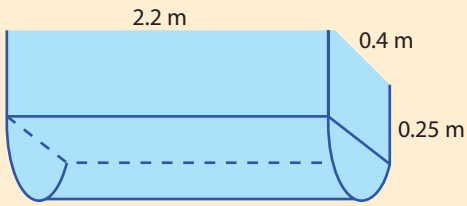
To calculate the volume of compound objects:

1. Identify the basic parts that make up the compound object.
2. Calculate the volume of each basic part.
3. Add or subtract the volumes to calculate the volume of the compound object.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example 17 Calculating the volume of compound objects

A cattle drinking trough on a farm has the dimensions shown. The curved bottom of the trough is half a cylinder.



a Calculate the volume of the drinking trough in m^3, correct to 3 decimal places.

b How much water would be required to fill the drinking trough up to the top? Answer correct to the nearest litre.

THINKING	WORKING
STEP 1 Identify the basic parts in the compound object.	**a** The trough is made up of half a cylinder and a rectangular prism.
STEP 2 Calculate the volume of each part, correct to 5 decimal places where appropriate (to ensure the final answer is correct to 3 decimal places).	Volume of half a cylinder $= \frac{1}{2}\pi r^2 h$ $r = \frac{1}{2} \times 0.4 = 0.2\,\text{m}, h = 2.2\,\text{m}$ Volume of half a cylinder $= \frac{1}{2} \times \pi \times 0.2^2 \times 2.2$ $= 0.13823\,\text{m}^3$ (to 5 d.p.) Volume of rectangular prism $= lwh$ $l = 2.2$ m, $h = 0.4$ m, $w = 0.45$ m Volume of rectangular prism $= 2.2 \times 0.4 \times 0.25$ $= 0.22\,\text{m}^2$
STEP 3 Add the volumes of basic parts to determine the volume of the compound object.	Volume of trough $= 0.138\,23 + 0.22$ $= 0.358\,23\,\text{m}^3$ The volume of the trough is $0.358\,\text{m}^3$ (to 3 decimal places).
STEP 4 Determine the capacity of the trough by converting the volume in cubic metres to capacity in litres.	**b** $1\,\text{m}^3 = 1000$ L Capacity $= (0.358\,23 \times 1000)$ L $= 358.23$ L $= 358$ L (to the nearest litre) The trough requires 358 L of water to fill it to the top.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Density

The density of a material is the amount of substance contained in a certain volume. Another way to think of it is the mass per unit of volume.

This nugget of platinum might look like the same size (or volume) as the rubber duck but it will be much heavier as the density of platinum is much higher than that of rubber.

The formula for calculating density is:

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

The standard units of density are kilograms per cubic metre (kg/m^3) or grams per cubic centimetre (g/cm^3). The density of water is about 1 kg per litre or 1 kg/L, which can also be expressed as 1 g/cm^3. Any material that floats on water has a lower density, and any material that sinks has a higher density.

Example 18 Calculating density

Which material has the greater density?

Rectangular block of steel	Rectangular block of aluminium
Mass: 560 g	Mass: 875 g
Dimensions: 6 cm, 6 cm, 2 cm	Dimensions: 9 cm, 9 cm, 4 cm

THINKING	WORKING
STEP 1	
Calculate the volume of each block using the formula for a rectangular prism.	$V = lwh$ Steel: $V = 6 \times 6 \times 2 = 72$ cm^3 Aluminium: $V = 9 \times 9 \times 4 = 324$ cm^3
STEP 2	
Calculate the density of each block using mass and volume. Round each value to 1 decimal place.	$\text{Density} = \frac{\text{mass}}{\text{volume}}$ Steel: $\text{Density} = \frac{560}{72} = 7.8$ g/cm^3 (to 1 d.p.) Aluminium: $\text{Density} = \frac{875}{324} = 2.7$ g/cm^3 (to 1 d.p.)
STEP 3	
Write your answer.	Steel has a higher density than aluminium.

Note: The block of aluminium is bigger and has a greater mass than the block of steel, but its density is lower.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

13F Tasks and questions

Thinking tasks

1 How does the relationship between the different dimensions of a 3D object (e.g. length, width/depth and height) affect on its volume (or capacity). Investigate different-shaped packages of common supermarket items (boxes/rectangular prisms or cylinders are best to compare). Find a range of such products where some are relatively tall and thin, with some that are short but wide. What are their relative volumes/capacities. Are you surprised which ones hold more?

2 For the Smarties packet in section 13A, you are asked to design a larger sized packet to hold twice as many Smarties as the 50-gram packet.

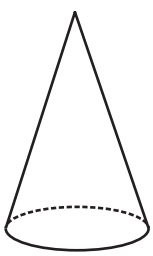
- **a** Which measurement quantity (length, area or volume) needs to double?
- **b** If you doubled all of the side dimensions, how much could it hold?
- **c** Think about the general formula for working out the volume of a prism. Does this help explain the story?
- **d** How would you design a new packet that would hold twice as many Smarties?

Skills questions

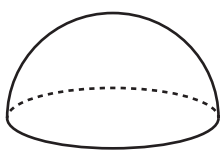
Where appropriate, round answers to 1 decimal place.

3 Which of these three-dimensional objects is a prism? Explain why.

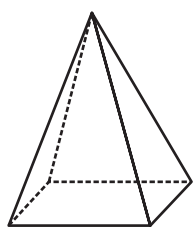
A



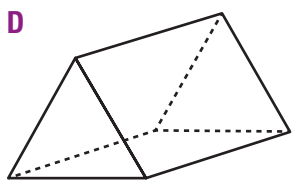
B



C

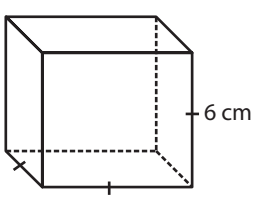


D

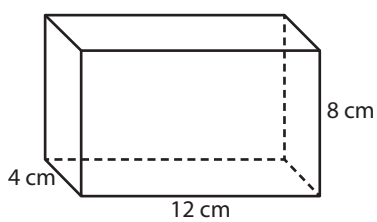


4 Calculate the volume of these three-dimensional objects.

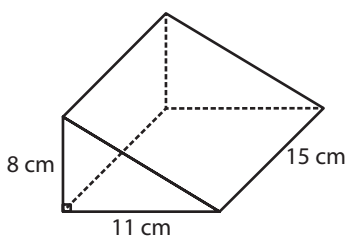
a



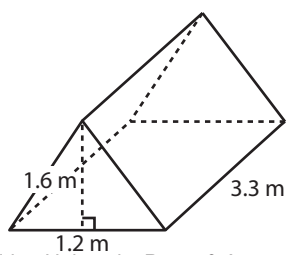
b



c

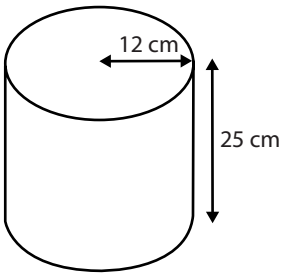


d

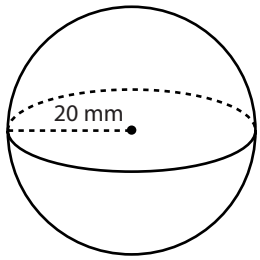


ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

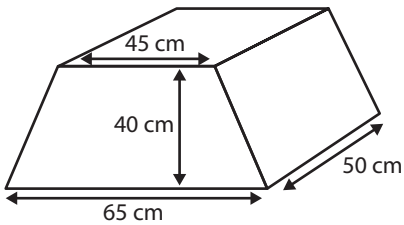
e



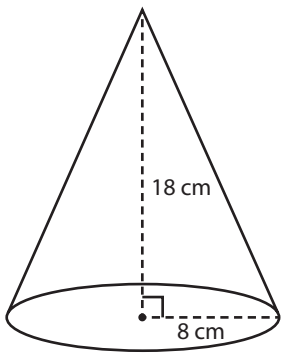
f



g

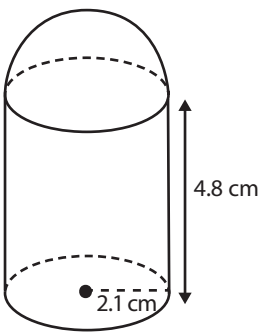


h

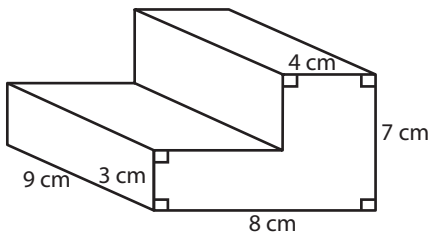


5 Calculate the volume of these compound objects.

a



b



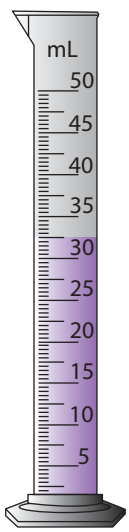
6 Calculate the density of the following materials.

a

Volume: 265 cm^3

Mass: 5000 g

b



Mass of liquid: 50 g

c

Volume: 120 cm^3

Mass: 428 g

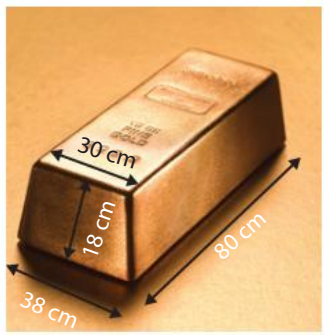
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mixed practice

7 Calculate the volume of the following objects.

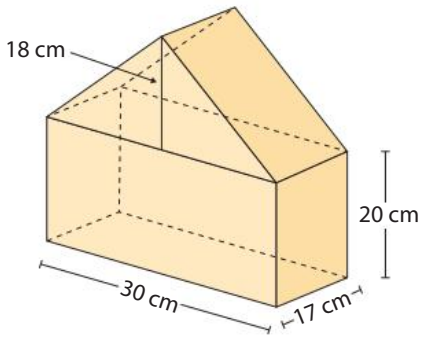
a

b



c

d



8 A cylindrical water bottle has a height of 18 cm and a radius of 4 cm.

a Calculate the volume (to the nearest cm^3) of the water bottle.

b How much water (in mL) would the water bottle be able to hold?

9 A cylindrical water tank has a radius of 2.5 m and a height of 4 m. Calculate the amount of water the water tank can hold in litres.

10 A size 6 basketball has a radius of 11.5 cm. A size 7 basketball has a radius of 11.9 cm. Calculate the volume of each size ball. What is the difference in the volume of the two ball sizes?

11 A wedding cake is made with three tiers. Each tier is a cylinder with a height of 10 cm and diameters of 15 cm, 22 cm and 30 cm respectively. Calculate the total volume of the cake.

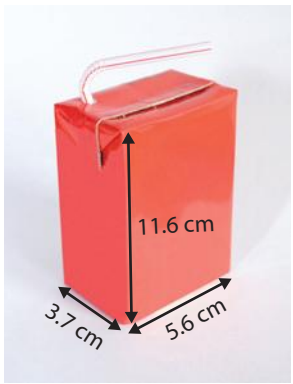
12 A small rectangular block of stone has the dimensions 2 cm, 4 cm and 5 cm. The mass of the stone is 895 g. Calculate the density of the stone in g/cm^3.

13 Liquid is poured into a measuring cylinder and its liquid volume is measured as 18.5 mL. The liquid has a mass of 260 g. Calculate the density of the liquid.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Application task

14 Two boxes of liquids with their dimensions are shown. Collect four more drink box packaging from home or measure them at a supermarket.
Answer the questions that follow and add all the information into the table below.



a Record the liquid volume (in mL) stated on each box.

b Measure and record the dimensions of each box (length, width and height).

c Calculate the total surface area of each box (in cm^2). This is the amount of packaging that each manufacturer has used to make the drink box. Are there differences in surface area of the different boxes?

d Calculate the volume of each box (in cm^3). This is the space contained by the drink box packaging. Are there differences in volume of the different boxes?

e Convert the volume calculated in part **d** into liquid units (mL) and record these values in the last column of the table. This is the capacity or maximum amount of liquid that the box can hold.

f Compare the capacity of the boxes (last column) to the liquid volume quoted by the manufacturer (second column). Are they similar? Are there any results that are unexpected?

Box	Liquid volume (mL)	Length (cm)	Width (cm)	Height (cm)	Total surface area (cm^2)	Volume (cm^3)	Capacity (mL)
1	200	5.6	3.7	11.6			
2	500	7.8	5.1	14.5			

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

13G Measurement error, accuracy, precision and tolerance

When you buy a box of chocolates, not every chocolate piece will be exactly identical or weigh the same amount. These differences will be small and are not likely to cause a problem. However, if the box stated that it contains 100 grams of chocolates and you found out that it only weighed 90 grams in total, then there may be cause for concern.

The level of accuracy or precision in the measurements made for such food items or products is important, but what is most important is often customer satisfaction!

In a wide range of other work practices and industries, measurements have to be much more precise. For example, parts manufactured for an aircraft jet engine need to be very close to what has been designed and specified by the engineers. An incorrect measurement may affect the ability of the aircraft engine to work properly, and potentially have significant consequences for the safety of the aircraft (and its passengers).

Similarly, a sheet of glass prepared and cut to fit a specific window in a building needs to be very close to what was specified, otherwise it will not fit, resulting in wastage of materials and money.

The accuracy and precision of measurements that are required for making products and items depends on the situation and the context. Small errors in measurements can be acceptable, provided that the item is still fit for purpose. This section looks at these issues and introduces the ideas of measurement error, accuracy, precision and tolerance.

Measurement error

When objects or events are measured, there will be an amount of error. Every time a measurement is repeated, a slightly different value may be obtained.

We can work out the error of a measurement by working out the difference between the exact value (also called the true or actual value) and its measured or estimated value. This is called the **absolute error** because we ignore whether the result is positive or negative.

$$\text{Absolute error} = \text{measured quantity} - \text{true or actual value}$$

We can use the symbol | at both ends of this expression to denote we only want the difference (the absolute value):

$$\text{Absolute error} = |\ \text{measured quantity} - \text{true or actual value}\ |$$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

The **relative error** is the proportion the absolute error is of the actual value:

$$\text{Relative error} = \frac{\text{absolute error}}{\text{actual value}}$$

We can convert this to a percentage, which is called the **percentage error**:

$$\text{Percentage error} = \frac{\text{absolute error}}{\text{actual value}} \times 100\%$$

When calculating an error in terms of goods, we will consider the exact or actual value to be the value that the producer or manufacturer has stated for the package/product.

Example 19 Calculating error

Bags of sand sold at a hardware store are meant to be 20 kg. One bag is weighed and found to be 21.1 kg. Calculate:

a the absolute error **b** the relative error **c** the percentage error.

THINKING	WORKING
STEP 1 Identify the measured quantity and the actual value.	Measured quantity: 21.1 kg Actual (true) value: 20 kg (shown on the bag)
STEP 2 Calculate the absolute error using the relationship.	**a** Absolute error = measured quantity – actual value $= 21.1 - 20$ $= 1.1$ kg
STEP 3 Calculate the relative error.	**b** $\text{Relative error} = \frac{\text{absolute error}}{\text{actual value}}$ $= \frac{1.1}{20}$ $= 0.055$
STEP 4 Calculate the percentage error. Note that the percentage error is the same as the relative error but expressed as a percentage.	**c** $\text{Percentage error} = \frac{\text{absolute error}}{\text{actual value}} \times 100\%$ $= \frac{1.1}{20} \times 100\%$ $= 5.5\%$

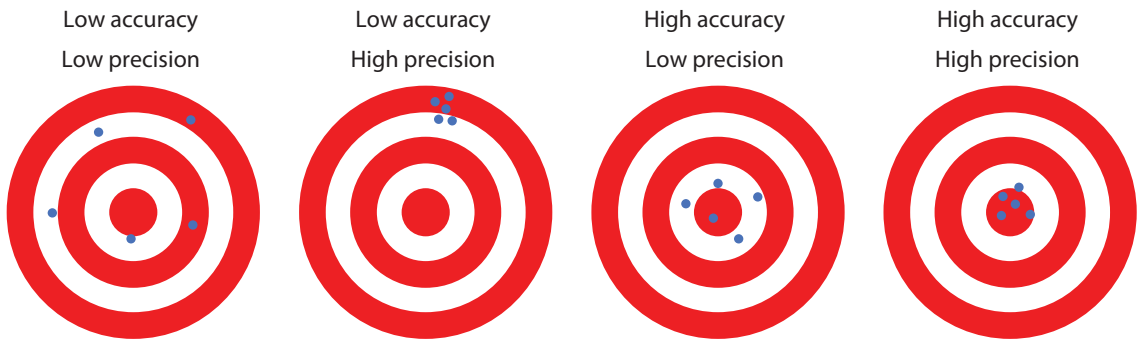
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Accuracy and precision

The words ‘accuracy’ and ‘precision’ are often used interchangeably but they have different meanings.

- **Accuracy** is how close a measurement is to the actual value.
- **Precision** is how closely multiple/repeated measurements are to each other.

This image visualises the difference between accuracy and precision. The centre of the target can be considered as the actual (or intended) value.



Example 20 Recognising accuracy and precision

A manufacturer has an automated saw that has two settings, A and B. The manufacturer uses the machine to cut lengths of wood with a desired length of 1.20 m. After producing three lengths of wood with each setting, the lengths of wood were recorded in a table.

Setting A	Setting B
1.24 m	1.21 m
1.24 m	1.18 m
1.25 m	1.22 m

a Which setting produces results that are more accurate?
b Which setting produces results that are more precise?

THINKING	WORKING
STEP 1	
Identify the setting which produces values closest to 1.20.	a Setting B has values that are closest to 1.20 m, so it is more accurate.
STEP 2	
Identify the setting which has values closest together.	b Setting A has values that are closest together, so it is more precise

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Tolerance

The **tolerance** of a measurement is the range of values established as being what is expected and/or seen as acceptable. Manufacturers will specify a range of values for manufacturing a product that are considered acceptable and not faulty.

For example, here are some international specifications for tennis balls which set out the tolerances that need to be met across a number of different measurements.

	Type 1 (fast)	Type 2 (medium)	Type 3 (slow)
Mass (weight)	56.0–59.4 g (1.975–2.095 oz.)	56.0–59.4 g (1.975–2.095 oz.)	56.0–59.4 g (1.975–2.095 oz.)
Size	6.54–6.86 cm (2.57–2.70 in.)	6.54–6.86 cm (2.57–2.70 in.)	7.00–7.30 cm (2.76–2.87 in.)
Rebound	138–151 cm (54–60 in.)	135–147 cm (53–58 in.)	135–147 cm (53–58 in.)
Forward deformation	0.56–0.74 cm (0.220–0.291 in.)	0.56–0.74 cm (0.220–0.291 in.)	0.56–0.74 cm (0.220–0.291 in.)

Tennis balls outside these sets of tolerances would not be acceptable for use in official tennis competitions.

Manufacturers set their manufacturing process and their machinery to meet agreed tolerances. For example, the mass of chocolate bars produced in a plant might be required to be 50 grams as stated on the packaging, with a tolerance of 0.7 grams. So, the values that the chocolate bar is supposed to meet is written as 50 ± 0.7 grams, which is a range of 49.3 –50.7 grams. This relates very closely to what we called *interval estimates*, back in section 2E.

Sometimes, because manufacturers need to meet specified standards, and also to keep their customers happy, they will set up their tolerances so that the range of acceptable values starts at the advertised or stated net weight. For example, a producer might be packaging up some sliced cold meat with an advertised net weight of 100 grams. They therefore set up their machinery and processes so that the tolerance is 105 ± 5 grams, which is the same as saying an interval estimate of 100–110 grams.

In other cases, as mentioned above, the manufacturer will not want to consistently have their measure be above their stated target value but be close to the specified value. This would be true in the two situations mentioned at the start: manufacturing parts for an aircraft engine or when cutting glass. In these cases, the tolerances, and associated interval estimates, would be centred around the target value.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

13G Tasks and questions

Thinking task

1 When objects are measured there is always going to be an amount of error. There are methods that are used to reduce the amount of error in measurements. For example, taking multiple measurements and calculating a mean, using a measurement tool that is highly accurate and identifying any sources of errors and minimising them. But sometimes it is not necessary to know a measurement to a high level of accuracy and a value close enough will be sufficient.

Consider each of the following scenarios and decide:

- **i** whether the accuracy needs to be high, medium or low
- **ii** the methods that could be used to increase or ensure the accuracy of the measurement.

a Measuring the area of your bedroom walls to determine how much paint to buy

b Measuring out the dosage of a medicine

c Measuring the temperature of a chicken Kiev after it has been cooked

d Measuring the volume of soft drink syrup mix to be added to water in the soft drink mix at a fast-food restaurant.

Skills questions

2 The actual and measured values for three measurements are shown below.

In each case, calculate the:

- **i** absolute error
- **ii** relative error
- **iii** percentage error.

	Actual value	Measured value
a	125.6 g	130 g
b	546 s	550 s
c	2.56 km	2.5 km

3 The volume of a liquid is 35.0 mL. A student measures the volume three times, and the results are 35.2 mL, 35.4 mL and 34.8 mL.

For each measurement, calculate the:

a absolute error **b** relative error **c** percentage error.

4 A machine part has been manufactured to a tolerance of 5.6 ± 0.05 cm.

a What is the top limit of the tolerance?

b What is the bottom limit of the tolerance?

c A part is manufactured that measures 5.7 cm. Does this part fall within the acceptable range? Will it be considered faulty or not faulty?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

5 Packets of biscuits, labelled as weighing 225 grams, have been packaged with a tolerance of 230 ± 15 g.

a What is the top limit and the bottom limit of the tolerance?

b A packet of biscuits is chosen that weighs 235 g. Does this packet fall within the acceptable range? Will it be considered faulty or not faulty?

6 The expected length of a coil of wire is 200 m. Four samples were collected, and their measurements were 190 m, 194 m, 186 m and 198 m. Which statement is true?

A The lengths are accurate but not precise.

B The lengths are precise but not accurate.

C The lengths are both accurate and precise.

D The lengths are neither accurate nor precise.

7 The volume of a liquid is 35.0 mL. A student measures the volume three times, and the results are 35.2 mL, 35.4 mL and 34.8 mL.

Comment on the accuracy and precision of the results.

8 For each of the following products, decide if the range of values should be set so their tolerance range:

- starts at the advertised or stated measurement, or
- is centred around the target or stated measurement.

a Volume of drink in a 375 mL fruit juice container

b Weight of a packet of potato crisps

c Width of a floor tile.

Mixed practice

9 Jaz got a speeding fine for travelling at 55 km/h in a 50 km/h zone. What was the relative error in this situation?

10 A punnet of strawberries has a nominal weight of 250 g, with a tolerance range ± 10 g. What are the upper and lower limits of tolerance for each punnet?

11 A measurement of a liquid ingredient is meant to be 55 mL. In checking four measurements, the volumes measured 56.2 mL, 55.1 mL, 55.9 mL and 54.8 mL.

Comment on the accuracy and precision of the measurements.

12 When pumping up your front tyre, you were aiming for the manufacturer's specification of 250 kpa, but actually pumped the tyre to 255 kpa. What is the percentage error in this situation?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mathematical literacy

13 Use the following words to fill in the gaps in the sentences below.

error	precise	accurate	tolerance

a A basketballer shot 20 free throws in training and missed every one of them. Each shot hit the ring in the same spot and bounced off. The basketballer's shooting results were very _____.

b A drinks manufacturer has a _____ for each 600 mL bottle of water of 610 ± 10 mL.

c A set of measuring scales were sitting unevenly on a laboratory bench, so every measurement had a significant amount of _____.

d Measurements made by chemists in the manufacture of medications must be very _____.

Application tasks

14 A butcher prepares prepacked trays of mince which are supposed to have a mass of 500 g. For quality control, five packs are chosen at random, and the amount of mince is weighed. The results are shown in the table.

Pack	Weight
1	555 g
2	545 g
3	550 g
4	543 g
5	548 g

a Are the results accurate, precise or neither? Why?

b Calculate the average weight of the five packs of mince.

c For each of the five measurements, calculate the:

i absolute error **ii** relative error **iii** percentage error.

d Is the amount of mince in these trays a problem for the butcher? Why?

15 Lengths of wood sold in a hardware store must fall within these tolerances. Each week the hardware store receives a shipment of wood of varying lengths and must allocate the wood to each size. If lengths of wood don't meet the tolerance ranges of these three sizes, they can be cut down to make smaller lengths.

Short lengths (m)	1.8 ± 0.1
Medium lengths (m)	3.6 ± 0.2
Long lengths (m)	5.4 ± 0.2

One week the hardware store receives the following shipment of lengths of wood.

3.7 m	1.8 m	5.0 m	3.5 m	2.0 m
5.3 m	1.9 m	5.1 m	3.7 m	3.9 m

a Are there any planks of wood that do not fit within these tolerances? What should these lengths be cut into?

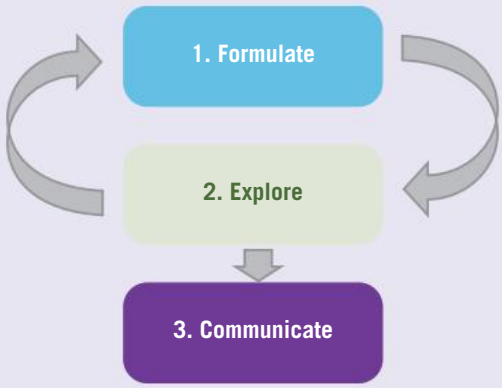
b Will there be any pieces of wood that cannot be sold in any of these lengths? Which ones?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Investigations

When undertaking your investigations, remember the problem-solving cycle steps:

- **Formulate** – Sort out and plan what you need to know and need to do to solve the problem.
- **Explore** – Use and apply the mathematics required to solve the problem.
- **Communicate** – Record and writeup your results.



1 Baking cupcakes as a fundraising activity

Your task is to develop a plan to sell cupcakes to the public for four consecutive Saturdays to raise money for a charity.

Cupcake recipe

Ingredients:

- $1\frac{1}{4}$ cups all-purpose flour
- $1\frac{1}{4}$ teaspoons baking powder
- $\frac{1}{4}$ teaspoon salt
- $\frac{3}{4}$ cup granulated sugar
- $\frac{1}{4}$ cup unsalted butter (at room temperature)
- 2 eggs
- 2 teaspoons vanilla extract
- $\frac{1}{2}$ cup thick cream

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Icing:

- 4 cups icing sugar
- $\frac{1}{2}$ cup butter (at room temperature)
- 2–3 tablespoons thick cream
- 2 teaspoons vanilla extract

Method:

- Bake at 350°F for 12–15 minutes
- Recipe makes 12 large cupcakes or 24 mini cupcakes

Formulate

The recipe chosen for this task is an American recipe so there are some preliminary adjustments that will need to be made before you can use it. Some questions that you will need to consider are:

a How will you adjust the imperial measurements to their metric equivalents?

b Are the American cup and teaspoon measurements the same as Australian cups and teaspoons?

c Will you make the cupcakes a regular size, or will you make mini cupcakes?

d What materials will you need to make the boxed sets of cupcakes for sale to the public?

e How many boxed sets do you plan on selling each Saturday? How does this affect your ingredients and packaging?

f What else will you need to do to plan to sell the cupcakes for four Saturdays?

g What equipment and tools will you use to undertake the tasks of the investigation?

Explore

h Convert the measurements of each ingredient into Australian metric units.

i Calculate the scaled-up quantity of ingredients required for your projected sales over the four weeks.

j Convert the cooking temperature into degrees Celsius.

k Design a net for the box in which you will sell the packs of cupcakes.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

l Calculate the total surface area of the box so that you can estimate how much material you will need for each box of cupcakes.

m Scale-up the quantity of packaging materials required for your projected sales. Factor in that the plan is to sell these cupcakes for four Saturdays.

Communicate

n Write up and present the results of your investigation. You can choose the format of your presentation.

You should:

- include the questions that you asked, and what you found
- include a sketch and an accurate net of the cupcake packaging
- explain the mathematical skills that you used in this investigation
- reflect on how technology was used to conduct the investigation and present the results
- consider what you would change, and why, if you were to do this investigation again.

2 Street sculpture

Your task is to design a piece of sculpture for a public garden or area.

The design brief is that the piece of sculpture must use at least three geometric solid shapes.

Formulate

a Develop a plan for the design of your sculpture. Some questions that you should consider are:

- What 3D solids could be incorporated into the design?
- Is your design intended for children to climb on and play around?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- How high should the sculpture be for the safety of people using the park?
- How much area should the sculpture occupy?
- Given that the sculpture is planned as a permanent feature of the garden, what would need to be done to ensure that it withstands extremes of wind, sun and rain?
- Given that the sculpture is outdoors, what materials could be used?
- What tools and equipment will be used to create your design?

Explore

b Sketch at least two concept designs. Select one to be the final design.

c Create an accurate plan of the sculpture, including measurements of all components.

d Determine the total overall, external dimensions of your design.

e Determine the total volume of all the components of your design.

f Investigate the weight, density, strength and durability of materials that could be used to construct the sculpture and decide which ones to use.

g Determine an approximate cost of materials for your structure.

Communicate

h Write up and present the results of your investigation. You can choose the format of your presentation.

You should:

- include the questions that you asked, and what you found
- provide the concept design sketches.
- provide the accurate plan of the sculpture
- provide the accurate drawing of the sculpture
- explain the mathematical skills that you used in this investigation
- reflect on how technology was used to conduct the investigation and present the results
- consider what you would change, and why, if you were to do this investigation again.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key concepts

- **Measuring**
  - Measuring is the process of determining how big or small an object or event is. We use measurement tools to assign a value to a quantity.
  - It is important to be able to estimate measurements.
- **Identifying and using units**
  - The standard system of measurement units used in Australia is the SI metric system.
  - Derived measurements are when we use what we know to calculate another measurement – like multiplying the lengths of the sides of a 2D shape to calculate the area.
- **Pythagoras' theorem**
  - $c^2 = a^2 + b^2$
  - The relationship can be used to calculate unknown side lengths in a right-angled triangle and confirm whether a triangle contains a right angle.
- **Calculating area**
  - Area is the amount of space enclosed by a two-dimensional (2D) shape. Metric units used are mm^2, cm^2, m^2, km^2.
- **Calculating surface area**
  - Total surface area is the sum of all the areas of the surfaces of a three-dimensional (3D) object.
  - Most surface area problems are solved by calculating the area of each surface and then adding them together.
- **Volume**
  - The volume is the space occupied by a three-dimensional (3D) object. Metric units used are m^3, cm^3, mm^3.
- **Liquid volume / capacity**
  - Capacity is the amount of fluid a container can hold. The metric units used for liquid volume/capacity are L, mL, kL and ML.
- **Formulas for calculating area, surface area, volume and capacity of different shapes**
  - Common formulas used to calculate these measurement are summarised on the formula sheet available.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- **Density**
  - Density is the amount of substance contained in a certain volume. The formula for calculating density is:

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

  - Units used are kilograms per cubic metre (kg/m^3) or grams per cubic centimetre (g/cm^3).
- **Conversions**
  - There are a number of standard conversions between different metric measurement units that are based around the metric prefixes and involve either multiplication or division by powers of 10. However, there are also some potential conversions between metric units and non-metric (imperial) measurements.
- **Error, accuracy, precision and tolerance**
  - **Error** is the difference between a measured value and its actual (true) value, which is commonly assumed to be the size specified by the designer or the manufacturer.

$$\text{Absolute error} = \text{measured quantity} - \text{actual value}$$

$$\text{Relative error} = \frac{\text{absolute error}}{\text{actual value}}$$

$$\text{Percentage error} = \frac{\text{absolute error}}{\text{actual value}} \times 100\%$$

  - **Accuracy** is how close a measurement is to the actual (true) value.
  - **Precision** is how closely multiple or repeated measurements are to each other.
  - **Tolerance** of a measurement is the range of values that are acceptable, usually expressed with the ± symbol.
  - To calculate percentage error, we use the formula:

$$\text{Percentage error} = \frac{\text{estimated number} - \text{exact number}}{\text{exact number}} \times 100\%$$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Success criteria and review questions

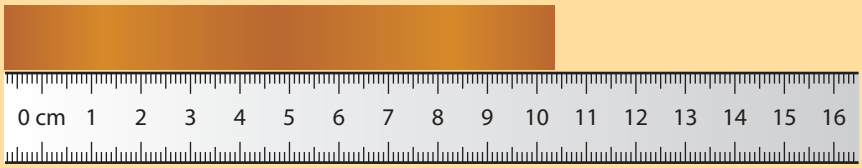
☐ I can use a measurement tool to measure quantities.

1 Read the measurements shown in the following images.

a

b

c



☐ I can estimate a measurement including appropriate units.

2 Estimate the measurements of the following objects, including the appropriate units.

a The mass of a bunch of six bananas

b The height of a double decker bus

c The amount of water in a bath

☐ I can convert between different units.

3 Convert each measurement to the unit shown in brackets.

a	6.5 cm^3	(mL)	**b**	4 inches	(cm)
c	5.35 cm	(mm)	**d**	3 days	(hours)
e	6 fluid ounces	(mL)	**f**	2 pounds weight	(g)
g	1255 m	(km)	**h**	5 ha	(m^2)
i	75 °F	(°C)	**j**	84 900 mL	(L)

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

☐ I can calculate lengths for right-angled triangles and arcs of circles.

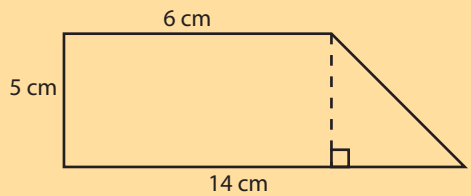
4 Calculate these lengths, correct to 2 decimal places.
- **a** The hypotenuse of a right-angled triangle, short sides 7 mm and 4 mm
- **b** The unknown side of a right-angled triangle, hypotenuse 15 cm, base 10 cm
- **c** The length of an arc, radius 3 cm, angle 50 degrees
- **d** The length of an arc, radius 20 mm, angle 165 degrees

☐ I can use Pythagoras' theorem to determine if an angle in a triangle is 90°.

5 Are these right-angled triangles?
- **a** Base 6 cm, vertical height 8 cm, hypotenuse 10 cm
- **b** Base 14 mm, vertical height 22 mm, hypotenuse 25 mm

☐ I can calculate the perimeter of two-dimensional shapes.

6 Calculate the perimeter of this shape.



☐ I can calculate the area of two-dimensional (2D) shapes.

7 Calculate the area of these shapes, correct to 1 decimal place as needed.
- **a** A square, sides 15 mm
- **b** A triangle, base 9 cm, height 60 mm
- **c** A parallelogram, length 100 mm, vertical height 5 cm
- **d** A trapezium, base 10 cm, top 4 cm, vertical height 6 cm
- **e** A circle, radius 8 mm
- **f** A sector of a circle, radius 2 cm, angle 230 degrees
- **g** A square, sides 12 cm, with a circle of radius 6 cm removed
- **h** A kite, 10 cm long, 7 cm wide

☐ I can calculate the area of a compound shape.

8 Calculate the area of the compound shape shown in question **6**.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

☐ I can calculate the area of triangles using Heron's formula.

9 Calculate the area of these triangles, correct to 1 decimal place.
- **a** Sides 7 cm, 5 cm and 8 cm
- **b** Sides 10 mm, 14 mm, 6 mm

☐ I can calculate the total surface area (TSA) of three-dimensional objects.

10 Calculate the total surface area of these solids.
- **a** A triangular prism, base 9 cm, height 12 cm, length 15 cm
- **b** A cuboid, 8 cm long, 60 mm wide, 5 cm high
- **c** A cylinder, radius 4 cm, height 10 cm

☐ I can calculate the volume of three-dimensional (3D) objects.

11 Calculate the volume of these objects, correct to 1 decimal place.
- **a** A cube, sides 30 mm
- **b** A cuboid, length 50 mm, width 8 cm, height 20 cm
- **c** A triangular prism, base 10 mm, vertical height 9 mm, length 12 mm
- **d** A cylinder, radius 5 cm, height 11 cm
- **e** A sphere, radius 6 cm
- **f** A square-based pyramid, base length 90 mm, vertical height 150 mm
- **g** A cone, radius 8 cm, vertical height 20 cm

☐ I can calculate the capacity of three-dimensional objects.

12 A water tank is the shape of a cylinder with a diameter of 3 m and a height of 5 m. How many litres of water can the tank hold?

☐ I can calculate the density of objects.

13 Calculate the density of these objects, correct to 1 decimal place.
- **a** A small marble sphere has a volume of 3.6 cm^3 and a mass of 9.7 g.
- **b** A stone kitchen bench top is the shape of a rectangular prism with dimensions 20 mm, 3060 mm and 1440 mm, and has a mass of 220 kg.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

☐ I can calculate the absolute error, relative error and percentage error.

14 Terri is making blocks of honeycomb to sell for fundraising. The honeycomb is to be sold as 200-gram blocks. One block is weighed and found to have a measurement of 206.5 g.
Calculate the:

a absolute error **b** relative error **c** percentage error.

☐ I can identify when measurements are accurate or precise.

15 Charlie is responsible for monitoring the weights of the content of packets coming off a process line in a smallgoods factory. One specific product is supposed to weigh 350 g. Charlie weighs five samples and their weights are shown in the table.

Sample	Weight of product
1	365 g
2	362 g
3	368 g
4	364 g
5	367 g

Which statement is true about these measurements?

A The measurements are accurate but not precise.
B The measurements are precise but not accurate.
C The measurements are both accurate and precise.
D The measurements are neither accurate nor precise.

☐ I can calculate the tolerance range for a measurement.

16 The net weight of a bag of lollies has a tolerance of 190 ± 15 g.

a What is the top limit of the tolerance?
b What is the bottom limit of the tolerance?
c A bag is selected and weighed as 202 g. Does this bag fall within the acceptable range? Will it be considered faulty or not faulty?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Mathematical toolkit

1 Reflect on the range of different calculations, technologies and tools you used throughout this chapter, and how often you used them for undertaking your work and making calculations. Indicate how often you used and worked out results and outcomes for each of these methods and tools.

Method and tools/ applications used	How often did you use this?
• Calculating and working in your head, and using algorithms	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using pen-and-paper	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using a calculator	A little: ☐ Quite a bit: ☐ A lot: ☐
• Using a spreadsheet	Not at all: ☐ A little: ☐ Quite a bit: ☐
• Using measuring tools – name the tool, technology or application: _____ _____	Not at all: ☐ A little: ☐ Quite a bit: ☐ Not at all: ☐ A little: ☐ Quite a bit: ☐
• Using other technology or apps – name the technology or application: _____ _____	Not at all: ☐ A little: ☐ Quite a bit: ☐ Not at all: ☐ A little: ☐ Quite a bit: ☐

2 Did this chapter and the activities help you to better understand how you use different tools and technologies in using and applying mathematics in our lives and at work? In what areas and ways? Write down some examples.

3 In one sentence, explain something relating to tools and technologies that you learned in the unit. Write an example of what you learned.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key vocabulary

Here is a list of this chapter's key maths terms and their meanings.

Term	Meaning
Absolute error	The difference between the actual value and the measured quantity: Absolute error = measured quantity – true or actual value.
Accuracy	How close a measurement is to the actual value.
Acre	An imperial unit of land area equal to 0.405 hectares.
Analogue device	Where measured values are read from a continually variable scale, e.g. tape measure or clock with hour and minute hands.
Arc length	The length of part of a circle's perimeter It can be calculated from the radius and the degrees at the centre of the circle.
Capacity	The volume of fluids or their containers.
Compound shapes	Shapes that are made by adding or subtracting multiple different shapes. They can also be called composite shapes.
Cuboid	A 3D solid object with six rectangular faces.
Density	The amount of substance contained in a certain volume. Another way to think of it is the mass per unit of volume.
Derived measurement	The measurement that is calculated by knowing other measurements, e.g. area is length multiplied by width.
Digital device	Where measured values are displayed as numbers on the screen of an electronic tool.
Dimensions	A measurable extent such as length, width or height, or a numerical description of a 2D shape or 3D object.
Hectare (ha)	A metric unit of land area equal to 10 000 square metres or 2.471 acres.
Heron's formula	Used to calculate the area of a triangle when the lengths of the three sides are known. It also can be used to calculate the area of irregular quadrilaterals that can be split into two triangles.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Term	Meaning
Hypotenuse	The longest side of a right-angled triangle and represented by the symbol c in Pythagoras' theorem.
Mass	A measure of the quantity of matter in an object.
Net weight	The weight of the contents of a packet or container.
Percentage error	The *relative error* expressed as a percentage: $\text{Percentage error} = \frac{\text{absolute error}}{\text{actual value}} \times 100\%$
Perimeter	The total length around a 2D shape.
Plane	A flat 2D surface.
Precision	How closely multiple or repeated measurements are to each other.
Prism	A 3D object where the two ends are the same size, and the sides are rectangles.
Pythagoras' theorem	For right-angled triangles with a hypotenuse of length c and sides of length a and b: $c^2 = a^2 + b^2$ This can be used for calculating unknown lengths of a right triangle. It also can be used to check if a triangle is a right-angled (90°) triangle.
Relative error	The proportion the *absolute error* is of the actual value: $\text{Relative error} = \frac{\text{absolute error}}{\text{actual value}}$
Sector area	The area of part of a circle given the radius and the degrees at the centre of the circle.
Tare	The weight of an empty container.
Tolerance	An allowable amount of variation in a dimension or measurement of an item or product.
Volume	The space occupied by a 3D object.
Weight	The measure of a *mass* under gravity.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Revision of Chapters 9–13: Exam-style questions

Areas of Study 3 and 4

- The questions are divided into two sections: Section A and Section B.
- For Section A, all multiple-choice questions are worth one mark each.
- For Section B, the marks are indicated next to the questions and individual question parts.
- A downloadable version of these questions, including space for working out in Section B, is available in the Interactive Textbook.

SECTION A – Multiple-choice questions

1 If 1 US dollar is worth 0.80 euros, the exchange rate for converting euros to US dollars is

A 0.60 **B** 0.80 **C** 1.25 **D** 1.50

2 The GST included in the sale price of a $634 photography session is

A $57.06 **B** $57.64 **C** $63.40 **D** $69.74

3 The stem and leaf plot shows the number of orders received by a small business each day.

Key 1|1 = 11

Stem	Leaf
0	0 3 4 8
1	1 4 5
2	1
3	
4	1

The business owner uses the plot to calculate the median number of orders over the time period, then realises that they left off the day they received 31 orders.

Which of the following describes how the median would change when this extra value is accounted for?

A The median would decrease by 3.

B The median would decrease by 1.5.

C The median would increase by 1.5.

D The median would increase by 3.

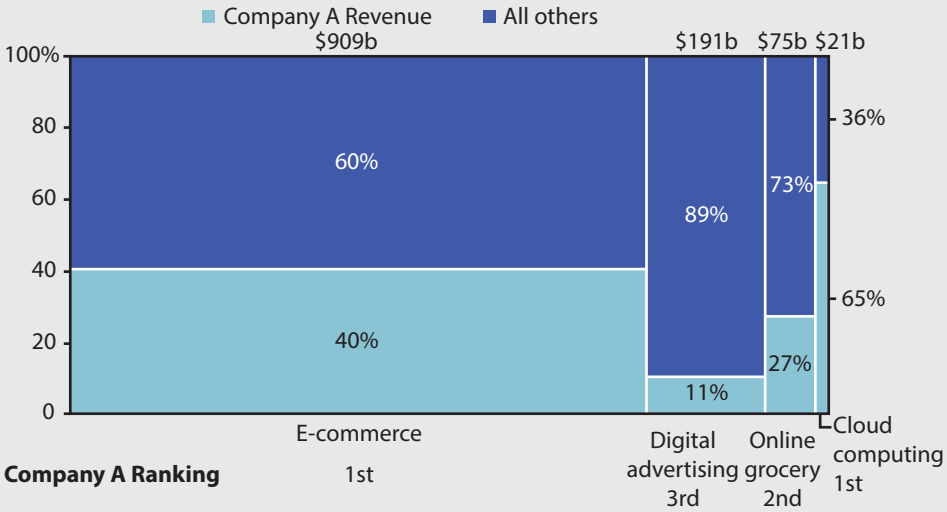
4 Megan initially intends to take out a simple interest loan of $28,900 to purchase a car at an interest rate of 5.4% per annum. However, she decides to accept a different simple interest loan at an interest rate of 4.2% per annum.

Given the loan is to be paid off completely in 10 years, how much did Megan save in total over the course of the loan?

A $346.80 **B** $3,468 **C** $12,138 **D** $15,606

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

5 This Mekko chart displays the market share of Company A in four different industries, and the amount of revenue produced by each of these industries. The height of the bars represents the market share in a particular industry. The width of the bar represents the size of the market.



Which of the following statements is true?

A 40% of Company A's revenue is from e-commerce.

B Company A's revenue in digital advertising is $21.01 billion.

C Company A's revenue in cloud computing is greater that its revenue in online grocery.

D Across all industries, Company A's market share is 143%.

6 Tori is a window cleaner. She charges a $120 callout fee, plus $15 per window cleaned. If Tori is to clean a building with 20 windows, she will charge

A $135 **B** $300 **C** $420 **D** $1,800

7 During her first year after leaving school, Ellie earned $20,000 from her part-time job. In her second year she increased her work hours, so her salary increased by 50%. Her salary then increased by a further 10% for her third year.
The percentage of Ellie's first-year salary that she earns in her third year after leaving school is

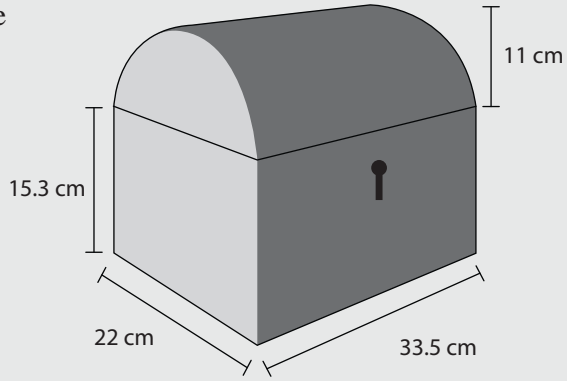
A 60% **B** 155% **C** 160% **D** 165%

8 Courtney is attempting to figure out how much a recommended handyman will charge to do a job. The handyman charged one of her neighbours his flat callout fee and two hours of work for a total cost of $240. He charged one of her other neighbours his flat callout fee and five hours of work for a total cost of $450.
The handyman's hourly rate is

A $70/h **B** $90/h **C** $120/h **D** $210/h

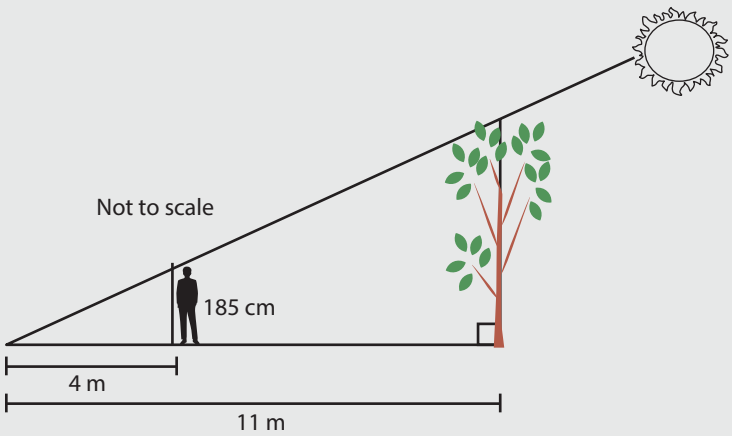
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9 Bailey purchases a small chest to use as a jewellery box. The lower part is a rectangular prism, and the lid is half a cylinder.
She decides to cover the curved surface of the lid in silver leaf.
The cost to cover one square centimetre using silver leaf is $0.08.
Using $\pi = 3.14$, the cost of this project is



A $58.96 **B** $92.57 **C** $122.96 **D** $185.14

10 The sun shines down on a tree and a man at the same angle.
The man is 185 cm tall, and his shadow is 4 m long. The shadow of the tree is 11 m long.
To the nearest metre, the height of the tree is



A 5 m **B** 7 m **C** 8 m **D** 24 m

SECTION B

1 Dove is a used car salesperson. She tracks her sales each month and compares the number of her sales of cars that are at least 7 years old versus the number of her sales of cars that are less than 7 years old. This is shown in the radar chart on the next page. (5 marks)

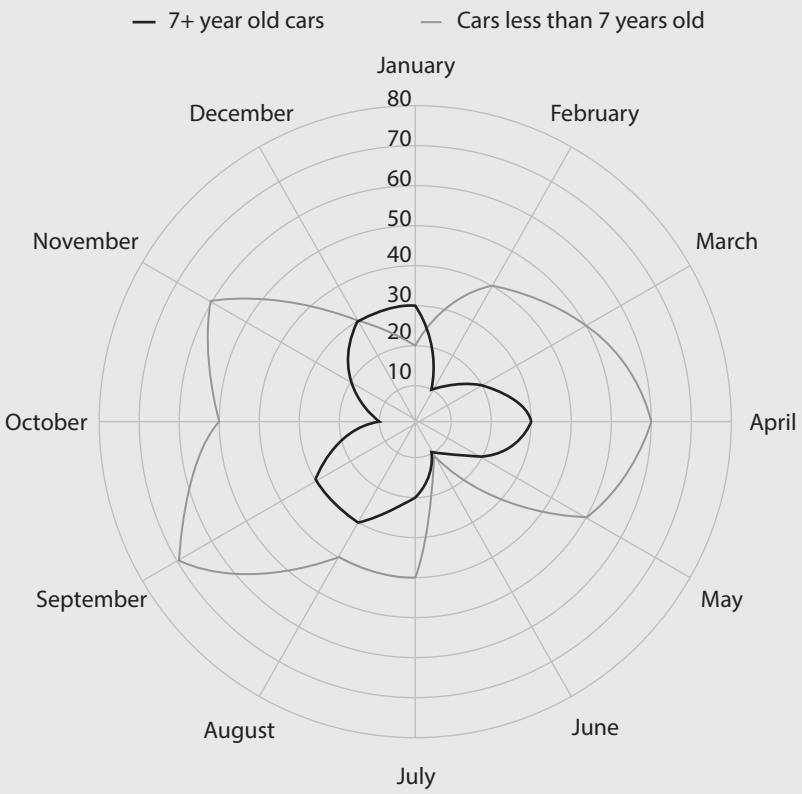
a When comparing her sales of cars that are at least 7 years old versus her sales of cars that are less than 7 years old, what is unusual about the values for January? 1 mark

b In which two months were her sales of cars that are at least 7 years old equal to her sales of cars that are less than 7 years old? 2 marks

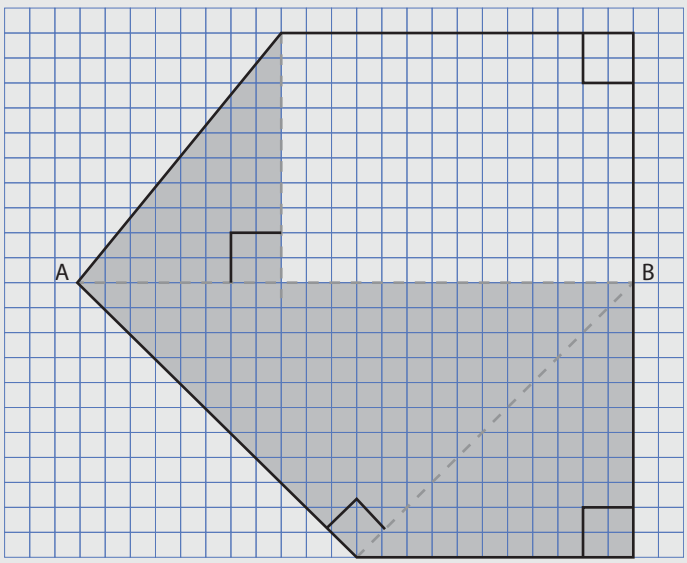
Dove compares the range of her monthly sales of cars that are at least 7 years old versus the range of her monthly sales of cars that are less than 7 years old.

c What is the difference between the two values of the range, and how could this affect her sales strategy overall? 2 marks

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.



2 A scale drawing of a block of land is shown below. The shaded area is to be concreted. Each small grid square represents 1 m by 1 m. (5 marks)



a Using the given scale, what is the actual distance AB? 1 mark

b Calculate the area, in square metres, that will be concreted. 3 marks

c The quote to concrete the area is $110 per square metre.
Calculate the total cost to do this work. 1 mark

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3 David's gross weekly income is $1,134, and his employer withholds $186 in PAYG tax every week. On his tax return, he lists $1,200 in tax deductions. (6 marks)

Assume David's income is consistent for the 52 weeks of the year.

Taxable income	Tax on income in the 2024–25 financial year
$0 – $18,200	Nil
$18,201 – $45,000	16 cents for each $1 over $18,200
$45,001 – $135,000	$4,288 plus 30 cents for each $1 over $45,000
$135,001 – $190,000	$31,288 plus 37 cents for each $1 over $135,000
$190,001 and over	$51,638 plus 45 cents for each $1 over $190,000

a Calculate David's taxable income. Show all required calculations. 3 marks

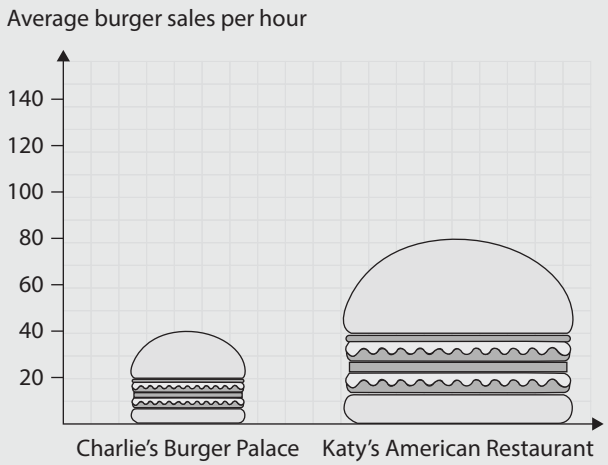
The Medicare levy is an amount paid in addition to the tax paid on taxable income. It is equal to 2% of taxable income.

b Calculate the amount David pays towards the Medicare levy. 1 mark

c Calculate the amount David paid via PAYG throughout the year. 1 mark

d Calculate the amount David will receive as a tax refund. 1 mark

4 Katy owns a successful burger restaurant. Her newest competitor is Charlie's Burger Palace. She produces the following chart to demonstrate her success relative to her competitor. (10 marks)



a Determine the average number of burger sales per hour for each restaurant according to the chart. 1 mark

b Explain what is misleading about this data representation. 1 mark

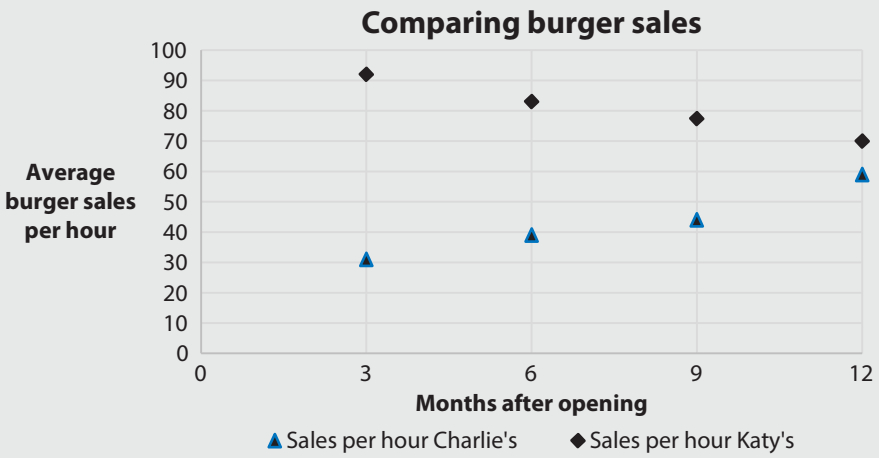
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

This table shows the average hourly burger sales from each restaurant at various points in time.

Months after Charlie's Burger Palace's opening	Average burger sales per hour	
	Charlie's Burger Palace	Katy's American Restaurant
3	31	92
6	39	83
9	44	77
12	59	70

c This chart shows the data values from the table. 2 marks

Draw a line of best fit for each data set.



d Describe the general trend of average hourly burger sales for each restaurant and propose a reason for this. 2 marks

e What is the linear equation for the line of best fit for Charlie's Burger Palace? 2 marks

f Using your equation, estimate the average hourly burger sales for Charlie's Burger Palace five months after opening. 1 mark

g Charlie estimates that the average hourly burger sales 30 months after opening will be 110 burgers per hour. How realistic is this estimate likely to be? 1 mark

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Revision Units 3 and 4: Exam-style questions

- The questions are divided into two sections: Section A and Section B.
- For Section A, all multiple-choice questions are worth one mark each.
- For Section B, the marks are indicated next to the questions and individual question parts.
- A downloadable version of these questions, including space for working out in Section B, is available in the Interactive Textbook.

SECTION A – Multiple-choice questions

1 This back-to-back stem-and-leaf plot illustrates the heights (cm) of Year 5 and Year 6 students in a composite class.

The number of students who have a height of at least 145 cm is

A 6 **B** 9

C 12 **D** 13

Key: 11 | 0 = 110 cm

Year 5	stem	Year 6
	12	9
9 9 6 5 1	13	3 4 5 6
9 7 6 4 3 2 1	14	1 2 5 8 9
	15	3 5 8
1	16	1 4
	17	1

2 A company is investigating ways to reduce gender inequality.

If $\frac{3}{8}$ of the employees are women, the ratio of women to men at the company is

A 3 : 5 **B** 3 : 8 **C** 5 : 3 **D** 5 : 8

3 A formula for calculating body weight for males is $W = 50 + 2.3h$ where W is the weight in kilograms, and h is the number of inches over 5 feet tall.

The calculated body weight for a man who is 5 feet and 8 inches tall is

A 61.5 kg **B** 68.4 kg **C** 73.0 kg **D** 108.0 kg

4 Archie's car insurance is $1181. Since Archie has not made any claims for three years, he receives a no-claim bonus discount of 30%.

His car insurance this year will cost

A $826.70 **B** $881.00 **C** $1062.90 **D** $1535.30

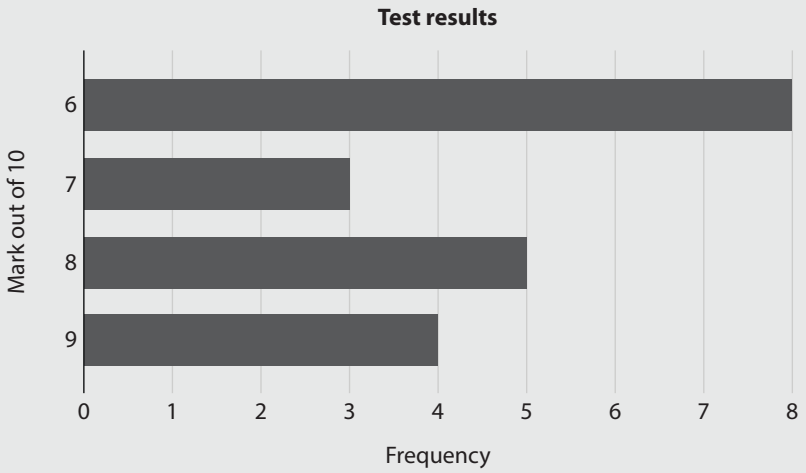
5 Fruit and vegetables are exempt from Australia's 10% GST.

If the total shopping bill is $163.00, and fruit and vegetables amount to $31.00, the cost of the other items prior to adding GST is

A $120.00 **B** $132.00 **C** $146.70 **D** $148.18

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6 A teacher assigns an automatically marked online quiz to their students. The software produces the following bar graph summarising the students' scores.



The range of the scores is

A 3 **B** 4 **C** 5 **D** 6

7 John budgets for the following housing-related costs: $2,200 per month for rent, $200 per month for utilities, $500 per year for renter's insurance, $300 per year for garden maintenance, and an amount to save towards a house deposit.
If he has an annual take-home income of $70,000 and allots 60% of it towards these costs, the maximum he can afford to save for his house deposit, per year, is

A $6,900 **B** $9,100 **C** $12,400 **D** $14,600

8 A full-time employee in Australia accrues annual leave at a rate of 2.923 hours per full-time work week of 38 hours. Annual leave does not accrue while an employee is on paid parental leave.

Suppose that Jake works full time for 15 weeks, excluding three weeks of paid parental leave. The amount of annual leave accrued by Jake is closest to

A 9 hours **B** 35 hours **C** 44 hours **D** 111 hours

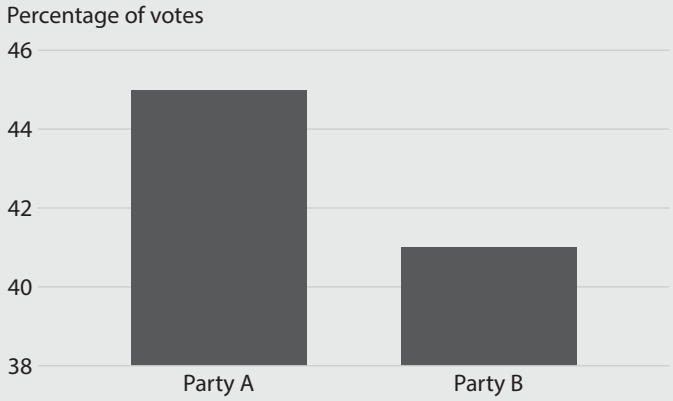
9 A company manufactures two types of smartphones, Type A and Type B. Last month they produced 5000 Type A smartphones and 3000 Type B smartphones. Out of the Type A smartphones, 212 had manufacturing defects, and out of the Type B smartphones, 138 had manufacturing defects.

The probability that a randomly selected smartphone from last month's total production will have a manufacturing defect is

A 4.24% **B** 4.38% **C** 4.42% **D** 4.60%

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

10 A graph was published by Party A to announce that they had won the election by a large margin over Party B.



What is the main reason this graph is misleading?

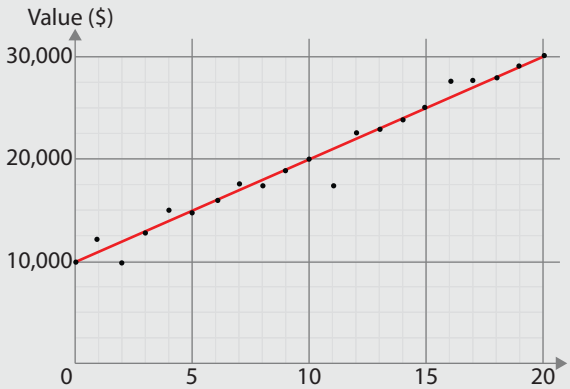
A The chart lacks a horizontal axis title.

B The percentages given do not add to 100.

C The broken vertical axis scale distorts the actual relative size of each column.

D The graph does not present the results for every candidate.

11 This graph shows how the value of an investment has increased over the past 20 years. A line of best fit has been drawn.



Next year, the increase in the value of the investment is most likely to be

A $1,000 **B** $1,500

C $2,000 **D** $2,500

12 A handmade jewellery store sells ceramic earrings. Each pair of earrings has $20 of associated costs, and there was also the $3,000 fixed cost of setting up the jewellery-making equipment.

The number of pairs of earrings that need to be sold so that the average cost per pair is $35 is

A 55 **B** 86 **C** 150 **D** 200

13 Anne has a drawing on A3 paper (297 mm × 420 mm). However, she wants to sell prints of this drawing that are A4 (210 mm × 297 mm) in size.

Which scale factor should Anne use to figure out the exact lengths of various parts of her drawing when it is scaled down?

A 0.50 **B** 0.71 **C** 1.41 **D** 2.00

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

14 Two friends compare their monthly incomes over the course of a year. One friend, Selena, owns her own business and the other, Bridie, is a full-time employee. They conclude that while Bridie's earnings are more consistent than Selena's, Selena's monthly income is generally higher than Bridie's.

Which is the most likely statement to represent this situation?

A Bridie's mean monthly income and the standard deviation of her monthly income are lower than Selena's.

B Bridie's mean monthly income is lower than Selena's, but the standard deviation of her monthly income is higher than Selena's.

C Selena's mean monthly income is lower than Bridie's, but the standard deviation of her monthly income is higher than Bridie's.

D Selena's mean monthly income and the standard deviation of her monthly income are lower than Bridie's.

15 The population of Lucky Springs increases by 1% every year.

After 10 years, the percentage increase, to 2 decimal places, is

A 10.00% **B** 10.46% **C** 110.00% **D** 110.46%

16 In a suburb with a population of 7532 people, a sample of 300 people are interviewed about whether they feel the area is safe.

Given 25 people answer 'no', the best estimate for the number of people in the entire suburb who feel unsafe is

A 301 **B** 325 **C** 587 **D** 628

17 A sales agent has a plan of an off-the-plan house with scale 1 : 100. She decides to double the length and width of the plan so she can display it on the wall of her office.

The scale of the enlarged plan is

A 1 : 25 **B** 1 : 50 **C** 1 : 200 **D** 1 : 400

18 The stated radius of a tennis ball is 3.35 cm, but the manufacturing tolerance is actually 3.35 ± 0.08 cm. Three tennis balls must be able to fit tightly inside a cylindrical container, as shown.

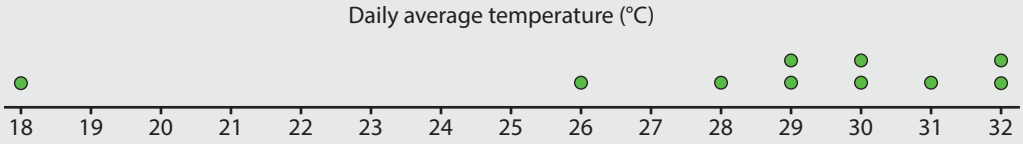
The tolerance for the total height of three balls in the cylinder is

A 6.70 ± 0.16 cm **B** 6.70 ± 0.48 cm

C 20.10 ± 0.16 cm **D** 20.10 ± 0.48 cm

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

19 The following dot plot shows the daily average temperature in a portable classroom for ten days.



After the outlier at 18°C is removed, the mean of the data set changes by

A 0.8°C **B** 1.2°C **C** 1.8°C **D** 2.0°C

20 A cylindrical rainwater tank can hold 10 000 litres, and it is 1.8 metres tall.

Note: 1000 litres capacity = 1 cubic metre volume. Use $\pi = 3.14$.

The radius of the tank is closest to

A 1.21 m **B** 1.33 m **C** 2.15 m **D** 2.39 m

SECTION B

1 A bakery is making a special type of bread called *SuperGrain* using two types of flour, Flour A and Flour B. Flour A costs \$4 per kilogram, while Flour B costs \$6 per kilogram. (5 marks)

a Calculate the cost per kilogram of flour used in the *SuperGrain* recipe if:

i the bakery decides to use Flour A and Flour B in a ratio of 3 : 2 for making *SuperGrain* bread 1 mark

ii the bakery decides to use Flour A and Flour B in a ratio of 2 : 1 for making *SuperGrain* bread. 1 mark

Baker's percentages give the weight of each ingredient as a percentage of the total weight of flour used. For instance, when the total weight of flour is 2 kg and the weight of sugar is 1 kg, the baker's percentage of sugar is 50%.

b Suppose the bakery decides to use Flour A and Flour B in a ratio of 3 : 2 for making *SuperGrain* bread. If 300 g of Flour B is used and 150 g of sugar is used, calculate the baker's percentage of sugar. 1 mark

Now, suppose the bakery's other loaf called *Basic* bread is produced according to the following recipe, where the amount of each ingredient is given as a baker's percentage.

Flour: 100% Water: 65% Salt: 2% Yeast: 1%

c Calculate the weight of water in grams in a batch of *Basic* bread using 10 g of yeast. 1 mark

d Emma is experimenting with the *Basic* bread recipe and chooses to increase the water percentage to 70%. If Emma uses 600 g of flour for this test batch, calculate the amount of water, salt and yeast needed. 1 mark

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

2 The ages of the seven employees in a team at a call centre are: 32, 19, 27, 21, 25, 24 and 65. (4 marks)

a Calculate the median age. 1 mark

b Calculate the mean age. Round your answer to the nearest year. 1 mark

c Suggest which measure of centre, the median or the mean, more accurately describes this data set. Explain your answer. 2 marks

3 The frequency of sound, measured in hertz, varies inversely with the wavelength of the sound waves, measured in metres. (3 marks)

a Given a sound with wavelength of 20 metres has a frequency of 17.15 hertz, determine the constant of proportionality. 1 mark

b Calculate the frequency of a sound of wavelength 13 metres. Give your answer in hertz, rounded to 1 decimal place. 1 mark

c Calculate the wavelength of a sound with frequency 10 hertz. Give your answer in metres, rounded to 1 decimal place. 1 mark

4 Heath is undergoing a training program to increase his running speed. He calculates his speed for one sprint every day to track his progress. He does this by measuring his distance and time using a trundle wheel and stopwatch. (8 marks)

a After dividing his distance from the trundle wheel by the time on the stopwatch, he calculates a speed of 2.07601 metres per second. Given the equipment he is using, explain why it makes sense for Heath to round the speed to a more realistic value. 1 mark

b He rounds the speed value in part **a** to 3 significant figures. What is that rounded value? 1 mark

Heath decides to use an app to determine his speed per run. His speeds, along with his friend Kabir's speeds, are displayed on the following back-to-back stem-and-leaf plot, correct to 1 decimal place. They vary the distance of the run on different days.

Key: 2 | 1 = 2.1 metres per second

Heath	stem	Kabir
9 9	0	9
7 6 4 3 1 1	1	3 5 7 7 9
3 2	2	1 4 8
	3	0

c Compare the shape of the two data distributions. 1 mark

d Complete the table of summary statistics for Heath's data and Kabir's data, rounding your answers to 1 decimal place as required. 2 marks

	Heath	Kabir
Mean		
Median		
Range		
Interquartile range		

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

e Decide who is the faster runner. Use summary statistics to explain your answer. 2 marks

f Heath wants to run at a speed of at least 2.1 metres per second for his next run. Calculate the probability of this. Give your answer as a simplified fraction. 1 mark

5 A factory produces coffee mugs. The cost associated with setting up a weekly production run is \$300, and the cost to produce each mug is \$1.50. Each mug is sold for \$3.50. (6 marks)

Let C be the cost in dollars per week, R be the revenue generated in dollars per week, and x be the number of mugs produced.

a Write a rule for C in terms of x, and a rule for R in terms of x. 2 marks

b The factory uses a spreadsheet to keep track of costs and revenue. Complete the remaining values in the table. 2 marks

	A	B	C
1	**Number of mugs, X**	**Production cost, \$$C$**	**Revenue form sales, \$$R$**
2	0	300	0
3	50	375	175
4	100		
5	150		
6	200		
7	250		
8	300		

c State the number of mugs that must be sold to break even. 2 marks

6 A large random sample of attendees at an interior design expo are asked: 'How important is it to you that your bedding feels soft and luxurious to ensure a good night's sleep?' (5 marks)

They rate this importance on a scale of 1 to 5. The data collected is displayed in this table.

Score given	Male	Female
1	10	14
2	3	11
3	6	14
4	0	15
5	1	16
Total	20	70

a State two flaws in the survey's approach. 2 marks

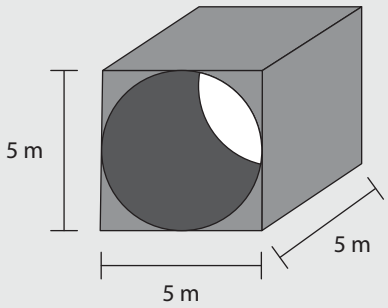
b Explain why the one score of 5 given by the male group is an outlier. 1 mark

c Explain, using values from the survey, whether the data supports the notion that soft and luxurious bedding matters more to females than males. 2 marks

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

7 The following 'hollowed out cube' tunnel is to be produced for a three-dimensional art installation. The tunnel is in the shape of a cylinder. (5 marks)

The surface area of the tunnel, including both the interior and exterior, is to be decorated with a mural. There is one design for the interior of the tunnel and another design for the exterior of the tunnel.



a Calculate the combined area of the flat exterior surfaces of the tunnel, not including the square base. 2 marks

b Calculate the area of the curved interior surface of the tunnel. Hence, find the total surface area of the whole solid, not including the base. 2 marks

c The unpainted tunnel costs $3,000 to construct. The mural painter charges $1,000 per decorated square metre. Calculate the total cost of the finished tunnel installation. 1 mark

8 A dance studio owner identified 12 beginner ballroom dancers as 'struggling'. They are offered additional practice hours to improve their chances of receiving a passable result at an upcoming examination. (5 marks)

The table shows the number of additional practice hours for these dancers, as well as their examination mark.

Student	Additional practice hours	Mark awarded at examination
Aisha	4	55
Bianca	5	65
Carlos	3	40
Daiki	8	80
Elena	6	65
Farid	3	60
Gabriela	5	60
Hanif	6	70
Ingrid	4	45
Jia	4	50
Khaled	7	75
Leela	1	35

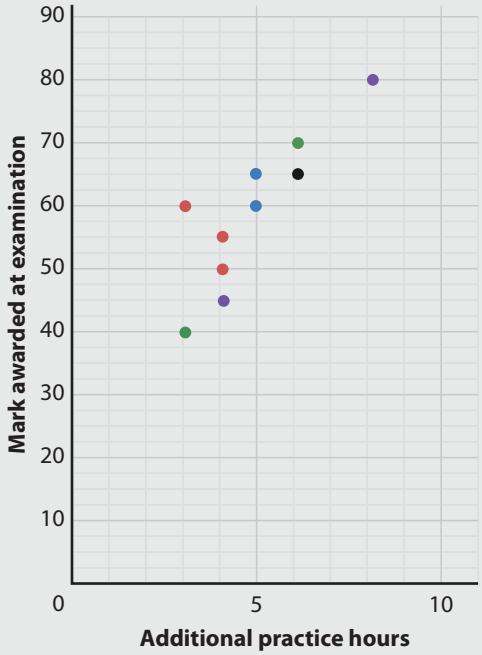
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

a The scatterplot shows the data values for all students except Khaled and Leela. Plot the results for these two students using a cross, X. 1 mark

b Suggest why a scatterplot was a suitable representation for this data. 1 mark

c Draw a line of best fit on the given scatterplot. 1 mark

d Use your line of best fit to estimate the typical result these students may have received if they had not done the additional practice. 1 mark



The following year, the studio owner decides to repeat the strategy. One of the 'struggling' students asks what mark she are likely to receive if she does two hours of additional practice.

e Use your line of best fit to estimate the result she is likely to receive. 1 mark

9 John is designing a wheelchair-friendly ramp for his building. He wants the ramp to have a 1 : 14 slope ratio, meaning for every centimetre of vertical rise, there should be a horizontal distance of 14 cm. (5 marks)

The ramp needs to connect the ground level to the entrance of the building. The vertical rise from the ground level to the entrance is 50 cm.

a Calculate the horizontal distance needed for the ramp to meet the 1 : 14 slope ratio. 2 marks

The maximum horizontal distance the ramp can take up is 1500 cm. John decides to use the 1 : 14 ratio and take up the entire maximum horizontal distance. In addition, John wants to add a level platform in the middle of the ramp to allow for wheelchair users to have a rest. He decides to place the level platform exactly halfway between two identical inclined sections.

b Calculate the length along the slope of each of the inclined sections, as well as the length of the platform. Show all working. 3 marks

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Answers

Chapter 1

1C Tasks and questions

1, 2 Answers will vary

3 Answers will vary but an example might be:
Formulate the problem: Questions c, d, g, h
Explore solutions: Questions a, b, e, f; Answers c, d, g, h
Communicate the solution: Answers a, b, e, f

1E Tasks and questions

1 Answers will vary

2 Mathematical words: Percentage of alcohol, Drink volume, Formula
Mathematical symbols: %, ×, ÷ (as fraction), =
Mathematical abbreviations: mL
Different types of numbers: 100, 12.50, 375, 2.7, 0.027. 0.81, 150, 11.5, 0.115, 1.38

3 a Drink volume is multiplied by percentage of alcohol content of the drink divided by 100. The result is then divided by 12.50.

b Answers will vary

c No, they were exact to 2 decimal places.

4 a 7.5 **b** 0.9

c 1.5 **d** 1.37

Chapter 2

2B Practice questions

1 a Five hundred and ninety-three

b Four hundred and thirty-five thousand, two hundred and thirty-seven

c Four hundred and thirty-five million, six hundred and seventy-eight thousand, two hundred and forty-five

d Two billion, three hundred and forty-nine million, nine hundred and eighty-eight thousand, one hundred and twenty-three

2 a $\frac{1}{4}$, 25% **b** $\frac{2}{5}$, 40%

c $\frac{2}{3}$, $66\frac{2}{3}\%$ **d** $\frac{3}{4}$, 75%

2C Tasks and questions

3 a $\frac{5}{1}$ **b** $\frac{5}{2}$

c $\frac{15}{4}$ **d** $\frac{39}{20}$

4 a Rational **b** Rational

c Irrational **d** Rational

5 a 0.2 **b** 0.04

c $0.\dot{3}$ **d** $0.\dot{1}$

6 a $\frac{9}{2}$ **b** Irrational

c $\frac{27}{4}$ **d** $\frac{7}{3}$

7 Answers will vary

8 a 1.414 or 0.416 (to 3 d.p.)

b $\sqrt{2}$

2D Tasks and questions

1

Power	Squares	Square roots	Cubes	Cube roots
2	$2^2 = 4$	$\sqrt{4} = 2$	$2^3 = 8$	$\sqrt[3]{8} = 2$
3	$3^2 = 9$	$\sqrt{9} = 3$	$3^3 = 27$	$\sqrt[3]{27} = 3$
4	$4^2 = 16$	$\sqrt{16} = 4$	$4^3 = 64$	$\sqrt[3]{64} = 4$
5	$5^2 = 25$	$\sqrt{25} = 5$	$5^3 = 125$	$\sqrt[3]{125} = 5$
6	$6^2 = 36$	$\sqrt{36} = 6$	$6^3 = 216$	$\sqrt[3]{216} = 6$
7	$7^2 = 49$	$\sqrt{49} = 7$	$7^3 = 343$	$\sqrt[3]{343} = 7$
8	$8^2 = 64$	$\sqrt{64} = 8$	$8^3 = 512$	$\sqrt[3]{512} = 8$
9	$9^2 = 81$	$\sqrt{81} = 9$	$9^3 = 729$	$\sqrt[3]{729} = 9$
10	$10^2 = 100$	$\sqrt{100} = 10$	$10^3 = 1000$	$\sqrt[3]{1000} = 10$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

2 **a** 13 **b** 5
c −22 **d** 35
3 **a** 9 **b** 1
c 64 **d** 216
e 16 **f** 36
g 625 **h** 64
4 **a** 2 **b** 5
c 2 **d** 4
e 7 **f** 5
5 **a** 32 **b** 8
c 14 **d** 256
e 34 **f** −14
g 9 **h** 4
6 Number of cars = ((4 + 3 + 2 + 3) ÷ 2) ÷ 2
7 Answers will vary
8 **a** $1,380 **b** $1,400 **c** $1,390
9 **a** Erica: 34 + (572 ÷ 52), Josiah: 34 + 15
b Erica: $45, Josiah: $49
c Erica: $2,340, Josiah: $2,548
d $2,165.80
10 **a** 27 cm^3 **b** 64 m^3
c 274.625 cm^3 **d** 15 625 mm^3
e 5 cm **f** 6 m

2E Tasks and questions

1 **a** Estimated **b** Actual
c Estimated **d** Actual
2 **a** 23.77 **b** 1 345 000
c 0.055 **d** $68
e 123 693 **f** $176.94
3 **a** 23.1 **b** 0.30
c 45 000 **d** 0.004 57
4 **a** 0.000 000 3 **b** 900
c 0.000 03 **d** 70 000
5 **a** Floor value: 15, ceiling value: 16
b Floor value: 4, ceiling value: 5
c Floor value: 1403, ceiling value: 1404
d Floor value: −1, ceiling value: 0
6 **a** 36.5–37.5°C
b 241–259 mL
c Answers will vary; e.g. 35–45 min
d Answers will vary; e.g. 50–60 min
e 0.9–1.2 mL
7 **a** E **b** A **c** F **d** G
e D **f** B **g** H **h** C
8 0.02
9 $76
10 23.35–23.45 g
11 Floor value: 1 m, ceiling value: 2 m
12 Reasonable
13 Unreasonable
14 Reasonable
15 No, this is unreasonable
16 **a** 60 m
b Answers will vary; possible example: Cost of timber fence is between $3000 and $7200.
c Estimate is 16 × $40 = $640
d Answers will vary; possible example: Total cost of timber fence is between $4000 and $8000.
17 Answers will vary

2F Tasks and questions

1 Answers will vary
2 **a** $2.458\,76 \times 10^{8}$ **b** 5.6×10^{-6}
c 2.3×10^{-1} **d** 1.0×10^{6}
3 **a** 2300 **b** 0.000 013 6
c 0.005 **d** 745 000 000
4 **a** 6.82×10^{-7} **b** 3.84×10^{-2}
c 8.59 **d** 4.27×10^{-9}
e 2.92×10^{9}
5 9.2×10^{18} dollars
6 **a** 2.12×10^{7}
b New Zealand and Micronesia
c 3.64×10^{7}

Chapter review questions

1 **a** Rational **b** Irrational
c Irrational **d** Rational
2 **a** 4 **b** 100
c 4 **d** 2187
e 10 000 000 000 (or 10^{10})
f 15 552 **g** 25
h 257

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3 **a** 45.68 **b** 68 000
c 0.000 76 **d** $2,600
4 **a** 20 **b** 0.000 34
c 100 000 **d** 790 000
5 **a** 0.000 07 **b** 20
c 0.008 **d** 20 000 000
6 **a** Floor value: 98, ceiling value: 99
b Floor value: $798, ceiling value: $799
c Floor value: 3030 mm, ceiling value: 3031 mm
d Floor value: 246, ceiling value: 247
e Floor value: −17°C, ceiling value: −16°C
f Floor value: −$2,570, ceiling value: −$2,569
7 **a** 120–130 g
b 45–55 min
c 1150–1250°C
d Answers will vary
8 **a** 3.5×10^{7} **b** 7.6×10^{-5}
c 6.5×10^{4} **d** 4.35×10^{-5}
9 **a** 20 000 000 000 000
b 0.0065
c 0.000 009 8 **d** 4 550 000 000

Chapter 3

3A Starting activities

Activity 1

1 **a** 2 times taller, 2 : 1
b $\frac{2}{3}$ times smaller, 2 : 3
c 50%
d 1 : 4
e 3 : 2

Activity 2

1

Project	Total amount of dry ingredients	Cement	Sand	Aggregate
Heavy duty floor	30 shovels	5 shovels	10 shovels	15 shovels
Path	17.5 shovels	2.5 shovels	5 shovels	10 shovels
Mortar	6.25 shovels	1.25 shovels	5 shovels	
Column	24 shovels	6 shovels	6 shovels	12 shovels
Footings	3.5 m^3	0.5 m^3	1.5 m^3	1.5 m^3
High strength floor	3 m^3	0.75 m^3	0.75 m^3	1.5 m^3

3B Practice questions

1 **a** 6 cm and 4 cm
b 1 cm and 48 cm, 2 cm and 24 cm, 3 cm and 16 cm, 4 cm and 12 cm, or 6 cm and 8 cm
2 $6\frac{3}{4}$ cups of flour, 6 eggs, 750 mL of milk
3 $70, $70 and $35
4 34.3%
5 **a** 21.1%, $\frac{1}{5}$ **b** 25.1%, $\frac{1}{4}$
c 12.5%, $\frac{1}{8}$
6 **a** 4 : 15 **b** 14 : 5 **c** 9 : 16
7 $2,720

3C Tasks and questions

1, 2 Answers will vary
3 **a** **i** 4 **ii** 4 **iii** 1 : 4
b **i** 8 **ii** 30 **iii** 2
iv 3 **v** 2 : 3

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4 **a** 3 : 2 **b** 2 : 1 : 3
c 1 : 2 **d** 4 : 1

5 **a** 1 : 3 **b** 11 : 2
c 5 : 3 **d** 60 : 37

6 **a** 6 : 1 **b** 1 : 20
c 8 : 1 **d** 1 : 8

7 **a** Ratio 1 : 5

x	1	2	4	7	9
y	5	10	20	35	45

b Ratio 5 : 2

x	10	20	40	50	110
y	4	8	16	20	44

8 **a**

x	10	15	40	50	100
y	6	9	24	30	60

b

x	2	4	6	10	40
y	3	6	9	15	60

9 b

10 a

11 **a** 20 **b** 6
c 66 **d** 9

12 **a** **i** Multiply by 8
ii 720 g
iii 18 cups
b **i** Divide by 2
ii 1 egg
iii $\frac{1}{2}$ cup

13 **a** Ratio 1 : 3

a	3	6	9	12	15
b	9	18	27	36	45

b Ratio 4 : 3

a	4	8	12	20	40
b	3	6	9	15	30

14 **a** Not in proportion. First shape = 4 : 10 = 2 : 5, second shape 2 cm by 5 cm
b Not in proportion. First shape = 5 : 5 : 3, second shape 4 cm by 4 cm by 2.4 cm

15 **a** Factor of $\frac{2}{3}$
b 8
c $2\frac{2}{3}$ cups

16 d

17 **a** 2 cm **b** 2 km

18 **a** 2 : 4 : 1 : 1
b James $100, Lin $200, Bob and Sharon $50 each

19 **a** 1 : 250
b **i** 32 mL **ii** 8 mL **iii** 2 mL
c **i** 5 L **ii** 1 L **iii** 250 mL

20 **a** 2.5 m **b** 85 cm
c 4.8 m **d** 95 cm

21 **a** 10 kg
b 45 kg Chemical A, 30 kg Chemical B

22 **a** 400 g
b 225 g primary colour, 75 g secondary colour, 300 g developer
c Add 3 extra parts primary colour and 1 extra part secondary colour
d Multiply by a factor of 0.8

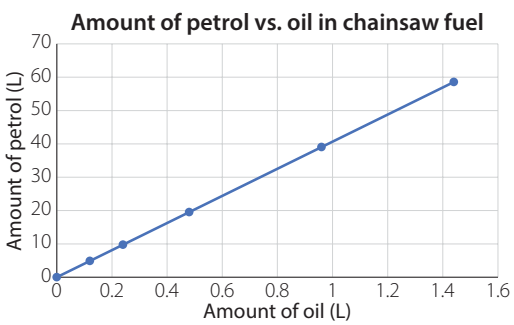
3D Tasks and questions

1 Answers will vary

2 **a**

Total fuel (L)	5	10	20	40	60
Petrol (L)	4.88	9.76	19.51	39.02	58.54
Oil (L)	0.12	0.24	0.49	0.98	1.46

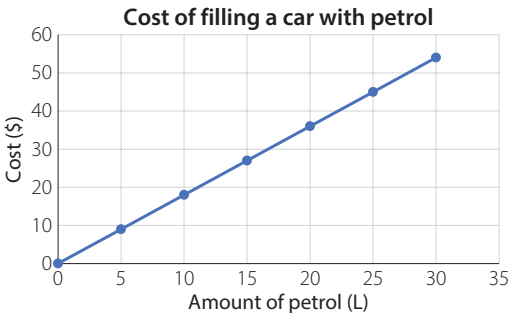
b



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3 **a** Graphs b and d

4 **a**



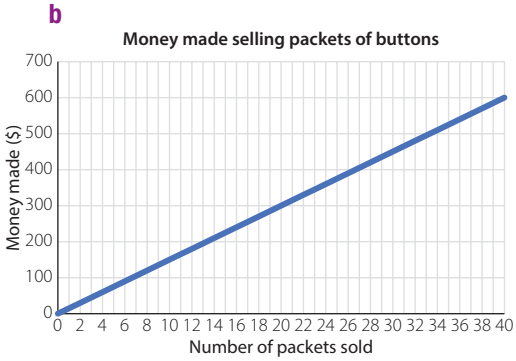
b Straight-line graph starting from (0, 0).

5 $584.80

6 **a**

Packets sold	0	1	2	3	4	…	39	40
Money made ($)	0	15	30	45	60	…	585	600

b



c Yes, straight-line graph starting at (0, 0).

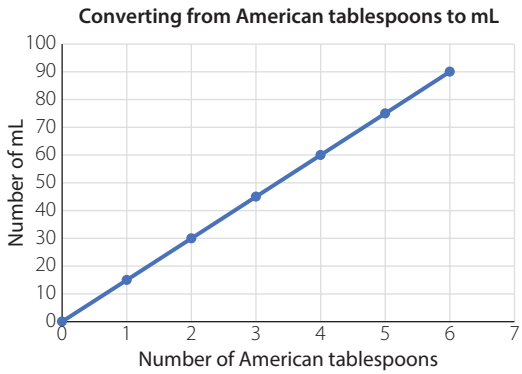
7 **a** 500 kg **b** 24 mL

8 **a** 5.71 cm **b** 875 mL

9 **a**

Number of American tablespoons	0	1	2	3	4	5	6
Number of mL	0	15	30	45	60	75	90

b



10 **a** **i** 6 kg **ii** 14 kg
iii 56 kg **iv** 210 kg

b 4 bags total, with only 1.5 kg used from the last bag

3E Tasks and questions

1, 2 Answers will vary

3 6 days

4 1.25 hours

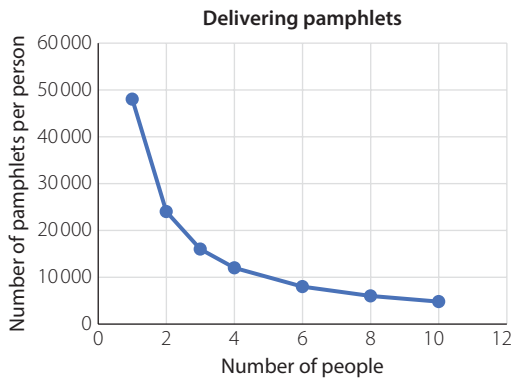
5 3 hours

6 **a** 4.5 hours **b** 6 hours **c** 9 hours

7 **a**

Number of people	Number of pamphlets per person
1	48 000
2	24 000
3	16 000
4	12 000
6	8000
8	6000
10	4800

b

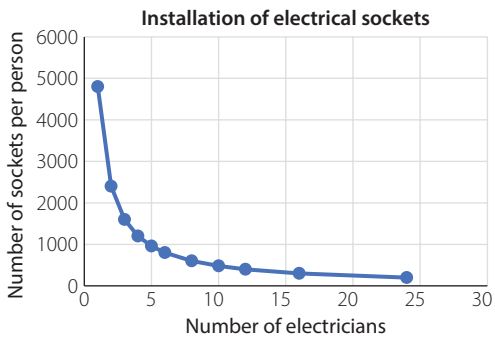


ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

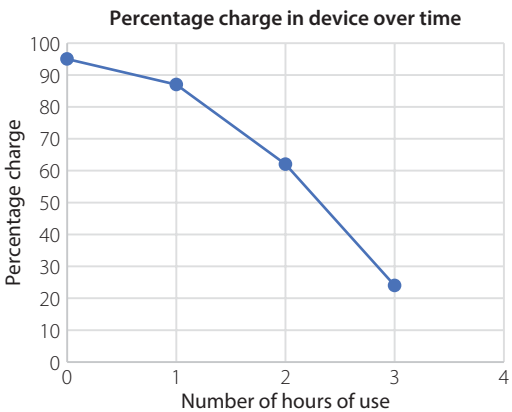
8 a

Number of electricians	Number of sockets per person
1	4800
2	2400
3	1600
4	1200
5	960
6	800
8	600
10	480
12	400
16	300
24	200

b



9 a



b Approx. 2.3 hours

10 a 18 workers

b

Number of workers	2	4	6	8	10	12
Hours taken to build barrier	72	36	24	18	14.4	12

11 a 4 hours (round up to empty all water)

b 2 pumps

3F Tasks and questions

1 a No, the final level (L3) is not the same as the first level (L1).

$L2 = 0.85 \times L1$

$L3 = 1.15 \times L2 = 1.15 \times 0.85 \times L1$

$= 0.9775 \times L1$

b Yes, $\frac{32}{100} \times 15 = \frac{15}{100} \times 32 = 4.8$

2 Answers will vary

3 a 11.0% **b** 40.6%

c 30.9% **d** 80.8%

4 a 7.8 **b** 26.1

c 48.94 **d** 214.38

5 a 1097.0 **b** 216.7

c 147.4 **d** 143.3

6 320

7 69.6% (to 1 d.p.)

8 36

9 5000

10 47.25

11 42.8% (to 1 d.p.)

12 101.16

13 a 8 **b** 12.5%

c 3.5% **d** 3.5%

e 0.121% **f** 0.121%

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

14

	Number of loaves to manufacture				
	1	5	10	100	200
Flour (g)	450	2 250	4 500	45 000	90 000
Water (g)	283.5	1 417.5	2 835	28 350	56 700
Salt (g)	8.1	40.5	81	810	1 620
Dry yeast (g)	6.3	31.5	63	630	1 260
Butter (g)	18	90	180	1 800	3 600

3G Tasks and questions

1 Answers will vary

2 **a** $164 **b** $304
c $43.74 **d** $59.37

3 **a** $345 **b** $80.07
c $18.20 **d** $65,205

4 **a** 17.6% **b** 65.8%
c 50.9% **c** 10.2%

5 $133

6 47.1% (to 1 d.p.)

7 $156.98

8 38.5% (to 1 d.p.)

9 $79.20

10 **a** wholesale
b retail, increase, profit
b discount
c expenses, income, mark up

11 Answers will vary

3H Tasks and questions

1 Answers will vary

2 **a** 9% **b** 17%
c 93%

3 **a** 5.2% **b** 0.4%
c 5.6% **d** 1.3%

4 **a** 16.7% **b** 2.1%
c 15.4%

5 26.4%, acceptable

6 18.1%, unacceptable

7 46.7%, unacceptable

8 0.4%, acceptable

9 **a** 8.6%, acceptable
b 8.1%, acceptable
c 90%, unacceptable
d 0.9%, unacceptable

10 **a** 3.8% **b** 7.6%
c 7.4% **d** 6.7%
e 11.8%

11 Answers will vary

Chapter review questions

1 **a** 4 : 7 : 3 **b** 10 : 3
c 7 : 16 **d** 12 : 19

2 Ratio 1 : 3

a	1	5	10	15	25	30
b	3	15	30	45	75	90

3

a	2	4	10	20	50
b	5	10	25	50	125

4 b and d

5 67.5 cm

6 150 mL

7 Direct variation

8 2 m

9 **a** 0.5 teaspoons
b 1.5 teaspoons
c Direct variation; variables are in direct proportion

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

10 a

Number of people	1	2	3	5	10	20
Time (in hours)	10	5	3.3	2	1	0.5

b Indirect variation

11

Fuel tank size (in L)	18	30	50	62	78
Petrol (in L)	17.6	29.4	49.0	60.8	76.5
Marine oil (in L)	0.4	0.6	1.0	1.2	1.5

12 a 18%
b 24 g
c $78,000
d 25%

13 a 11.1%
b 2.0%

14 a Unacceptable
b Acceptable

Chapter 4

4A Starting activities

Activity 1

6 7

Activity 2

1 Total cost = fixed cost + hourly cost × number of hours

2 $C = 75 + 150 \times n$, where C is the total cost and n is the number of hours spent on the job

3 $300

4 30 min

4B Practice questions

1, 2 Answers will vary

3 a Number of notes = 420 ÷ 5
b Number of holes = 200 ÷ 4
c Number of crates = 5 × 50 ÷ 9
d Average distance between stops = 68 ÷ 14
e Cost = 6 × 19.95 + 3 × 11.35

4C Tasks and questions

1 a D
b G
c A
d E
e F
f C
g B

2 a 2
b π
c $\frac{5}{9}$
d $\frac{1}{3}$

3 a P, r
b V, a, h
c D, m, v
d V, r, h

4 a Variable: x; coefficient: 3; constants: 10, 28

b Variable: m; coefficient: 5; constants: −8 and 22

c Variables: a, b, c; coefficients: 2, 5; constant: 120

d Variables: p, x; coefficients: 12, 4; constant: 6

5 a $100 - (2j + h)$; j is cost of jeans ($), h is cost of hoodie ($)

b $2g + 45$; g is cost of gold pass ($)

c $6c + 2h + s + 2$; c is cost of chicken nugget ($), h is cost of hash brown ($), s is cost of soft drink ($)

d $n(12a + 15b)$; n is number of rows, a is income from an orange tree ($), b is income from an avocado tree ($)

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6 $4s + 2j$; s is cost of a shirt (\$), j is cost of a jumper (\$)

7 $3A + 2C$

8 $2.35p$

9 C is cost (\$), b is number of bags

a $C = 99 + 35b$ **b** $C = 454 + 45b$

c $C = 448.5 + 55b$ **d** $C = 637 + 68b$

e $C = 570 + 35b$ **f** $C = 454 + 90b$

10 a 500 000 **b** 417

c $\frac{5N}{6}$ **d** 1200

e 2880 **f** 28 800

g 3840 **h** 5760

4D Tasks and questions

1 Answers will vary

2 a 26 **b** 26

c 6.5 **d** 30

3 a 290 **b** 450

c 100 **d** 229

4 a \$90 **b** \$39.50

c \$632 **b** 10

5 a 78.5 mm^2 **d** 200 km

c 600 cm^3 **b** 30°C

6 235.6 cm^2

7 \$22.75

8 a 1987.8 **b** 0.3

9 a $n = \frac{l \times w \times h}{8}$ **b** 7.7 trucks

c No, we cannot have 0.7 trucks

c 8 trucks

10 a i $m = 2c + 3k$; m is daily number of feeds, c is number of cats, k is number of kittens

ii $n = 2d + 3p$; n is daily number of feeds, d is number of dogs, p is number of puppies

b $T = 2c + 3k + 2d + 3p$; T is daily total number of feeds, c is number of cats, k is number of kittens, d is number of dogs, p is number of puppies

c $F = 14(2c + 3k + 2d + 3p)$; F is total number of feeds in 2 weeks, c is number of cats, k is number of kittens, d is number of dogs, p is number of puppies

d 2632

e \$23,072

4E Tasks and questions

1 Answers will vary

2 a $y = 7 - 2$ or $y = 5$

b $y = 7 - z - 5$ or $y = 2 - z$

c $y = \frac{x + 8}{4}$

d $y = \frac{3x - 54}{6}$ or $y = \frac{x}{2} - 9$

3 a $A = lw$ **b** $A = \frac{3V}{h}$

c $A = \pi r^2$ **d** $A = \frac{h(t + b)}{2}$

4 a $b = \frac{2A}{h}$ **b** 4.8

5 a $E = V + F - 2$ **b** 12

6 a $x = \frac{y - 30}{5}$ **b** $h = \frac{a}{2\pi r} - r$

c $r = \frac{p}{2\pi}$ **d** $m = \frac{2E}{v^2}$

7 a $a = \frac{F}{m}$ **b** $a = 1.96$

8 a $W = 25.65h + 0.15s$ **b** \$1195.95

c $0.15s = W - 25.65h$ **b** \$1200

9 a $D = 15w$; D is dose (mg), w be the weight of the child (kg)

b 75 mg

c $w = \frac{D}{15}$

d 10 kg

10 a $l = \frac{P - 2w}{2}$ **b** 10 m

11 a $a = \frac{v_f - v_i}{t}$ **b** 0.4 m/s^2

4F Tasks and questions

1 Answers will vary

2 Linear: a, c, d, e, f, i, j, k, l
Quadratic: b, h
Exponential: g

3 Linear: c, e
Quadratic: a, d
Exponential: b, f

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4 a

x	0	1	2	3	4	5
y	3	5	7	9	11	13

b

x	0	1	2	3	4	5
y	2	6	10	14	18	22

c

x	0	1	2	3	4	5
y	8	6	4	2	0	−2

d

x	0	1	2	3	4	5
y	7	5	3	1	−1	−3

5 a

x	0	1	2	3	4	5
y	−2	−5	−8	−11	−14	−17

b

x	0	1	2	3	4	5
y	2	2.5	3	3.5	4	4.5

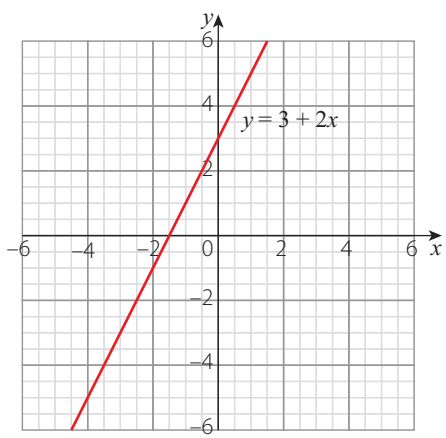
c

x	0	1	2	3	4	5
y	3	5	7	9	11	13

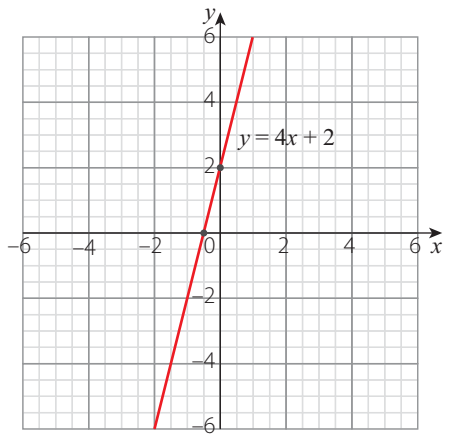
d

x	0	1	2	3	4	5
y	3	1	−1	−3	−5	−7

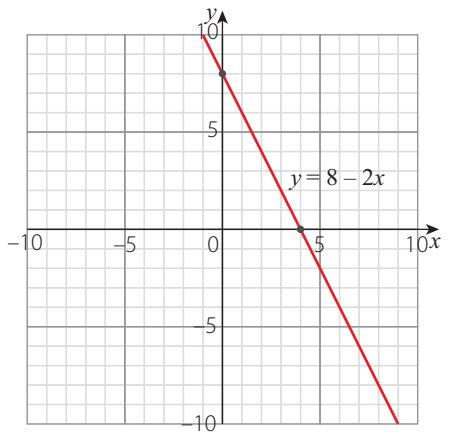
6 a



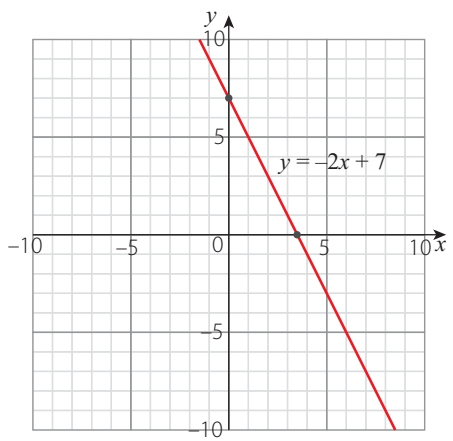
b



c

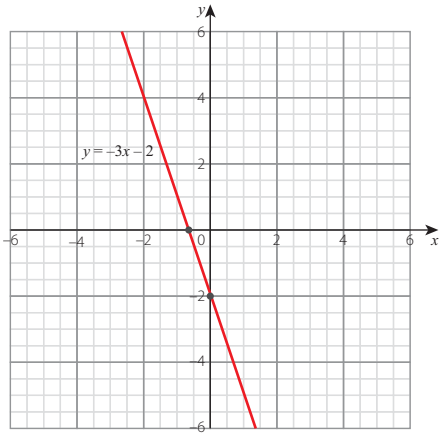


d

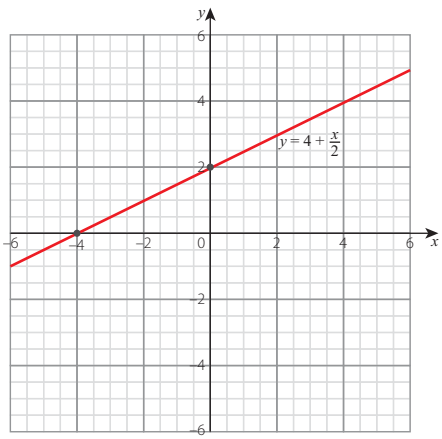


ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

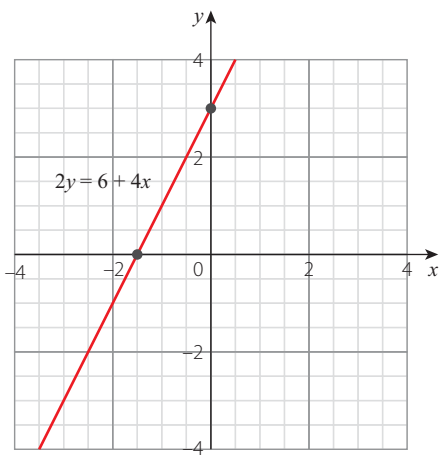
7 a



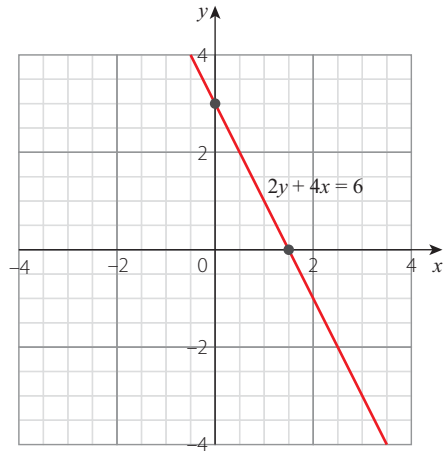
b



c



d



8 a y-intercept: 30, slope: 4
b y-intercept: 14, slope: 6
c y-intercept: 4, slope: 15
d y-intercept: 18, slope: -3
e y-intercept: 6, slope: -4
f y-intercept: 12, slope: 1

9 a y-intercept: 7, slope: 4
b y-intercept: 3, slope: 2
c y-intercept: 19, slope: -2

10 a $y = 1 + 2x$ **b** $y = 20 - 2x$
c $y = 4 + \frac{1}{2}x$ **d** $y = 20 - 4x$
e $y = 5 - 3x$ **f** $y = 5 + 3x$

11 Linear: b, d, e, f, h (x and y raised to power of 1)
Not linear: a (x raised to power of 2, not 1), c (y raised to power of 2, not 1), g (x is a power)

12 b $y = -2x + 7$ **d** $y = \frac{3}{4}x + 4$
e $y = 2x + 5$ **f** $y = \frac{2}{3}x + \frac{5}{3}$
h $y = -\frac{2}{3}x + \frac{1}{3}$

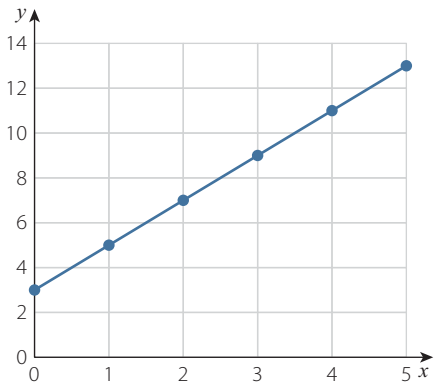
13 a B **b** B
c A **d** B

14 a C **b** B

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

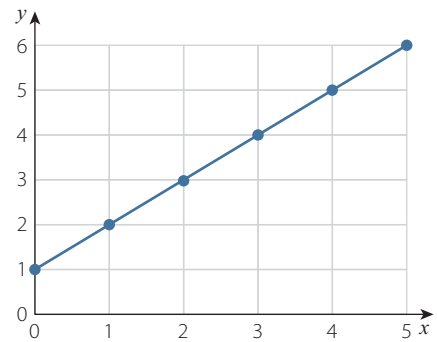
15 a

x	0	1	2	3	4	5
y	3	5	7	9	11	13



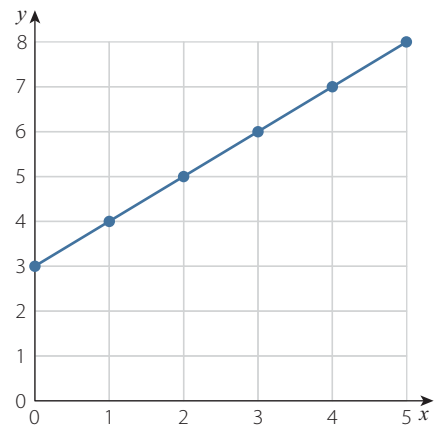
b

x	0	1	2	3	4	5
y	1	2	3	4	5	6



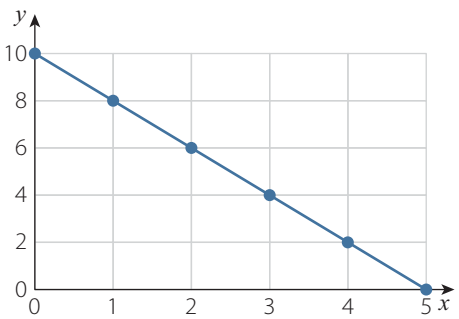
c

x	0	1	2	3	4	5
y	3	4	5	6	7	8



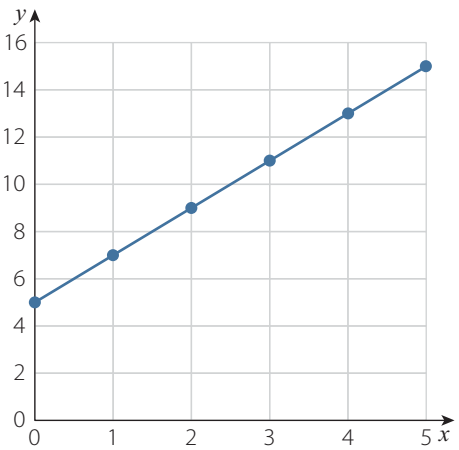
d

x	0	1	2	3	4	5
y	10	8	6	4	2	0



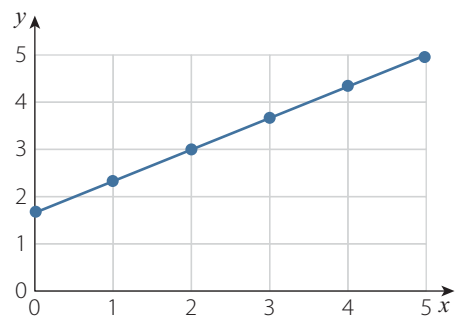
e

x	0	1	2	3	4	5
y	5	7	9	11	13	15



f

x	0	1	2	3	4	5
y	$\frac{5}{3}$	$\frac{7}{3}$	3	$\frac{11}{3}$	$\frac{13}{3}$	5



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

16 **a** C **b** F
c E **d** D
e B **f** A

17 Answers will vary

18 $T = 75 + 120h$, T is total amount charged ($), h is number of hours worked

h	0	1	2	3	4	5
T	75	195	315	435	555	675

a $435 **b** 2 hours
c 6 hours

19 **a** Chris
b Slope of the graph; steeper line shows greater rate per hour
c m

20 **a** 2.4 km/h **b** 11:20 am
c 3.2 km **d** 4 km
e $y = 8 - 2.4x$ **f** 0.8 km

21 **a** $3.50 **b** $2
c Flag fall is a constant (doesn't depend on the distance)

4G Tasks and questions

1 Answers will vary

2 **a** **i** Selling 3 artworks for $850
ii Price of both options same for selling 3 artworks, option A best for selling more than 3 artworks, option B best for selling less than 3 artworks
b **i** Hiring for 3.5 hours for $340
ii Cost at both companies same when hiring for 3.5 hours, company A best when hiring for less than 3.5 hours, company B best when hiring for more than 3.5 hours
c **i** Catering for 34 people for $2,700
ii Cost at both venues same when catering for 34 people, venue A best when catering for more than 34 people, venue B best when catering for less than 34 people
d **i** Commission of $1,140 for selling 14 items
ii Commission at both companies same when 14 items sold, company A best when less than 14 items sold, company B best when more than 14 items sold

3 **a** $x = 9, y = 6$ **b** $x = 1, y = -1$
c $x = 1, y = -1$ **d** $x = 15, y = 3$

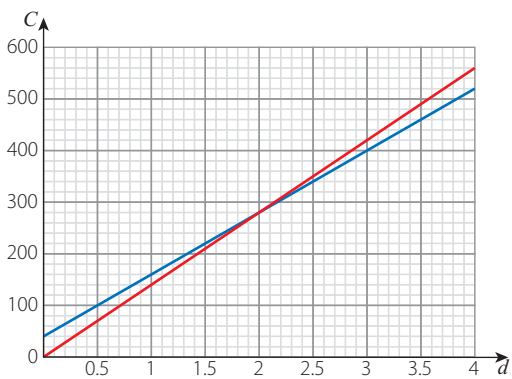
4 **a** $a = 2, b = 6$ **b** $x = -2, y = -1$
c $h = 4, i = -2$ **d** $x = -1, y = 1$

5 **a** $x = 2, y = -4$ **b** $a = 5, b = 7$
c $x = 5, y = -1$ **d** $x = 1, y = 4$
e $x = 16, y = 10$ **f** $x = -\frac{13}{3}, y = -6$

6 1200 children and 800 adults

7 When the distance is greater than 100 km

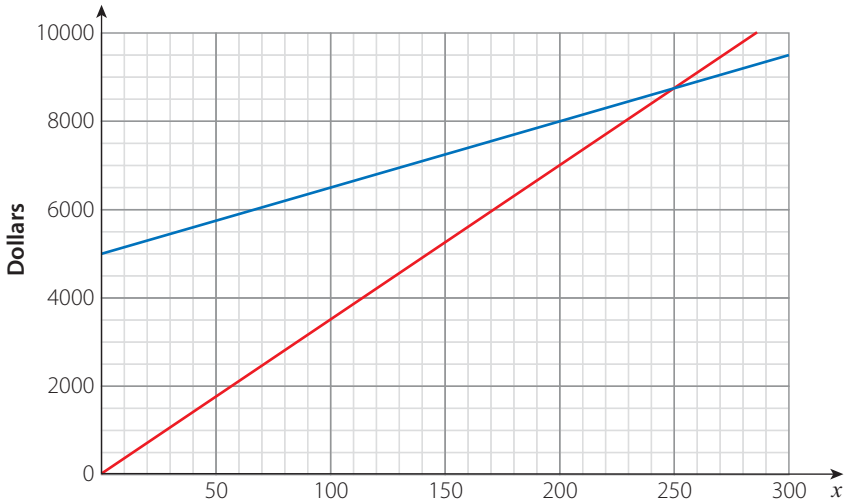
8 Hilda's Hiring: $C = 40 + 120d$
Rex's Rents: $C = 140d$
C is hire cost, d is number of days



Costs same when rotary hoe hired for 2 days. Cheaper to hire Hilda's for more than 2 days and cheaper to hire Rex's for less than 2 days

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9



The break-even point is 250 paddle boards.

Chapter review questions

1 a Number of boxes = 500 ÷ 80

b Answers will vary

c Number of cars = 1000 ÷ (1.8 × 4.85)

2 Answers will vary

3 a Variables: P, l, w; coefficients: 2

b Variables: C, r; coefficients: π, 2

c Variables: x, y; coefficient: 7; constant: 5

d Variables: F, m_1, m_2, d; coefficient: G

e Variables: F, V, E; constant: 2

4 a 12.96 m^2

b 1.452 m^3

c $81.37

5 a $y = -x - 13$ **b** $t = \dfrac{C - 120}{5}$

c $r = \dfrac{A}{2\pi h}$ **d** $q = xy - 7$

6 a, c, d and f are linear

7 a

x	0	1	2	3	4	5
y	2	5	8	11	14	17

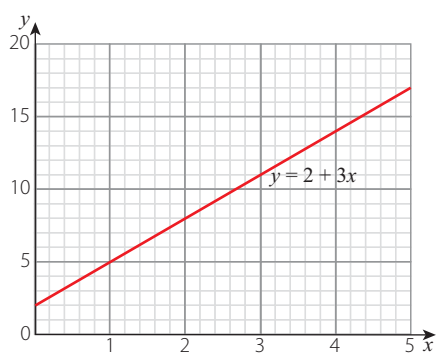
b

x	0	1	2	3	4	5
y	1	4	7	10	13	16

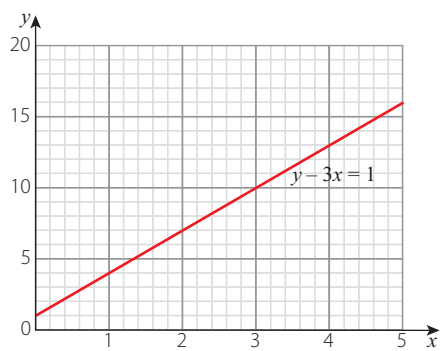
c

x	0	1	2	3	4	5
y	3	5	7	9	11	13

8 a

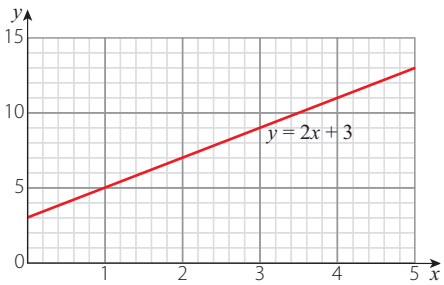


b



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

c



9 **a** **i** 12 **ii** 3
b **i** 4 **ii** 3
c **i** 18 **ii** −3
d **i** 5 **ii** 4
e **i** 17 **ii** −3

10 **a** $y = x + 2$ **b** $y = 2x + 3$
c $y = -2x + 14$

11 2 hours

12 $x = 3, y = 10$

13 $x = 2, y = 1$

Chapter 5

5B Practice questions

1 A population refers to the entire set of individuals or items that are of interest in a statistical study. A sample is a subset of the population that is selected for the actual study.

2 Random selection is used to choose a sample from a population in such a way that every individual has an equal chance of being selected.

3 Answers will vary

4 **a** A structured question provides predefined response options, making it easier to analyse and compare answers. An unstructured question allows for open-ended responses.

b Table to include this information:
Structured questions
Advantages: easy to analyse and compare responses, faster for respondents to complete, reduces ambiguity in responses
Disadvantages: limited response options may restrict depth, may not capture detailed insights
Unstructured questions
Advantages: provides rich, detailed information, allows for a wide range of responses, encourages respondents to express freely
Disadvantages: difficult and time-consuming to analyse, responses may be varied and hard to compare

c Multiple choice, Likert scale, Rating scale, Yes/No, Checkbox, Dropdown menu, Ranking

d Answers will vary

5C Tasks and questions

1, 2 Answers will vary

3 Pose a question to investigate: What type of car do I want? What is my budget?
Collect data: What is the typical selling price of this car?
Plan investigation: How can I find out if this is the best car for me? How will I get the extra money I need once I've chosen a specific car? Should I buy from a private seller or from a car yard? What sort of insurance will I need?

4 **a** Analyse data
b Collect data
c Interpret results
d Plan investigation
e Plan investigation

5 **a** Plan investigation, collect data
b Analyse data, interpret results
c Collect data
d Analyse data, interpret results

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6

Activity	Order	Stage
a	8	Interpret results
b	7	Interpret results
c	3	Analyse data
d	5	Analyse data
e	2	Plan investigation
f	6	Interpret results
g	4	Analyse data
h	1	Plan investigation

5D Tasks and questions

1 a, b Answers will vary
c Nominal data

2 a Nominal, artist
b Continuous, doctor concerned about healthy growth
c Ordinal, sports journalist
d Discrete, traffic engineer
e Nominal, consumer group monitoring public transport
f Continuous, ecologist
g Nominal, fashion magazine editor
h Ordinal, company asking opinion about their products

3 a Students, teachers, IT staff
b Online survey or paper questionnaire
c Nominal data (e.g. brand of computers); ordinal data (e.g. satisfaction rating); discrete data (e.g. number of computers in each lab); continuous data (e.g. average age of computers)

4 Answers will vary

5E Tasks and questions

1 a Answers will vary

2 Answers may vary.
a Answer a question
b Answer a question
c Make a prediction
d Make a decision
e Answer a question

3 a Transport Accident Commission (TAC)
b From 2013 to 2023
c Age of person involved in accident, number of fatalities and crashes
d Victoria. No, it can still be used as a guide to inform the rest of Australia.
e Answers will vary
f People who are older are more likely to be killed in car crashes.
g To determine which age groups should have specific road safety training. To help create new rules that are specific to age range to reduce total fatalities.

4 a Requires simple yes or no answer without considering details
b Lacks clarity and can be interpreted in multiple ways
c Contains two negatives that can confuse respondents
d Asks two questions at once, making it difficult to answer accurately
e Phrased in a way that suggests a particular answer
f Contains emotionally charged language or assumptions

5 Answers will vary

5F Tasks and questions

1 Answers will vary. Possible examples:
a Destination preferences, travel budgets, preferred activities, accommodation options
b Personal interests, skills, educational requirements, job market demand, potential salary ranges
c Training schedules, nutrition plans, running routes, previous race times
d Preferences for roommates, budget allocation, household chores, rental agreements
e Types of pets owned, their names, breeds, ages, any interesting stories or anecdotes about them

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

f Instrument preferences, available resources for learning, practice schedules, progress tracking.
g Club activities, membership fees, meeting schedules, member demographics.

2 **a** ABS; reliable due to its authority and rigorous data collection methods
b Age group, gender, employment status, country of birth
c August 2021
d Australia
e To analyse employment trends and patterns
f Surveys, administrative records

3 **a** Online survey
b Pew Research Center is a reputable research firm known for conducting surveys on various topics.
c April 2021
d No, the number of respondents relative to the population of the US is very small.
e Data suggests a majority support by Democrats respondents for gun control in the US.

4 **a** Refers to data that can be divided into groups or categories, such as types of animals or colours
b Consists of numbers and represents quantities or measurements, such as height or temperature
c Data collected firsthand by the researcher for a specific purpose
d Data obtained from existing sources, such as research papers or databases

5 Answers will vary

5G Tasks and questions

1, 2 Answers will vary

3 **a** Yes/no question
b Open-ended question
c Multiple-choice question
d Likert scale question

4 **a** data
b someone, current, unbiased
c Categorical, numerical
d closed, open

5 Answers will vary

5H Tasks and questions

1 Answers will vary

2 **a** Fake or biased
b Fake or biased
c Fake or biased
d Valid and reliable
e Valid and reliable
f Valid and reliable
g Fake or biased

3,4 Answers will vary

Chapter review questions

1 Answers will vary

2 **a** Categorical; nominal; no
b Numerical; continuous; yes
c Numerical; continuous; yes
d Numerical; discrete; yes
e Categorical; ordinal; no

3 Categorical: b, c, e, f, j
Both: a, d, g, h, i

4 Answers will vary

5 Answers may vary. Possible answers are given.
a Stratified sampling: ensures representation of different age groups and demographics, avoiding bias in preferences.
b Simple random sampling: each person in the age group has an equal chance of being selected, reducing bias.
c Cluster sampling: select different groups (e.g. schools, workplaces) to get varied and comprehensive data, minimising bias.
d Systematic sampling: every *n*th person is selected, ensuring a spread across different times and routes, reducing bias.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

e Stratified sampling: different crop types and farming methods are proportionately represented, avoiding bias.

6 a Multiple choice, short answer; nominal
b Likert scale or continuum/slider; ordinal
c Short answer; nominal
d Short answer (numeric response); discrete
e Yes/No; nominal
f Likert scale; ordinal
g Short answer (time entry); continuous

7 Answers will vary

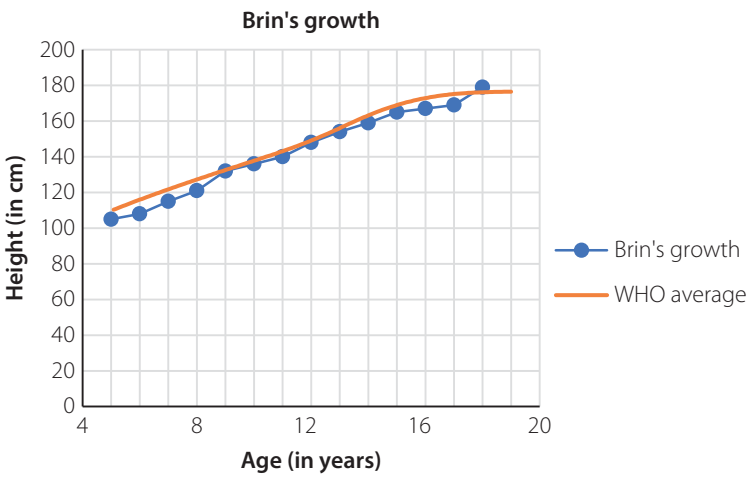
8 a Fake or biased
b Valid and reliable
c Fake or biased
d Fake or biased
e Valid and reliable

Chapter 6

6A Starting activities

Activity 1

1, 2



3 Brin grew fastest from age 8 to 9 (height increase 11 cm). Second fastest growth period was from age 17 to 18 (10 cm). These age periods have the steepest gradient on the graph.

4 Compared to the WHO growth chart, Brin was mostly below average. For ages 9 and 12, he was roughly the same as average, and for age 18 he was above average.

Activity 2

Graph A

1 Graph title indicates that the accumulated rainfall for 2021 is compared to the historical average, indicating periods where 2021 experienced significantly more or less rainfall than usual, which helps explain the occurrence of floods.

2 Line graph

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3 Cumulative rainfall for 2021 does not follow the trend from the long-term averages. On average, there is more rainfall earlier in the year.
4 Rainfall from 2021 will continue to grow above the long-term average.

Graph B

1 Graph title indicates a comparison between the river's water level at Lismore and established levels that signify minor, moderate, and major flooding, providing context for assessing flood risks and impacts.
2 Line graph
3 Height of Wilsons River was heading towards a major flood between Friday to Monday
4 Major flood on Tuesday, and possibly some other levels of floods in the days to follow

Graph C

1 Graph title indicates a depiction of the financial impact of natural disasters over each decade, highlighting trends and changes in economic losses over time.
2 Bar graph
3 Cost of weather-related disasters in Australia was greatest in 2010s.
4 Cost of weather-related disasters in Australia will continue to rise.

Graph D

1 Graph title indicates the analysis of the number of insurance claims over a specified period, highlighting patterns and changes in the frequency of claims filed.
2 Line graph
3 Flooding in Far North Queensland and extreme weather in Queensland, New South Wales and Victoria had similar claims patterns over 19 days.
4 Claims for storm damage in Southeast Queensland and New South Wales will continue to rise.

6B Practice questions

1 a i Graph depicts the breakdown of cumulative Victorian road fatalities between 2017 and 2023, according to type of road user.
ii Pie chart
iii The most fatalities were drivers, accounting for almost half of the total fatalities.
b i Graph depicts the trend in number of total road fatalities in Victoria from 2013-2023.
ii Line graph
iii Number of fatalities in Victoria stays within the range of 200-300 between 2013 and 2023, with some peaks and troughs in the time frame.
c i Graph depicts the trend for 2019-2022 of gambling in Victoria, by type of gambling.
ii Multiline graph
iii Greatest contributor to total losses for gambling in Victoria for 2019-2022 was sports and race betting.

6C Tasks and questions

1 Choice of class intervals depends on range of heights observed and level of detail desired. Smaller class intervals might be more suitable for capturing subtle variations in height, while larger intervals might be sufficient if only general trends are needed.
2 Answers will vary. Possible examples:
a 0–24, 25–49, 50–74 etc.; depending on the range of scores observed
b 0–2, 3–5, 6–8 etc.; to capture the frequency distribution of goals scored
c 0–10, 11–20, 21–30 etc.; to account for varying margins of victory

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

d Yes, based on the typical scoring patterns and margins observed in that specific league.

3 Answers will vary. Possible examples:

a 0–< 1 kg, 1–< 2 kg, 2–< 3 kg etc.

b 1–50 characters, 51–100 characters, 101–150 characters etc.

c 61–70 years, 71–80 years, 81–90 years etc.

d 0–< 30 min, 30–< 60 min, 60–< 90 min etc.

4 **a** No, range of values too small

b

Number of parents	Frequency
0	5
1	2
2	3
3	2
4	2
5	1

5 **a** Gaming machines – hotels and clubs ($2,237.2 million)

b Yes

c 37.8%

d 79.4%

5 **a** Gaming machines – hotels and clubs

b Yes

c 37.8%

d 79.4%

6 **a** Answers will vary

b Possible answer using a class interval of 8:

Class interval	Frequency
0–7	2
8–15	10
16–23	13
24–31	5
32–39	1

7 **a** Mining; Information media & telecommunications; Professional, scientific & technical services; Financial & insurance services

b Other services; Accommodation & food services.

c 47.2%

d Average of the average weekly earnings across all industries.

8 Answers will vary

9 **a** Reduces from March to May

b Increase in spending for Alcoholic beverages and tobacco; Furnishings and household equipment; Miscellaneous goods and services

c Expenditures on items not categorised under other specific categories, e.g. personal care products, pet care, donations

d Mar-23: 53.5% ; Apr-23: 34.9%; May-23: 24.1%

e They represent the percentage change in spending for each category relative to the previous month, not the total percentage of household spending.

f No, only provides monthly changes in spending percentages for three months and does not include absolute spending amounts or other economic indicators.

g Answers will vary; e.g. reasons behind significant changes in spending for specific categories, seasonal trends or comparisons with previous years' data.

10 **a** 1961: Australia, Oceania, Europe, North America
2020: Australia, China, Europe, North America

b Increasing

c Decrease for Oceania

d Answers will vary; e.g. show data for 1961 and 2020 in separate columns for each region or country

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6D Refresher on common graphical representations

1 Ensures clarity, readability and consistency to make it easier to accurately interpret and compare data.

2 a i 2
ii 14
iii Most packets weigh between 50 g and 54 g.
iv Weight of packets in grams
v Frequency of packets

b i 4%
ii 13%
iii Consumption increased from young age to peak for 14-24 year olds, then decreased.
iv Age of people, in years, who consumed selected sugar sweetened drinks on a daily basis
v Percentage of total consumers of selected sugar sweetened drinks

c i 0
ii 6.5 million, 8.8%
iii Global EV sales increase from 2011 to 2021
iv Calendar year
v Number of registrations in millions and global market share as a percentage

d i 0%
ii 69%
iii Share of households with a pet increases steadily from age 18 to 45 years, remains relatively steady from age 45 to 49 then decreases steadily after age 49. Share of households with at least one child younger than 18 has a steady increase from 18 to 36, then starts to slowly decline from age 36 to 48 before declining rapidly after this.
iv Age in years
v Percentage share of households

3 a 38°C **b** 15°C
c 46°C **b** 18°C

4 a A **b** D
c C **d** B

5 a Number of tourist trips taken by people from Denmark between 1996 and 2022. The vertical scale is the number of departures per 1000 people.
b 2021
c 2016
d Fluctuates

6 a 30.0 **b** 1.5

7 a numbers, figures
b pie chart
c axes, vertical, horizontal
d scale
e labels, title
f maximum, minimum
g steady, increase, decrease
h trend, fluctuate, predictable, unpredictable

8 a One from 2019, one from 2023; 2023 has greater amount and more specific data.
b All types of media usage provided in 2019 have increased in 2023.
c None have decreased.
d Any data included in 2023 and not in 2019
e Demographic data (age, gender, location) for media consumption, comparison to global or other country averages, trends over a longer time period (5–10 years)

6E Creating graphs and charts using Excel and Word

1 Answers will vary

2 Add additional chart elements like data labels, error bars, trendlines and other analysis features.

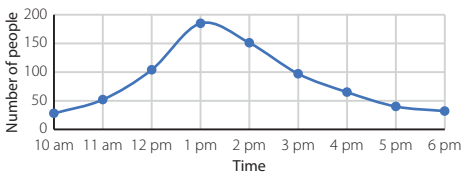
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3 Gives access to formatting options like changing the fill colour, border colour/style and effects.

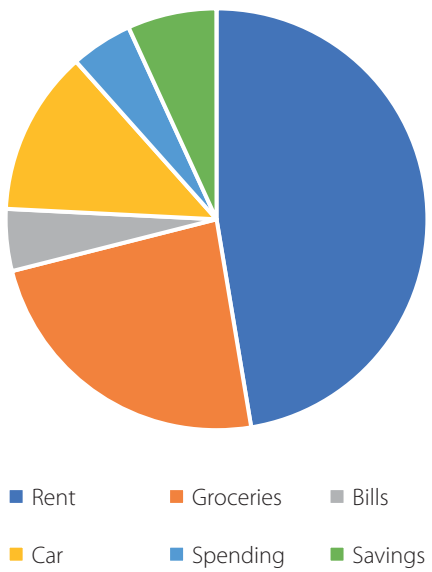
4 Pie charts are best suited for displaying data that represents percentages of a whole.

5 Scatterplots display data as a set of individual points, each having an x-y coordinate value. They are useful for visualising the relationship between two quantitative variables. Line graphs connect individual data points with straight line segments. They are useful for showing trends over a certain interval.

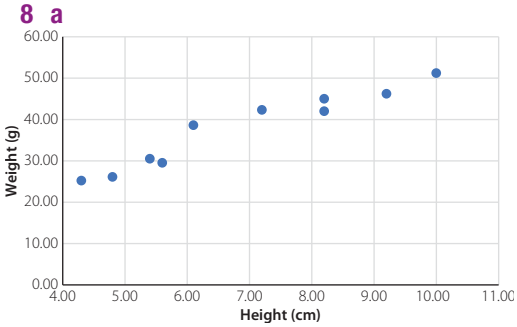
6



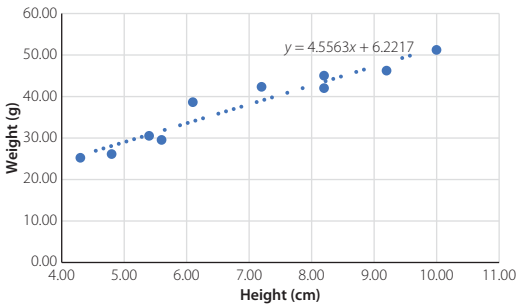
7



8 a



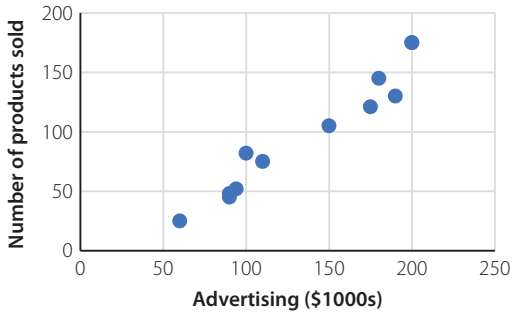
b



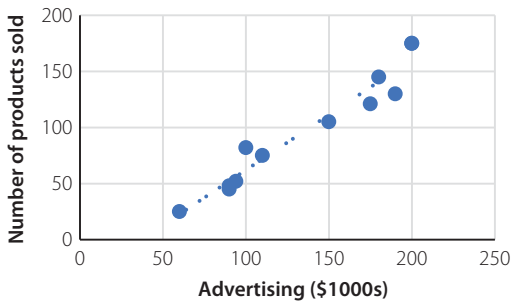
For height h and weight w, $w = 4.6h + 6.2$

c 43 g **d** Interpolation

9 a



b



c Direct relationship between money spent on advertising and products sold. The more money spent on advertising, the more products sold.

10 a Graph A for US disasters and Graph B for Australian disasters. They also show different ranges of time.

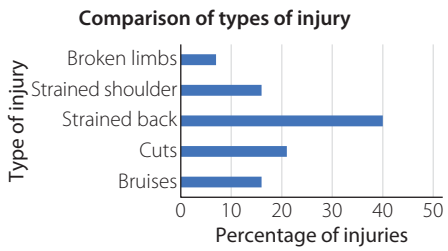
b On average, the cost of weather-related disasters is increasing with time.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

11 a

Bruises	16%
Cuts	21%
Strained back	40%
Strained shoulder	16%
Broken limbs	7%

b



c Type of injury, percentage of injuries

d Strained back

12 a, b Answers will vary

c Data shows that physical health or fitness is the primary motivation for adults engaging in sports, with the 25–34 age group showing the highest numbers, while fun/enjoyment and social reasons are also significant motivators, especially for younger and middle-aged adults.

6F Contemporary graphs

1 Answers will vary

2 a Red represents the hottest, and green represents the coldest.

b January

3 China

4 a Cristiano Ronaldo

b Tiger Woods

c 8

d 91% of 61 million, or about 56 million

e Sebastian Vettel, Auto racing

5 a Wind **b** Solar

c About 10% **d** 2011

e Answers will vary

6 a Product A

b Product B

c Product A

d Answers will vary

7 a Social media, direct traffic, email campaigns, search engines, referral sites

b United States

c Brazil

d Argentina has more social media blog traffic than Mexico.

8 a Fast food worker

b Nurse

c Legal clerk

d Answers will vary

9 a China

b Solar, biofuels, wind

c, d Answers will vary

10 a Answers will vary

b Children's books

c Magazine and mystery

d Answers will vary

11, 12 Answers will vary

Chapter review questions

1 No labels on axes, no graph title

2, 3 Answers will vary

4 a 25 **b** 8

5 a 2017–2022

b Increases over time

c Decreases over time

d Remains reasonably steady

e Answers will vary

6 a 29%

b 46%

c 28%

d Yes, overall it is lower. Range of values smaller, so less variable.

7 a Excel

b Use + button (Chart elements)

c Updates automatically to reflect the new data

d Modify the bin settings in the histogram properties

8 Answers will vary

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9 **a** Life expectancy compared to GDP per capita
b Lower life expectancies and lower GDP per capita on average
c Higher GDP per capita and high life expectancy on average
d The higher the GDP per capita, the higher the life expectancy

10 Grouped bar chart

11 **a** Smartphones **b** January

Chapter 7

7A Starting activities

Activity 2

1 Scatterplot

7B Discussion questions

1 Possible examples: email, phone number, name, address, viewing preferences, number of devices, language

2 Yes

3-5 Answers will vary

7C Tasks and questions

1 Answers will vary

2 **a** Can be interpolated but not extrapolated because the full range of possible ages is already covered
b Can be interpolated and extrapolated as there is a clear and gradual trend for the number of visits to space
c Cannot be interpolated or extrapolated

3 Values are approximate.
a **i** 25% **ii** 43%
iii 65% **iv** 97%
v 106% (extrapolated value is not feasible)
b **i** 520 million **ii** 765 million
iii 1100 million **iv** 1500 million

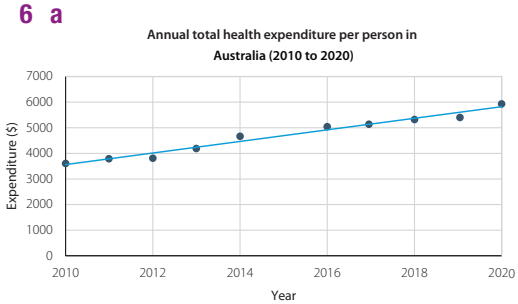
4 **a**

Number of folds	Thickness	Creases
0	1	0
1	2	1
2	4	3
3	8	7
4	16	15
5	32	31
6	64	63
7	128	127
8	256	255
9	512	511
10	1024	1023

b Answers will vary

5 **a** About 8 mm; interpolation
b About 32 mm; extrapolation

6 **a**



b $y = 226.12x - 450\,934$
c $4,697.80
d Answers will vary; for example, value is $6,732.88 for 2024

7 **a** 5 hours
b $41
c $62
d Cost = 3 × number of hours + 35 or $C = 3n + 35$
e $95

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

7D Tasks and questions

1 Answers will vary

2 **a** Median = 21, mode = 18

b Median = 29, mode = 29

c Median = 1248, no mode

3 Median = 217 973, no mode

4 **a** Mean = 38.5, median = 39, mode = 39

b Mean = 1751.1, median = 1934.5, no mode

5 Mean = 157.77, median = 156.07, no mode

6 **a** Mean = 22.9, median = 24, mode = 24

b Mean = 108.6, median = 110, mode = 115

7 **a** **i**

Values	Frequency (f)	Midpoint (x)	$f \times x$
0–4	6	2	12
5–9	5	7	35
10–14	7	12	84
15–19	2	17	34
20–24	8	22	176
25–29	5	27	135
Total	**33**		**476**

ii 14.4

b **i**

Values	Frequency (f)	Midpoint (x)	$f \times x$
0.02–0.04	56	0.03	1.68
0.05–0.07	43	0.06	2.58
0.08–0.10	67	0.09	6.03
0.11–0.13	34	0.12	4.08
0.14–0.16	50	0.15	7.5
0.17–0.19	62	0.18	11.16
Total	**312**		**33.03**

ii 0.11

8 **a** **i**

Values	Frequency (f)	Midpoint (x)	$f \times x$
0–< 5	4	2.5	10.0
5–< 10	7	7.5	52.5
10–< 15	9	12.5	112.5
15–< 20	12	17.5	210.0
20–< 25	14	22.5	315.0
25–< 30	20	27.5	550.0
30–< 35	31	32.5	1007.5
35–< 40	38	37.5	1425.0
40–< 45	45	42.5	1912.5
Total	**180**		**5595.0**

ii 31.1

b **i**

Values	Frequency (f)	Midpoint (x)	$f \times x$
140–< 150	3	145	435
150–< 160	5	155	775
160–< 170	6	165	990
170–< 180	9	175	1575
180–< 190	12	185	2220
190–< 200	5	195	975
Total	**40**		**6970**

ii 174.75

c **i**

Values	Frequency (f)	Midpoint (x)	$f \times x$
100–< 200	16	150	2400
200–< 300	14	250	3500
300–< 400	17	350	5950
400–< 500	10	450	4500
500–< 600	15	550	8250
600–< 700	10	650	6500
700–< 800	18	750	13 500
Total	**100**		**44 600**

ii 446

9 Mean = 1724.9, median = 1711

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

10 **a** Mean = 40.3, median = 40–< 50 or approx. 45, mode = 40–< 50

b Mean = 47.8, median = 40–49 or approx. 44.5, mode = 40–49

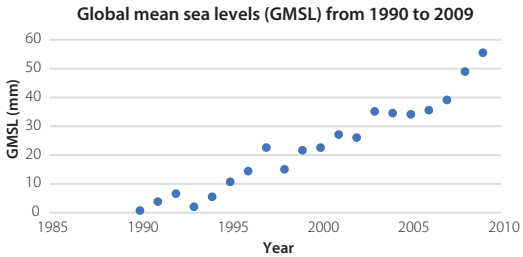
11 **a** Sea level is rising

b 22.6, no

c 22.6

d 23.09

e Increasing trend



f Approx. 132 mm (actual from internet is about 86 mm)

g Answers will vary

7E Tasks and questions

1 Answers will vary

2 **a** **i** 12 **ii** 87 **iii** 47.5 **iv** 27.5 **v** 69.5 **vi** 75 **vii** 42

b **i** 6 **ii** 148 **iii** 41 **iv** 17 **v** 129 **vi** 142 **vii** 112

c **i** 109 **ii** 299 **iii** 213 **iv** 145.5 **v** 259.5 **vi** 190 **vii** 114

3 **a** Minimum = 31, maximum = 395, range = 364

b Minimum = 56, maximum = 898, range = 842

c Minimum = 58, maximum = 1909, range = 1851

d Minimum = 31, maximum = 148, range = 117

4 **a** 219 450

b 54 656

c Q1 = 210 963, Q3 = 236 971

d 26 008

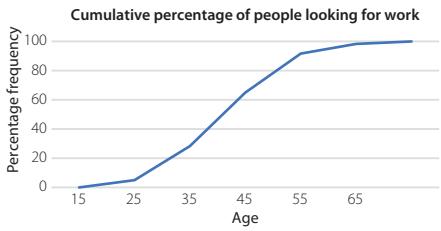
e 219 450; yes

f 219 450; yes

5 **a**

Age group	Cumulative percentage frequency
15–24	5.00
25–34	28.33
35–44	65.00
45–54	91.67
55–64	98.33
65 and over	100.00

b



c 25–34

d 35–44

e 45–54

6 **a** range, smallest

b four, equal-sized

c median

d 25%, 50%, 75%

e first, third

f percentage

7 **a** **i** 5, 120

ii 68.5

ii 26, 112

iii Range = 115, IQR = 86

b **i** 57, 106

ii 86.5

iii 69, 92.5

iv Range = 49, IQR = 23.5

c **i** 92, 116

ii 104.5

iii 99, 114

iv Range = 24, IQR = 15

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

d i 18, 93
ii 38.5
iii 24, 63
iv Range = 75, IQR = 39

8 Answers will vary

9 a i 1 114 800 and 1 665 200
ii 550 400
iii Q1 = 1 249 300; Q2 = 1 419 450; Q3 = 1 530 200
iv 280 900
v Answers will vary

b i 41 400 and 79 400
ii 38 000
iii Q1 = 54 500; Q2 = 64 400; Q3 = 72 000
iv 17 500
v Answers will vary

c i 130 700 and 160 500
ii 29 800
iii Q1 = 140 100; Q2 = 147 650; Q3 = 150 600
iv 10 500
v Answers will vary

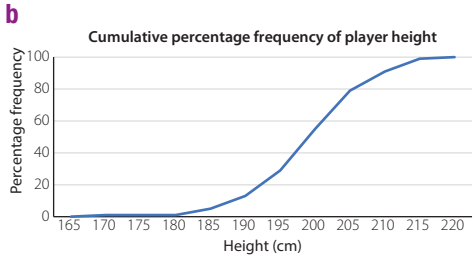
d i 137 300 and 300 700
ii 163 400
iii Q1 = 167 000; Q2 = 194 850; Q3 = 197 000
iv 30 000
v Answers will vary

10 a i Median = 314, range = 207, IQR = 54
ii Median = 511, range = 81, IQR = 19
b WTP receives more water inflow, but the amount of water doesn't vary as much as ETP.

11 a

Height (cm)	Number of players	Cumulative frequency	Cumulative percentage frequency
165–< 170	1	1	1
170–< 175	0	1	1
175–< 180	0	1	1
180–< 185	4	5	5
185–< 190	8	13	13
190–< 195	16	29	29
195–< 200	26	55	55
200–< 205	24	79	79
205–< 210	12	91	91
210–< 215	8	99	99
215–< 220	1	100	100

b



c i 190–< 195 **ii** 195–< 200
iii 200–< 205 **iv** 10

c Possible answer: small IQR indicates a small variation in player heights with most players in the height range of 190 cm to 205 cm.

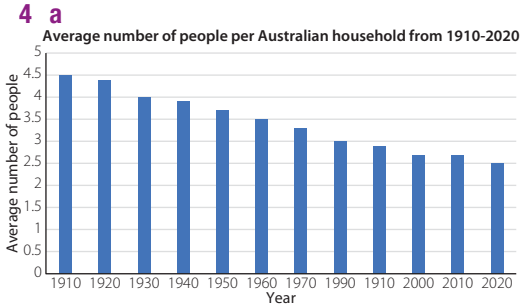
7F Tasks and questions

1 Company A

2 a i 48.8 **ii** 24.1
b i 67.7 **ii** 56.5
c i 204.1 **ii** 63.7

3 a 2012: mean = 79.5 years, SD = 2.9 years; 2021: mean = 79.8 years, SD = 3.8 years
b Slight increase in life expectancy
c Answers will vary

4 a



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

b 3.4
c 0.7
d Answers will vary
e Number of people decreasing

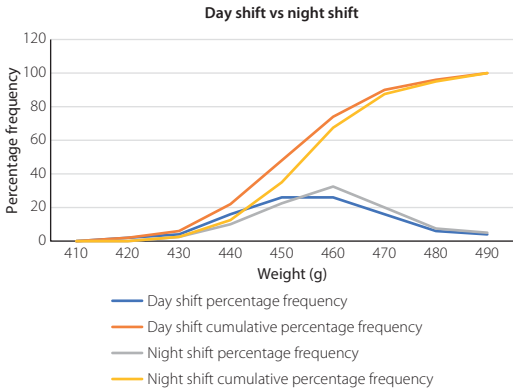
5 a Answers will vary
b Percentages used as the number of data values is different in each shift.
Day shift:

Weight (g)	Frequency	Percentage frequency	Cumulative percentage frequency
410–< 420	1	2	2
420–< 430	2	4	6
430–< 440	8	16	22
440–< 450	13	26	48
450–< 460	13	26	74
460–< 470	8	16	90
470–< 480	3	6	96
480–< 490	2	4	100
Total	**50**	**100**	

Night shift:

Weight (g)	Frequency	Percentage frequency	Cumulative percentage frequency
410–< 420	0	0	0
420–< 430	1	2.5	2.5
430–< 440	4	10	12.5
440–< 450	9	22.5	35
450–< 460	13	32.5	67.5
460–< 470	8	20	87.5
470–< 480	3	7.5	95
480–< 490	2	5	100
Total	**40**	**100**	

c



d Answers will vary
e Day shift: 450.7 g, night shift: 454.8 g
f Day shift: 14.8 g, night shift: 13.5 g
g Answers will vary

7G Tasks and questions

1 a Median; less susceptible to influence of outliers so more accurate for this application
b Positively skewed

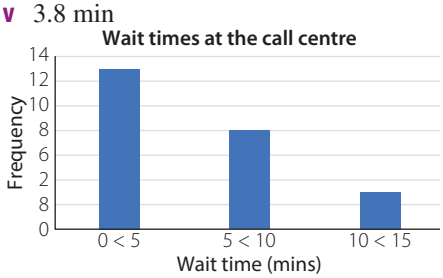
2 Answers will vary

3 Symmetrical: b, c
Positively skewed: a
Negatively skewed: d

4 a 4
b Negatively skewed
c Yes, one member is between 1.55 m and 1.6 m
d Mostly above 1.75 m in height, with most common heights in the range 1.75 m to 1.8 m.

5 a i 5.9 min **ii** 4.5 min
iii 13.3 min **iv** 5.6 min
v 3.8 min

b



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

c Positively skewed, one possible outlier (14.5 mins)

d Largely within 0–5 mins, with infrequent occurrence of a wait time that is >10 mins

6 a Asymmetrical distribution with positive skew

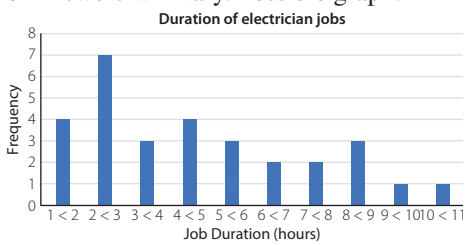
b Random distribution with no skew and no outliers

c Asymmetrical distribution with negative skew

d Asymmetrical distribution with positive skew and outlier at 90+

7 a i 4.4 hours **ii** 4.25 hours **iii** 9 hours **iv** 3.5 hours **v** 2.6 hours

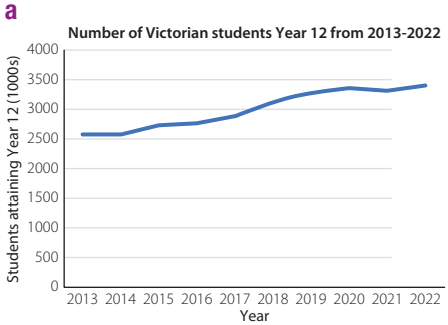
b Answers will vary. Possible graph:



Positively skewed asymmetrical graph

c 2-3 hours is the most common, with most jobs taking less than 6 hours

8 a



b Negatively skewed asymmetrical distribution

c Mean = 2997.3, median = 2998.9, IQR = 594.9, SD = 329.7

d Number of students attaining Year 12 increased from 2013 to 2022. However, to conclude that student attainment is increasing, the number of students attempting Year 12 should be considered.

9 Answers will vary

7H Tasks and questions

1 Answers will vary

2 a Misuse of the vertical axis

b Misuse or misunderstanding of pie charts

c Graphs not being constructed or labelled properly

d It is correct

e Graphs not being constructed or labelled properly, misuse of the vertical axis

3 a Improper use of vertical axis, no title, different width for each bar

b Improper use of vertical axis, no label on vertical axis

c Inaccurate sizing of each segment, confusing use of two segments for Russia

4 a Yes

b Graph B is distorting the data by beginning the vertical axis at 1000 instead of zero, and Graph C by making the pie chart three-dimensional makes the segments in the closer half appear bigger than the further half.

c Graph A allows for comparison with the previous survey, Graph B allows for greater detail to be revealed in the differences in listeners between the three stations, Graph C allows a large number of radio stations to be compared

5 a Yes

b Graph A has its vertical axis beginning at 160 instead of 0, making the difference between the height of the columns appear larger.

6 a No. This misrepresents the data because each runner gets a number based on the percentage of their own team's runs they have scored, but are being compared to the percentages of other team's runs.

b Bar chart

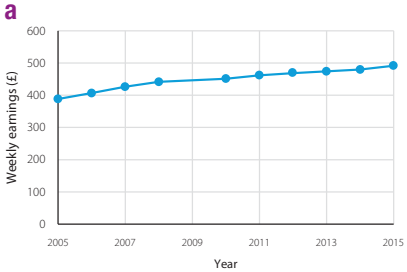
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter review questions

1 a 10 star-jumps, 7 bicycle-crunches

b 15 star-jumps, 9 bicycle-crunches

2 a



b 2009: approx. £440; 2020: approx. £540

3 a 6 **b** 2.5

c 2 **d** 2

e Mean; no outliers

4 a 198.8

b 195–< 200

c 195–< 200

d Median; to prevent the influence of outliers

5 a Q1 = 9, Q2 = 16, Q3 = 25, Q4 = 30

b 16

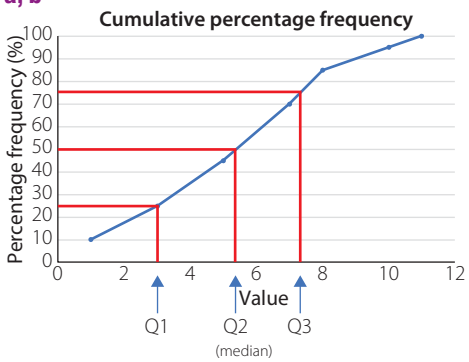
6 a Mean = 5.7, SD = 2.5

b Since the mean is 57%, this is a difficult test

7

Value	Frequency	Cumulative frequency	Cumulative percentage frequency
1	2	2	10
3	3	5	25
5	4	9	45
7	5	14	70
8	3	17	85
10	2	19	95
11	1	20	100
Total	**20**		

8 a, b



9 a Percentages listed, different colours used to distinguish the categories but chart is cluttered and proportions are very similar so it is difficult to distinguish meaningfully

b Clear utility of pie chart, could change the colours to make them more distinct, could label with percentages

c Gridlines are helpful to interpret the data, should label horizontal axis, include more information in the title, vertical axis should begin at 0 instead of 24 to not distort the information.

10 a Misuse of the vertical axis

b Misuse or misunderstanding of pie charts

c It is correct.

Chapter 8

8A Starting Activities

Activity 2 – Coin flipping

1 10 heads and 10 tails

8B Discussion questions

1 1970

2 4.54 in 2022 compared to approx. 30 in 1970. This means that it is 6.61 times less likely to die in a car accident in 2022 compared to 1970.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3 Answers will vary; e.g. slow uptake of new laws, gradual improvement in other car safety technology.

4 Yes, other factors involved; e.g. improvement of other car safety technologies, safer roads, lower speed limits, stricter licensing requirements

8C Tasks and questions

1 a $\frac{1}{6}$, approx. 0.167, approx. 16.7%

b $\frac{1}{2}$, 0.50, 50%

2 Answers will vary

3 Answers will vary; e.g. if die rolled 100 times you would expect the theoretical probability to more closely match the experimental probability. If die rolled 1000 times, you would expect it to be even closer.

4 a

	1	2	3	4	5	6
1	2	3	4	5	6	7
2	3	4	5	6	7	8
3	4	5	6	7	8	9
4	5	6	7	8	9	10
5	6	7	8	9	10	11
6	7	8	9	10	11	12

b 36

c 15

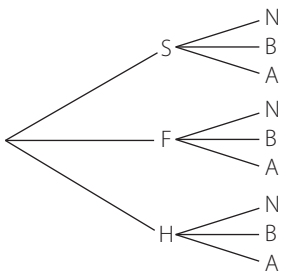
d 15

e 6

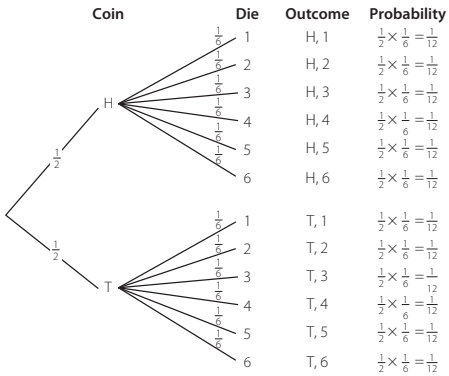
5 a {soccer, football, hockey}

b {netball, baseball, athletics}

c



6 a-c



d $\frac{1}{12}$

e $\frac{1}{4}$

7 a $\frac{1}{4}$ **b** $\frac{1}{6}$

c $\frac{1}{13}$ **d** $\frac{2}{5}$

8 Adelaide: $\frac{3}{31}$, 0.0968, 9.68%;

Brisbane: $\frac{8}{31}$, 0.2581, 25.81%;

Darwin: $\frac{20}{31}$, 0.6452, 64.52%;

Melbourne: $\frac{5}{31}$, 0.1613, 16.13%;

Perth: $\frac{1}{31}$, 0.0323, 3.23%;

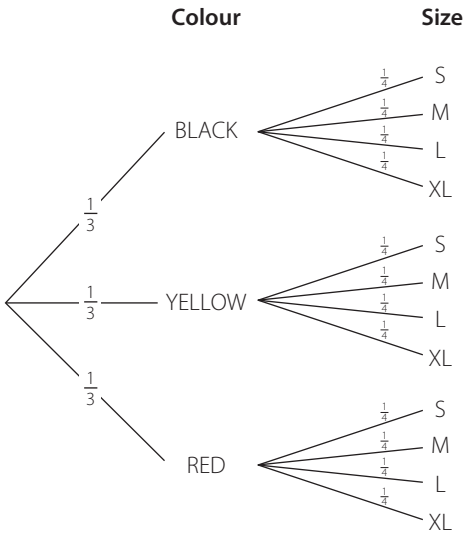
Sydney: $\frac{8}{31}$, 0.2581, 25.81%;

Hobart: $\frac{6}{31}$, 0.1935, 19.35%;

Canberra: $\frac{6}{31}$, 0.1935, 19.65%

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9 a



b $\frac{1}{12}$

10 a New building: 57.9%; Re-erection: 0.5%; Extension: 8.6%; Alteration: 15.1%, Change of use: 0.5%; Demolition: 8.5%, Removal: 0.3%, Other: 8.6%

b Answers will vary, any two types that cannot happen at the same time; e.g. New building and Demolition

c Answers will vary, any two types where one affects the other; e.g. Extension and Alteration

d 0.151 or 15.1%

e 0.088 or 8.8%

11 a 0.49

b 0.42

12 a $\frac{1}{10}$

b $\frac{1}{2}$

c i $\frac{1}{100}$ **ii** $\frac{9}{100}$ **iii** $\frac{1}{10}$

13 a Australia: 12%, 0.12; Brazil: 3%, 0.03; Canada: 13%, 0.13; China: 38%, 0.38; Denmark: 46%, 0.46; Finland: 54%, 0.54; Germany: 24%, 0.24; Greece: 14%, 0.14; India: 2%, 0.02; Japan: 4%, 0.04; Mexico: 1%, 0.01; New Zealand: 14%, 0.14; Norway: 93%, 0.93; Poland: 7%, 0.07; South Africa: 0%, 0.00; South Korea: 8%, 0.08; Spain: 12%, 0.12; Sweden: 60%, 0.60; UK: 24%, 0.24; USA: 9%, 0.09

b Norway

c South Africa

d Answers will vary but may include: South Korea, as it is a technologically advanced country

e Answers will vary but may include: wealth of car buyers, infrastructure, government incentives

f 0.10

g 0.27

14 a Mutually exclusive

b Independent

c Equiprobable

d Dependent

e Complementary

15 a Yes

b i About 20% **ii** 1.6%

c i About 8% **ii** About 34%

d, e Answers will vary

16 a 1918 and 1919

b Answers will vary

c i 34% **ii** 11% **iii** 3%

d Answers will vary

8D Tasks and questions

1 Answers will vary

2 a Australia: 8567% increase, 2253m; Asia: 527% increase, 29 469m; Hong Kong: 37 400% increase, 2813m; Ireland: 29% decrease, 4m; USA: 3270% increase, 11 357m; Europe: 232% increase, 2477m; Africa: 1567% increase, 23 338m

b Ireland

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

c Famine occurred from 1845 to 1852, caused by a potato disease which destroyed both the leaves and the edible roots of the potato plant and led to a massive decline in the population due to starvation, disease and emigration

d Projections for 2222 based on the same rate of growth are highly speculative and likely not accurate. Several factors can dramatically alter population trends over such a long period.

e Answers will vary but could include: technological advances, climate change, political and economic stability

3 a Life expectancy increased

b Answers may vary

c Approx. 60 years

d Approx. 85 years

4 a Premiums increase with age for all categories.

b Smokers consistently pay higher premiums than non-smokers in all age brackets.

c Males generally pay higher premiums than females in the same age and smoking categories.

d Answers will vary. Possible answer: The premiums are based on statistical data regarding life expectancy, health risks and mortality rates. Smokers and older individuals statistically present higher risks, justifying higher premiums.
Some might argue that charging higher premiums for smokers and males could be seen as discriminatory. However, insurance operates on risk assessment, and these higher charges reflect the increased costs to the insurance companies.

e Young people typically have lower risk of death and may not have significant financial dependents. Insurance premiums would be low and the potential payout needs minimal, making it less profitable for insurance companies.
Older individuals present a high risk of death due to age-related health issues. Premiums would be extremely high to cover the risk, often making it unaffordable for customers. Insurance companies might find it less profitable due to the higher likelihood of payouts.

5 a 16-24

b Insurance will be more expensive.

c-e Answers will vary

6 a Answers will vary

b Contamination of indoor air in residential spaces, primarily due to the use of solid fuels and other pollutants for cooking, heating and lighting.

c Answers will vary

7 a Approx. 7.7 billion (or 7700 million)
Answers for parts b-e result from using 7700 million for the population of the world in 2019.

b 0.00117

c 0.00011

d 0.00016

e 0.00087

f Many would be considered dependent

8 a Answers will vary

b Solomon Islands

c USA

d Solomon Islands

e Australia, Japan, New Zealand, Saudi Arabia, Spain, USA

f China, difference of 14%

g Answers will vary. Possible answer: Uganda is the only country in this list to have the risk increase from 1990 to 2019.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9 Values are approximate.

a 70+; true; reasons may vary, e.g. weaker immune system

b 2005: 260 000; 1990: 290 000; 2019: 200 000; number of deaths have steadily decreased from 1990 to 2019

c 2.3 million

d 690 000

e 2019: $\frac{0.69}{2.3} \approx 0.30$; 2005: $\frac{0.89}{3.5} \approx 0.25$; small difference only but higher proportion in 2019

f 2019: assuming world population of 7.7 billion, $\frac{0.20}{7700} \approx 0.000026$; 1990: assuming world population of 5.3 billion, $\frac{0.29}{5300} \approx 0.000055$; risk appears to have halved from 1990 to 2019

g 2019: $\frac{0.69}{7700} \approx 0.000090$; 1990: $\frac{1.14}{5300} \approx 0.00022$; % change: $\frac{0.000090 - 0.00022}{0.00022} \times 100 = -59\%$

Chapter review questions

1 Answers will vary

2 **a** Answers will vary

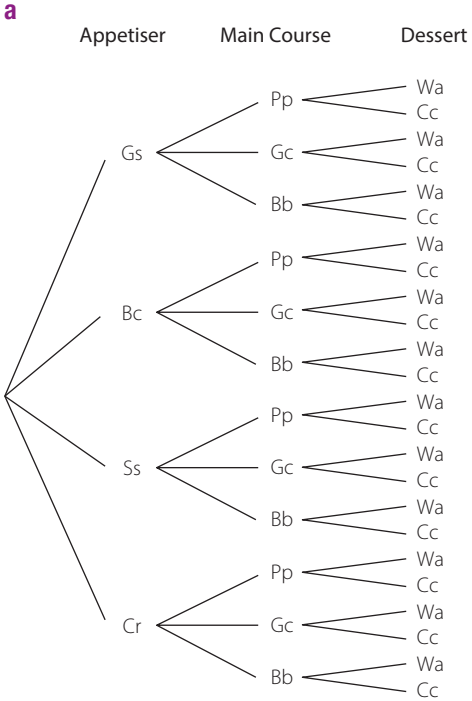
b 5%

c 80%

d '80% 1-5 mm' for Monday means there's an 80% probability that rain will occur at some point during that day within the forecast area. The '1-5 mm' indicates the expected amount of rainfall if it does rain, typically showing a range of possible rainfall amounts.

3 Gs: Greek salad, Bc: Beef carpaccio, Ss: Smoked salmon, Cr: Cucumber rolls, Pp: Prawn pasta, Gc: Grilled chicken, Bb: Baked barramundi, Wa: Waffles, Cc: Carrot cake

a

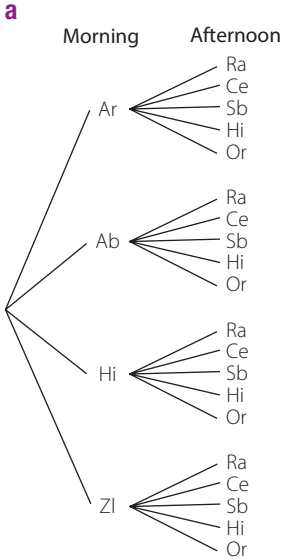


b {(Gs, Pp, Wa), (Gs, Pp, Cc), (Gs, Gc, Wa), (Gs, Gc, Cc), (Gs, Bb, Wa), (Gs, Bb, Cc), (Bc, Pp, Wa), (Bc, Pp, Cc), (Bc, Gc, Wa), (Bc, Gc, Cc), (Bc, Bb, Wa), (Bc, Bb, Cc), (Ss, Pp, Wa), (Ss, Pp, Cc), (Ss, Gc, Wa), (Ss, Gc, Cc), (Ss, Bb, Wa), (Ss, Bb, Cc), (Cr, Pp, Wa), (Cr, Pp, Cc), (Cr, Gc, Wa), (Cr, Gc, Cc), (Cr, Bb, Wa), (Cr, Bb, Cc)}

4 Ar: Archery, Ab: Abseiling, Hr: High ropes, Zl: Zip lines, Ra: Rafting, Ce: Cave exploration, Sb: Snowboarding, Hi: Hiking, Or: Orienteering

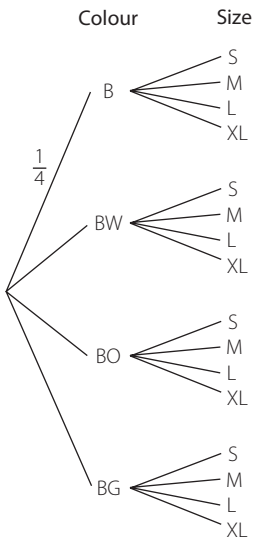
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

a



b {(Ar, Ra), (Ar, Ce), (Ar, Sb), (Ar, Hi), (Ar, Or), (Ab, Ra), (Ab, Ce), (Ab, Sb), (Ab, Hi), (Ab, Or), (Hr, Ra), (Hr, Ce), (Hr, Sb), (Hr, Hi), (Hr, Or), (Zl, Ra), (Zl, Ce), (Zl, Sb), (Zl, Hi), (Zl, Or)}

5 a The probability on each branch is $\frac{1}{4}$.



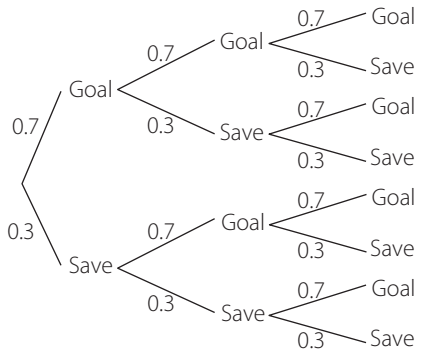
b $\frac{1}{16}$

6 89.3%

7 96.4%

8 Answers will vary. Possible answer: low risk of 8% means patient has 92% chance of not having a dangerous form of the disease.

9



a 0.027 **b** 0.189

10 a 43% **b** 11%
c 51% **d** 4%
e 2%
f Answers will vary

11 Answers will vary

Revision of Chapters 1-8: Exam-style questions

Section A

1 B **2** D **3** D **4** D **5** C
6 B **7** C **8** C **9** B **10** D

Section B

1 a One advantage is that it is easy to tally the scores. One disadvantage is that it does not allow customers to show the strength of their opinion.
b Categorical data
c 25% like, 30% are neutral and 45% dislike her food
d Neona could remove the 'neutral' option so customers will more clearly express satisfaction or dissatisfaction.

2 a $\frac{7}{12}$ **b** 70.59%
c Company C **d** 51%

3 a \$1190 **b** 145 hours **c** 19 months

4 a $C = 37\,000x + 100\,000$
b $R = 50\,000x$
c 8 cars

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

5 **a** $F = 25x$ **b** 125 newtons
c 0.5 cm **d** $F = \frac{200}{x^2}$
e 4 cm
f Decreases by a factor of 4.

Chapter 9

9A Starting activities

Activity 1

1 **a** Debit card
b Buy now pay later
c Personal loan, Credit card
d Credit card, Debit card, Personal loan

9B Practice questions

1 **a** BNPL splits purchases into interest-free instalments with minimal credit checks and potential late fees. Credit cards offer a revolving line of credit with monthly billing, high interest if not paid in full, and may have annual fees. BNPL focuses on short-term, interest-free payments, while credit cards involve more complex fee structures and credit requirements.
b Yes
c Incur additional fees
d Yes
2, 3 Answers will vary
4 **a** \$164.70 **b** \$59.96
c \$0.63 **d** \$77,582.75

9C Tasks and questions

Note: some online calculators give values to the nearest dollar.

1 Answers will vary
2 **a** \$5,047.30 **b** \$19,256.82
c \$16,144.64
3 **a** \$31,562.50 **b** \$32,288.70
c \$32,448.95
4 5 years
5 \$6,000
6 12.2%
7 **a** \$4,320 **b** \$12,320
c \$256.67
8 **a** \$4,613.75 **b** \$1,613.75
9 **a** \$892.50 **b** \$4,392.50
c \$183.02
10 **a** \$2,663.02 **b** \$12,663.02
11 **a** \$15,408.72 **b** \$4,408.72
12 Option B
13 **a** principal, borrowed
b interest
c years
d comparison, nominal, fees
e repayments, divide
14 **a** \$1,512.58 **b** \$9,862.58
c −\$25.84
15 **a** \$5,636
b \$6,344
c \$1,303,991
d \$1,178,290
e Super Bank has lower monthly repayments. Whole Homes Bank is cheaper overall.
f Answers will vary

9D Tasks and questions

1 Answers will vary
2 **a** **i** 3.5% **ii** 6.5% **iii** −1.0%
b Situation iii is the most unrealistic.
3 **a** \$1,448 **b** \$198
4 **a** \$195 **b** \$980
5 Answers will vary
6 Reduced total interest paid, faster loan repayment
7–9 Answers will vary

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9E Tasks and questions

1 Answers will vary
2 a Yes b 4.5%
c $3,836.25
3 a No b Yes
c $11,307.60
4 a Yes b 3.5%
c $2,747.50 d Yes, 4.7%
e $60,726
5 a 1.0% b $590
c 2023: 7.1%; 2024: 4.7%
6 a No, the correct amount is $1,712.50 (rate of 2.5%)
b Contact employer to discuss and verify with ATO if necessary
7 Answers will vary

9F Tasks and questions

1 Answers will vary
2 a i $76,557.00 ii $76,557
iii $77,628.80 iv $78,715.60
b $3,215.60
3 a $28.20
b $1.70 increase over the 3-year period
4 a 1st year: $26,548.00; 2nd year: $27,105.51; 3rd year: $27,674.73
b $1,924.73
5 a $99,808.52 b $102,825.23
c $7,080.23
6 a 1st year: $763.50; 2nd year: $777.24; 3rd year: $791.23
b $41.23
7 a Employer B
b Employer B due to the higher annual % increase
8 Answers will vary

Chapter review questions

1 a i $1,680 ii $11,680
b i $332 ii $2,332 iii $97.17
c i $1,500 ii $1,837.50 iii $153.13
d i 6 years ii $8,456 iii $54.21
2 a $621 b $6,820
3 a $112.20 b $962.20
4 $1,950
5 Best Cars: Interest = $4,675, Monthly repayments = $244.58; Top Cars: Interest = $4,036, Monthly repayments = $292.42
6 a $2,936
b i $13,132 ii $1,132
7 $5,192.53
8 Loan C
9 a $304.06 b $9,676.96
c $8,555.12
10 a 5.8% b 2.8%
11 a No b Yes, $6,330.06
c Yes, $1,280.20 d Yes, $16,023.50
12 a No indexing required
b $7,326
c No indexing required
d $30,276
13 a $38.40
b $2.00 over the 3 years
14 a 1st year: $10,771.55; 2nd year: $10,997.75; 3rd year: $11,162.72
b $612.72
15 a $294 b $304

Chapter 10

10B Practice questions

1 a Global extreme poverty rate increased in 2020 for the first time in decades.
b Increase from 8.9% to 9.7%
c Consistent global downward trend in working poverty
2 a Sub-Saharan Africa by 18%
b When the amount of health workers aged 55+ years exceeds the amount of health workers aged 35 years and under.
c Medical doctors: 32 times higher; Nursing and midwifery personnel: 10 times higher; Dentists: 175 times higher; Pharmacists: 44 times higher

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

3 **a** Overall global trend of the proportion having slightly decreased
b Answers will vary
c Sub-Saharan African primary schools have no access to the internet or computers.
4 **a** 153% increase
b Answers will vary

10C Tasks and questions

1, 2 Answers will vary
3 **a** $1,440
b $33,750
c $8,437.50
d Answers will vary
4 **a** $595
b 6 month term membership
5–7 Answers will vary

10D Tasks and questions

1 Answers will vary
2 **a** $4,100 **b** $1,900
c $1,440
3 **a** $9,801.80 **b** $5,255.50
c $14,127.75
4 **a** $135,001 – $190,000
b 37 cents
c $17,998
d $37,947
e $3,060
f $41,007
5 **a** $1,278 **b** $66,456
c $10,724 **d** $1,329
e $54,403 **f** $1,046.21
6 **a** $6.60 **b** $28.60
c $2.86 **d** $31.46
7 **a** 3 items **b** $24
c $2.40 **d** 5%
8 **a** $9,900 **b** 5.8 years
c Answers will vary.
9 **a** $444,556 (using *Moneysmart*)
b Answers will vary
10 **a** $6.19 **b** 2.40 $/L
11 **a** $92,977 **b** $1,500
c $91,477 **d** $18,231
e $10,692.36
12 **a** $58,500
b $522,543 (using *Moneysmart*)
c Yes
d Answers will vary.
e Her take-home pay will decrease but her superannuation would increase.
13 **a** $30,000 concessional contributions cap
b 15%
c Brin will pay less income tax at the higher rate.
14 Answers will vary.

10E Tasks and questions

1 Answers will vary
2 Answers will vary
3 **a** Answers will vary
b It will go further (you can buy more in the foreign currency for less AUD).
c It has less value (you will have to spend more AUD to buy less in the foreign currency).
d Answers will vary
4 **a** The graph shows Australia's current account balance as a percentage of GDP, and the trade balance between exports and imports.
b Australia imported more goods and services than it exported.
5 **a** The ABS is a reliable source. The data goes to 2023.
b Answers will vary
c The GDP for that period increased and there was a trade surplus.
d The GDP for that period decreased and there was a trade deficit.
6 **a** Total income of the country could be added up for one year, and then divided by the total population.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

b $84.01
c 68.83%
d 50.02%

7 a Australian Bureau of Statistics (ABS), Department of Foreign Affairs and Trade (DFAT), Reserve Bank of Australia (RBA). All reliable sources.
b United Kingdom
c Mainland China
d Over time, Australia has exported more to Asian Economies.

8 c Lithium-ion batteries

10F Tasks and questions

1 Answers will vary

2 a January 2009
b Approx. 18,000 USD
c No
d Yes
e Expect it to increase in value
f About 30,000 USD
g Answers will vary, but could include the end of COVID-19 pandemic
h Value of Bitcoin was declining and likely continued to decline to the end of 2022.
i, j Answers will vary

3 a 504 **b** Loss of $10

4 a Answers will vary
b 100
c 2000
d Answers will vary

5 $125

6 a $1,800
b 120
c, d Answers will vary.

7 a B **b** D **c** A
d C **e** F **f** E

8-10 Answers will vary

10G Tasks and questions

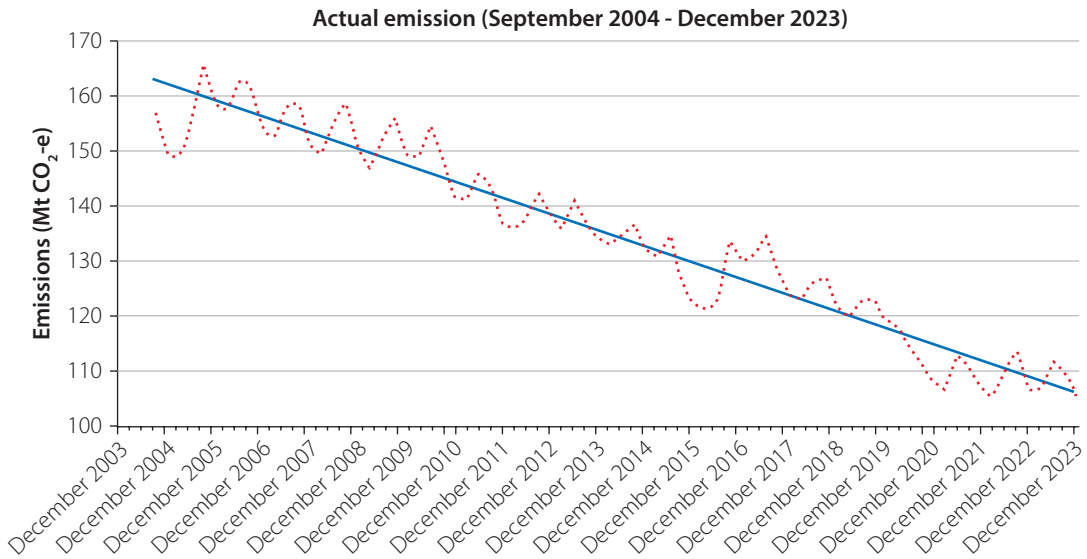
1-2 Answers will vary

3 a Fuel cost: $169.80, excise: $29.76
b Fuel cost: $169.15, excise is $13.77

4 a Horticulture: small scale, non-industrial cultivation of plants (e.g. fruits).
Dairy: a class of agriculture related to production of milk and dairy products.
Broadacre: farming operation with livestock and crops for large-scale production (e.g. wheat).
b Growing almonds (horticulture sector)
c By purchasing water allocations and fodder as a substitute for irrigated pastures
d Net buyer: the sector bought more water than it sold
Net seller: the sector sold more water than it bought
e They buy more water when the weather is dry and sell water when the weather is wet.
f Answers will vary

5 a, b See graph on next page
c December 2024: 103 Mt; December 2025: 100 Mt
d Carbon emissions are decreasing.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.



6 **a** Participation rates of 15-24 year olds in the top 10 sporting activities
b Participation slightly decreases after 17 years old but remains constant from 18 to 24 years old.
c Swimming participation decreases with age.
d With an increase in age, activities such as walking and going to the gym are favoured over organised sports.

7 **a** How many 15-19 year olds participated in sport and physical activity at least once per year
b Participation was steady at about 85%, with a decrease in 2020 to below 80%.
c Participation ranged from about 20% to 25%.
d Sport participation rates remained steady from 2016-2023, with a slight decrease in 2020.

8 **a** Answers will vary
b Not having access to sufficient food or food of adequate quality to meet your basic needs
c Ethiopia
d South Sudan
e Answers will vary

9 **a** 2.68 ML (to 2 d.p.)
b $308.40

10, 11 Answers will vary

Chapter review questions

1 **a** Lowest complaints ratio of any major fund
b Silver policy covers 30 treatments at a great price
c Earn Qantas points; only useful if you are a Qantas Frequent Flyer member
d-f Answers will vary

2 **a** 10 years **b** $317.42
c $38,090.40

3 **a** $19,288 **b** $1,900
c $21,188

4 $97,225

5 Answers will vary; for 2025-26 and 2026-27: $70.20

6 $9.50

7 $6

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

8 **a** $2.19 /L **b** $32.24
9 **a** $1,200 **b** 160
10 **a** Global surface temperatures from 1940 to 2024 shown as a monthly average and as an annual average
b Global surface temperatures have increased and will continue to rise.

Chapter 11

11A Activity 2

1 **a** 821,328.50 VND
b 60.88 AUD
2, 3 Answers will vary
4 **a** One Australian dollar (AUD) can buy more than one unit of the foreign currency.
b One Australian dollar can buy less than one unit of the foreign currency.
c Imports: A strong AUD (exchange rate greater than 1.0) makes imported goods and services cheaper for Australian businesses.
Exports: A weak AUD (exchange rate less than 1.0) makes Australian goods and services cheaper for foreign buyers, potentially increasing exports.
d Answers will vary
5 **a** Overall trend in the AUD/USD exchange rate from 2010 to 2024 is a gradual decline. The Australian dollar started strong against the US dollar but has weakened over time, with notable dips and periods of relative stability. The exchange rate moved from above 1.00 to between 0.60 and 0.75.
b Increased costs: As the Australian dollar weakens, importing goods from the United States becomes more expensive.
c Increased competitiveness: A weaker Australian dollar makes Australian goods and services cheaper for buyers in the United States. This can boost demand for Australian exports as they become more affordable and competitive in the US market. Consequently, Australian businesses may see increased sales and revenue from exports.

11B Practice questions

1 **a** $1,452 per week. Divide by 52.
b $5,850 per year. Multiply by 26.
c $4,562 per fortnight. Divide by 26.
d $4,145 per year. Multiply by 12.
e $2,925 per quarter. Multiply by 26 then divide by 4.
f $20,540 per year. Multiply by 52.
g $5,400 per quarter. Divide by 4.
2 $41,925
3 $387.50
4 **a** $1,131 **b** $4,900

11C Tasks and questions

1 Answers will vary.
2 **a** $9.45 **b** $3.59
c $16.80 **d** $27.00
3 **a** $176.97 **b** $7.82
c $12.35 **d** $40.91
4 **a** $1.17 per biscuit, $1.70 per muffin.
b **i** $290 **ii** $615
c Answers will vary
5 **a** Yes
b They need to pay the ATO.
c $2937
6 **a** Yes **b** $7,609
7 **a** Yes
b Answers will vary
8 **a** 325 USD **b** 769 AUD
9, 10 Answers will vary
11 **a** 123123
b Golf equipment: Nike Driver – Nike SQ MachSpeed Black Round Driver
c $263.12
d Yes, GST is $23.92
= (299.00 – 59.80) × 0.1

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

12 **a** INV-27
b 1 July 2024
c $846.80
d Yes, GST is $76.98

13 **a** $3,500 **b** $168,000
c $15,272

14

Carla's Gardening Services
Tax Invoice
Invoice #: 3006 1234 ABN: 12 345 678 910

To	Mr Ford 12 Third Street Four Springs VIC 3297		From:	Carla's Gardening Services 14 Snail Road Green Springs VIC 3298

Job completed:
- Deliver and plant 3 gum trees
- Deliver 2.5 cubic metres (m^3) of garden mulch

Task/Item	Qty	Cost	Total cost
Deliver and plant gum tree	3	$150	$450
Garden mulch (cubic metres)	2.5	$50	$125
Labour (hours)	3.5	$75	$262.50
		Sub total	$837.50
		GST 10%	$83.75
		Total amount owing	$921.25

Date: 26 June
Invoice prepared by: Carla Green

Balance due within 7 days of the completion of work.

11D Tasks and questions

1 Answers will vary
2 Higher risk of injury
3 **a** E **b** E **c** R **d** R **e** E **f** E **g** E **h** E **i** E
4 8 days
5 **a** $7,828.80 **b** $11,496
c $13,542.48
6 $382.52
7 $163,700
8 **a** Yes **b** $16,212
9 $28,339
10 **a** G1: 19986, G2: 0, G3: 0, G10: 0, G11: 6511, 1A: 1816, 4: 538, 5A: 0, 7: 0, 8A: 2354, 1B: 444, 5B: 0, 8B: 444, 9: 1910
b Owe money
c $1,910

11E Tasks and questions

1 Answers will vary
2 **a** Cash flow statement
b –$4,120
c No, more cash is flowing out of the company than in.
d Answers will vary but may include: reduce equipment purchasing
3 Total assets: $22,140;
Owner's equity: $8,640
a Balance sheet
b $8,640
c Yes
d Answers can vary but may include: invest more equity to grow the business.
4 Result: –$680
a Profit and loss statement
b –$680 or loss of $680
c No, it is making a loss.
d Answers will vary but may include: increase sales of additional products, find a cheaper supplier for stock purchases.
5 **a**

Revenue	
Sales	$16,200
Expenses	
Stock purchase	$5,400
Wages	$2,000
Rent	$6,120
Other expenses	$750
Result	$1,930

b Yes
c Answers can vary but may include: taxes, superannuation, advertising.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6 a Cash receipts

Details	Invoice number	Fees	GST	Total payment
Unity cars	1	$4,636.36	$463.64	$5,100
Total sales	2	85,454.55	$8,545.45	$94,000
Fixing air conditioning	3	$4,272.73	$427.27	$4,700
Office rent	4	$4,090.91	$409.09	$4,500
Ink cartridge	5	$100.18	$10.02	$110.20
New monitors	6	$3,236.36	$323.64	$3,560
Refurbishing office	7	$28,636.36	$2,863.64	$31,500
Phone and internet	8	$136.36	$13.64	$150

Total amount received: $143,620.20

Total amount of GST received: $13,056.39

Total revenue: $130,563.81

b Cash payments

Details	Reference number	Expense	GST	Total amount paid
Fred's bakery	101	$152.73	$1,527.27	$1,680
New chairs	102	$90.00	$900.00	$990
Taxis	103	$74.55	$745.45	$820
Event hosting	104	$2,204.55	$22,045.45	$24,250
York printing	105	$236.36	$2,363.64	$2,600
First aid training	106	$71.82	$718.18	$790

Total amount of money paid out: $31,130.00

Total amount of GST paid: $2,830.00

Total expenses: $28,300.00

c Profit

7 a F **b** D **c** A **d** C **e** G **f** H **g** E **h** B

8 a

	October	November	December	Total
Gross profit/net sales	$2,631	$3,441	$4,285	$10,357
Net profit (net income)	$537	$1,292	$1,813	$3,642

b No. If her gross profit is similar for the rest of the year, the gross profit minus GST will be under the $75,000 threshold.

c Answers will vary but may include: it is successful because it makes a net profit each month and the net profit is increasing each month.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

9 a

Profit & Loss Statement for the period of one month		
Income		
Event catering revenue	$890.00	
Sales of street food	$16,590.00	
Cost of goods sold (permit fees)	$558.00	
Cost of goods sold (supplies)	$5,920.00	
Gross profit		**$11,002.00**
Expenses		
Advertising and marketing	$250.00	
Bank fees and charges	$265.00	
Income tax	$1,144.00	
Insurance	$225.00	
Lease of van	$1,125.00	
Maintenance	$300.00	
Parking fees	$260.00	
Superannuation	$598.00	
Telephone	$94.00	
Wages (including PAYG)	$5,200.00	
Total expenses		**$9,461.00**
Net profit		**$1,541.00**

b 63%

c 9%

d No, the gross profit margin is above 45% but the net profit margin is below 10%.

e Answers can vary but may include: reduce costs of goods, raise prices increase revenue, do more event catering, reduce wages or staff hours.

Chapter review questions

1 Answers will vary

2 **a** $69.50 **b** $43.68

3 No

4 $6,632

5 7 days

6 **a** $1,345

b $64,560

c Dog minding $5, 30-minute walk $2.27, 45-minute walk $3.18, 60-minutes $4.09.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

7

Kala's Pet Minding Services Tax Invoice Invoice #: 2024 1234			ABN: 12 345 678 910
To:	Jim Ford 12 Third Street Four Springs VIC 3297	From:	Kala's Pet Minding Services 14 Snail Road Green Springs VIC 3298
Job: • Mind two dogs for 5 days • Cost per day: $50 per dog per day (excluding GST)			
Task/Item	Qty	Cost	Total cost
Dog minding	10	$50	$500
		Sub total	$500
		GST 10%	$50
		Total amount owing	$550
Date: 11 October 2024 Invoice prepared by: Kala Green			
Balance due within 14 days of the completion of work.			

a 2024 1234
b 25 October 2024
c $50
d $550

8 $35,995

9 $10,422

10 a

Profit & Loss Statement for the period of one month		
Income		
Sales	$148,583.00	
Cost of materials	$52,000.00	
Gross profit		**$96,583.00**
Expenses		
Advertising and marketing	$4,341.00	
Bank fees	$928.00	
Telephone	$743.00	
Stationery and printing	$7,774.00	
Postage and freight	$2,578.00	
Insurances	$1,040.00	
Superannuation	$4,282.00	
Utilities	$855.00	
Wages (including PAYG)	$37,125.00	
Miscellaneous fees and expenses	$5,868.00	
Total expenses		**$65,534.00**
Net profit		**$31,049.00**

a Yes
b 21%

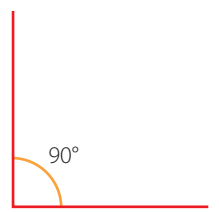
Chapter 12

12B Practice questions

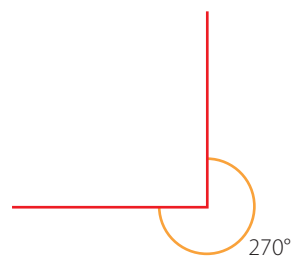
1 Answers will vary

2 d Sidelengths are equal.

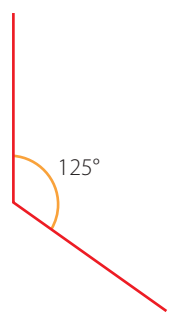
3 a



b

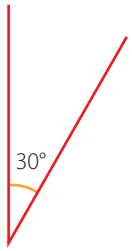


c



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

d



4 Answers will vary

12C Tasks and questions

1 Answers will vary

2 **a** Convex **b** Concave
c Convex **d** Convex

3 **a** Polygon, not regular, convex
b Not a polygon
c Polygon, regular, convex
d Not a polygon
e Polygon, not regular, convex
f Polygon, not regular, concave
g Polygon, regular, convex
h Not a polygon

4 **a** Not a tessellation
b Tessellation
c Tessellation
d Tessellation

5 **a** Cone
b Pyramid
c Bipyramid or octahedron
d Cylinder
e Sphere
f Triangular pyramid or tetrahedron
g Hexagonal prism
h Triangular prism
i Ellipsoid

6 **a** 6 faces, 8 vertices, 12 edges
b 4 faces, 4 vertices, 6 edges
c 7 faces, 10 vertices, 15 edges
d 0 faces, 0 vertices, 0 edges

7 **a** **i** 180° **ii** 60°
b **i** 720° **ii** 120°
c **i** 1080° **ii** 135°
d **i** 540° **ii** 108°

8 8

9 60°

10 Pentagon

11 d and e (triangle and hexagon)

12 30°

13 triangular prism

14 720°

15 10

16 **a** G **b** F **c** H **d** J **e** B
f D **g** I **h** C **i** A **j** E

17 Answers will vary. Possible answer:

	Number of items
Cuboids	60
Cylinders stacked vertically	360
Triangular prisms	594
Tetrahedrons	90

18 Answers will vary

19 12 triangles with lengths:
(8, 8, 8) - equilateral, acute-angled
(7, 6, 11) - scalene, obtuse-angled
(7, 8, 9) - scalene, acute-angled
(9, 6, 9) - isosceles, acute-angled
(6, 10, 8) - scalene, right-angled
(9, 5, 10) - scalene, acute-angled
(5, 11, 8) - scalene, obtuse-angled
(9, 4, 11) - scalene, obtuse-angled
(7, 10, 7) - isosceles, obtuse-angled
(4, 10, 10) - isosceles, acute-angled
(3, 10, 11) - scalene, obtuse-angled
(2, 11, 11) - isosceles, acute-angled

12D Tasks and questions

1 Answers will vary

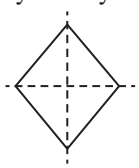
2 **a** Similar
b Congruent
c Congruent
d Congruent
e Similar

3, 4 Answers will vary

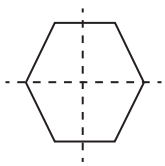
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

5 **a** Not symmetrical.

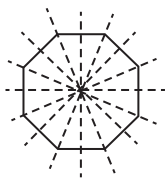
b Symmetrical. Give any of the lines of symmetry shown.



c Symmetrical. Give any of the lines of symmetry shown.



d Symmetrical. Give any of the lines of symmetry shown.



6 **a** **i** Reflection **ii** Congruent

b **i** Reflection and translation or rotation **ii** Congruent

c **i** Dilation **ii** Similar

7 **a** dilated

b reflected, symmetrical

c translated

d rotated

e congruent

8 **a**

Format	Size
A0	841 × 1189
A1	594 × 841
A2	420 × 594
A3	297 × 420
A4	210 × 297
A5	148 × 210

b They are halved. The pattern continues.

c **i** 50% **ii** 100% **iii** 141% **iv** 50%

9 **a** Irregular hexagons, squares. A large square is formed by one small square in the centre and in each of the four corners. The spaces left are filled by the irregular hexagons. These larger squares are repeated in a tessellating pattern.

b Irregular pentagons, squares. Four irregular pentagons are arranged to form irregular octagons. These are arranged in rows. Four small squares form one large square, which fills the gaps between the octagons.

12E Tasks and questions

1 Answers will vary

2 **a** 40° **b** 28° **c** 150°

3 **a** 70° **b** 120° **c** 90°

4 **a** 50° **b** 110° **c** 75°

5 **a** 60° **b** 100° **c** 65°

6 **a** 112° **b** 130° **c** 65°

7 **a** 45° **b** 130° **c** 130°
d 135° **e** 90° **f** 115°
g 115° **h** 60° **i** 90°
j 123°

8 **a** $d = 70°$

b $a = 47°$, $b = 88°$

c $a = 130°$, $b = 50°$, $c = 130°$, $d = 130°$

d $a = 80°$, $b = 80°$, $c = 80°$, $d = 80°$, $e = 80°$, $f = 80°$, $g = 80°$

e $a = 52°$, $b = 128°$, $c = 128°$

f $a = 120°$, $b = 120°$, $c = 60°$, $d = 60°$, $e = 60°$

9 **a** $a = 60°$, $b = 90°$, $c = 90°$, $d = 90°$, $e = 60°$

b $a = 35°$, $b = 110°$, $c = 110°$, $d = 70°$

c $a = 50°$, $b = 50°$, $c = 80°$, $d = 100°$, $e = 100°$, $f = 80°$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

12F Tasks and questions

1 Answers will vary

2 **a** 420 m **b** 120 m
c 350 m **d** 195 m

3 **a** South **b** North-east
c North **d** West

4 **a** 53 minutes **b** 13%
c 92 km/h **d** 10:48 a.m.
e 93 L **f** 2

5 The 1:05 p.m. Craigieburn line train from Broadmeadows (timetables may change). The bus takes almost 3 times as long, so if there is a delay or trains are cancelled, he should take a taxi.

6 **a, b**

Airport	Distances from Tullamarine airport (km)	Percentage of largest distance
Canberra	468	15%
Hobart	617	20%
Adelaide	643	21%
Sydney	706	23%
Brisbane	1377	44%
Perth	2701	86%
Darwin	3135	100%

c 7
d 21 714 km

7, 8 Answers will vary

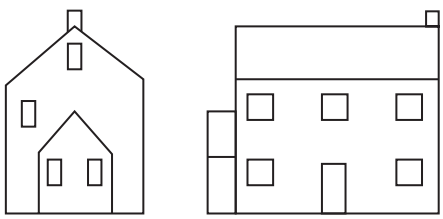
12G Tasks and questions

1 **a** Answers may include: orientation, sun control, natural ventilation, insulation and appropriate colour selection.
b They are used to keep houses cool in summer and warm in winter. Answers may include: orienting houses to minimise sun exposure in summer by place the longest side of the house facing north; eaves designed to block the high summer sun but not the lower winter sun; high ceilings allow hot air to rise and cooler air to circulate below; appropriate thickness of insulation is necessary to prevent heat transfer.

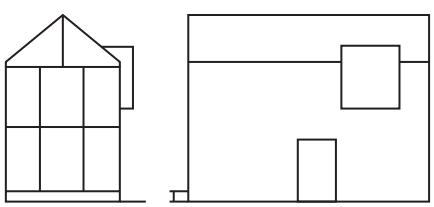
2 **a** 9.31 m
b 11.91 m wide, 26.26 m long, area 312.76 m^2
c 3.67 m wide, 3.67 m long, area 13.47 m^2
d 5.24 m wide, 3.67 m long, area 19.23 m^2

3 **a** Electrical: lighting outlets, receptacle outlets, special purpose outlets, fan outlets and switches; Plumbing: Heater/cooler, pipe routes for cold/hot water and waste.
b Clear communication between trades is crucial to ensure safety, quality, efficiency and cost-effectiveness.

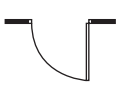
4 **a**



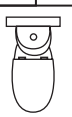
b



5 **a** **i**



ii



iii

iv

b Exterior walls are dark, and indicate the roofline of the building. The veranda is outside these lines.
c No, open areas are not included.
d 104.4 m^2 **e** 11.6
f $208,800 **g** 13.7 m^2
h $1439 **i** 52.3 m^2
j $4969

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

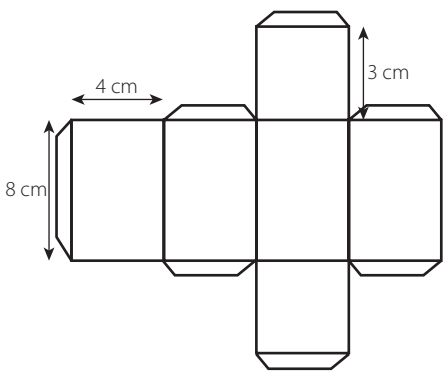
6 Answers will vary. Possible examples:
- **a** Family room being close to the kitchen is good for young children; multiple living rooms allow the adults to have child-free spaces.
- **b** Teenagers want their own room, which they would have in this house; there are multiple living rooms to allow the teenagers to study, watch TV, socialise separately.
- **c** For a family with three teenagers, an extra bathroom or separate shower prevents queues in the morning.

7 **a** Answers will vary but may include: the toilet and laundry have no interior doors.
- **b** Answers will vary

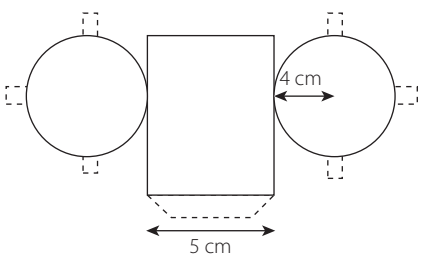
12H Tasks and questions

1 Answers will vary

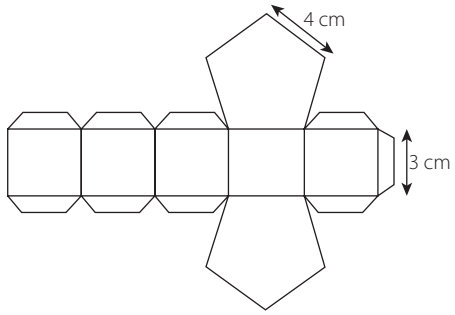
2 **a**



b



c

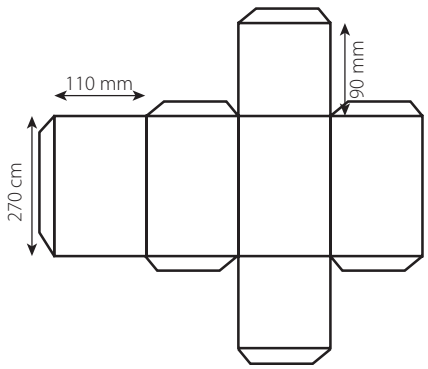


d Answers will vary

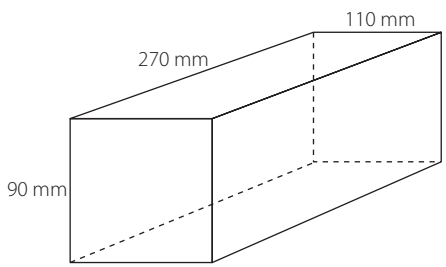
3 Answers will vary

4 **a** Rectangular prism

b-c



d



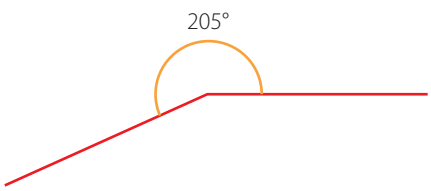
5 Answers will vary

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter review questions

1 a

b



2 a 7 faces, 10 vertices, 15 edges

b 6 faces, 8 vertices, 12 edges

3 a prism **b** ellipsoidal

c pyramid **d** planar

4 Answers will vary

5 a 65° **b** 142°

c 110° **d** 109°

e 63° **f** 71°

g 82° **h** 62°

i 77° **j** 134°

k both 135° **l** both 95°

6 a About 670 m **b** Red cross

c South-west **d** Gray

e Shopping precinct

f Answers will vary; one example is: Leave the Showgrounds at Factory Rd, turn right at Parker St then turn right into Turnbull St.

7 a 144 km

b 3 hours

c 95 km/h

8 a 8:39 a.m. Mernda line from Collingwood to Southern Cross Railway, then 8:58 a.m. Williamstown line to Spotswood (timetable subject to change).

b 46 minutes (timetable subject to change).

9 a Answers will vary but may include: cupboards, wardrobes, veranda

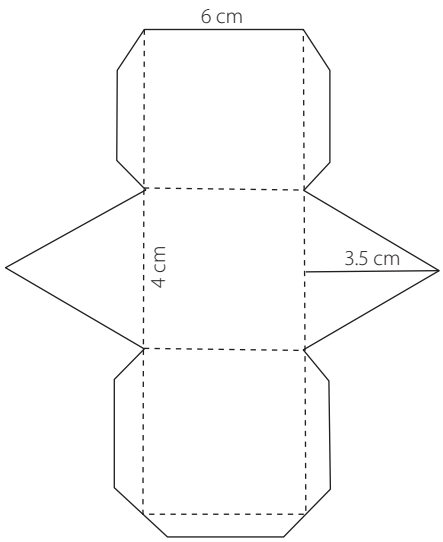
b 87.7 m^2

c 9.74 building squares

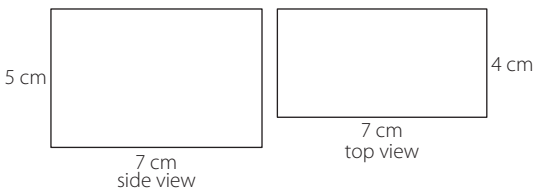
d $204 540

e $5706 to the nearest dollar

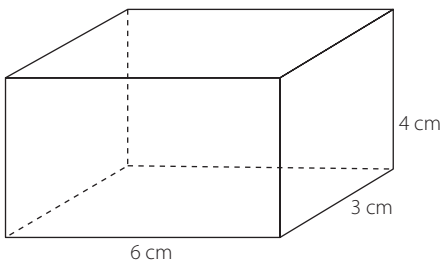
10 a



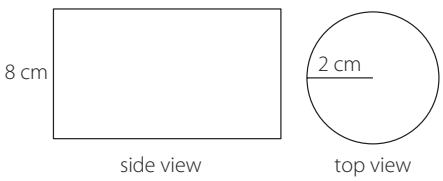
b



11 a



b



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter 13

13C Tasks and questions

1 Answers will vary

2 **a** 10.7 cm **b** 6 mL
c 0.59 kg **d** 400 mL
e 65 kg

3 **a** 4 hours
b 5 hours 23 minutes
c 4 hours 35 minutes

4 Answers will vary

5 10 mL and 2 mL (or 8 mL and 4 mL etc)

6 **a** Temperature in degrees Celsius, 37.6°C
b Length in millimetres, 15.08 mm
c Weight in grams, 289 g
d Temperature in degrees Celsius, 22.5°C

7 Answers will vary but may include: pH Meter (pH scale), spectrophotometer (absorbance A or transmittance %), barometer (pascals or millibars), conductivity meter (Siemens per metre)

8, 9 Answers will vary

13D Tasks and questions

1 Answers will vary

2 **a** Metres **b** Kilometres
c Centimetres **d** Millimetres

3 **a** 250 cm **b** 8.0 km
c 30.5 cm **d** 109 yd
e 1.83 m **f** 1750 mm

4 **a** 50 000 cm^2 **b** 150 000 m^2
c 0.255 cm^2 **d** 1 200 000 m^2
e 22.1 ha **f** 2.8 km^2

5 **a** 1 200 000 000 mm^3 **b** 0.000 25 m^3
c 1200 kL **d** 7500 mm^3
e 600 cm^3 **f** 14 787 mL

6 **a** 65 000 g **b** 0.0012 kg
c 135.2 kg **d** 650 000 mg
e 3500 g **f** 69.9 kg

7 **a** 90 min **b** 960 s
c 0.1 min **d** 75 min
e 6 days **f** 1.8 h

8 **a** 104°F **b** 10°C
c 86°F

9 **a** 2340 mm **b** 0.6 lb
c 3200 m **d** 56.7 kg
e 0.9 mi **f** 20 000 m^2
g 1200 s **h** 1.7 m
i 2500 kg **j** 0.0324 ML
k 3240 min **l** 25.6°C

10 1.134 kg ball clay, 0.684 kg grog, 0.9072 kg kaolin

11 **a** 22 yd, 20.1168 m **b** 10 ft, 3.048 m
c 28 in, 71.12 cm **d** 9 in, 22.86 cm

12 **a** 6.5 mm **b** 2.0 mm
c 9.5 mm **d** 8.0 mm
e 13.5 mm

13E Tasks and questions

1 Answers will vary

2 **a** 40 cm **b** 42.2 m
c 262.8 mm **d** 7.9 m

3 **a** 1.6 m **b** 2.5 cm

4 **a** 7.2 cm^2 **b** 4.1 m^2
c 1963.5 cm^2 **d** 235.2 cm^2
e 3750 m^2 **f** 93.7 m^2
g 37.7 cm^2 **h** 7.9 cm^2

5 **a** 145.1 m^2 **b** 102 m^2
c 104 cm^2 **d** 235.6 mm^2
e 273 m^2 **f** 18.7 cm^2
g 60.7 cm^2 **h** 151.3 cm^2
i 25.6 cm^2 **j** 223.6 cm^2

6 **a** 15 000 mm^2 **b** 123 m^2
c 40.4 cm^2 **d** 42.4 m^2
e 624 m^2 **f** 7354.1 cm^2
g 804.2 m^2 **h** 163.8 cm^2

7 **a** 373 cm^2 **b** 0.9 m^2
c 226.9 cm^2 (to 1 d.p.) **d** 15.3 m^3

8 **a** 22.8 cm **b** 41.7 m

9 **a** 15 000 cm^2 **b** 330 cm^2
c 829.38 cm^2 **d** 3614.16 cm^2
e 40 212.39 mm^2 **f** 162.86 cm^2

10 3.5 m (to 1 d.p.)

11 No, $10.5^2 = 110.25$ and $9.2^2 + 5.1^2 = 110.65$

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

12 **a** 69.4 m^2 **b** 1389 g
13 58.4 m^2
14 Answers will vary

13F Tasks and questions

1 Answers will vary
2 **a** Double the volume (which can be done by doubling one length or area of one side)
b Volume would increase by 8 times, fitting 400 g
c Volume of prism = base area × height or $V = A \times H$. (Area is related to the product of two length measurements)
d Answers will vary but should consider the effect of doubling different dimensions
3 D, the cross-section is the same across the length
4 **a** 216 cm^3 **b** 384 cm^3
c 660 cm^3 **d** 3.2 m^3
e 11 309.7 cm^3 **f** 33 510.3 mm^3
g 110 000 cm^3 **h** 1206.4 cm^3
5 **a** 85.9 cm^3 **b** 360 cm^3
6 **a** 18.9 g/cm^3 **b** 1.6 g/cm^3
c 3.6 g/cm^3
7 **a** 19 228 cm^3 **b** 48 960 mm^3
c 25.1 cm^3 **d** 14 790 cm^3
8 **a** 905 cm^3 **b** 905 mL
9 78 540 L (to the nearest L)
10 Size 6: 6371 cm^3; size 7: 7059 cm^3; difference is 688 cm^3
11 12 637 cm^3
12 22.4 g/cm^3
13 14.1 g/cm^3
14 Box 1: 453.7 cm^2, 576.8 cm^3, 576.8 mL; Box 2: 257.2 cm^2, 240.3 cm^3, 240.3 mL (*Note:* the values for volume and capacity have been rounded down so there is not overflow.) Other answers will vary.

13G Tasks and questions

1 Sample answers provided.
a **i** Low
ii Taking the average of multiple measurements, using an accurate tape measure or laser measuring device.
b **i** High
ii Using a precise measuring container, such as a syringe, or accurate scales.
c **i** Medium
ii Using an accurate meat thermometer and taking the measurement as soon as it has finished cooking, so that it does not cool before measuring.
d **i** Medium
ii Confirming the accuracy of the volume measuring device by checking it against a reference measurement (e.g. 1 L of water weighs almost exactly 1 kg) or mixing larger quantities of the mix so that small absolute errors lead to lower relative errors.
2 **a** **i** 4.4 g **ii** 0.035 **iii** 3.5%
b **i** 4 s **ii** 0.007 **iii** 0.7%
c **i** 0.06 km **ii** 0.023 **iii** 2.3%
3 **a** 0.2, 0.4, 0.2
b 0.0057, 0.0114, 0.0057
c 0.57%, 1.14%, 0.57%
4 **a** 5.65 cm
b 5.55 cm
c Not within acceptable range, considered faulty.
5 **a** 245 g
b 215 g
c Within acceptable range, not considered faulty
6 D
7 Accurate but not precise

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

8 **a** Centred around the target or stated measurement
b Starts at the advertised or stated measurement
c Centred around the target or stated measurement
9 0.1
10 Upper limit 260 g, lower limit 240 g
11 Poor accuracy and poor precision
12 2%
13 **a** precise **b** tolerance
c error **d** accurate
14 **a** Neither **b** 548.2 g
c

Pack 1	**i** 55 g	**ii** 0.11	**iii** 11%
Pack 2	**i** 45 g	**ii** 0.09	**iii** 9%
Pack 3	**i** 50 g	**ii** 0.10	**iii** 10%
Pack 4	**i** 43 g	**ii** 0.086	**iii** 8.6%
Pack 5	**i** 48 g	**ii** 0.096	**iii** 9.6%

d The amounts are all over 500 g by between 8.6% and 11% which means the butcher is losing money.
15 **a** 5.0 m cut to 3.6 m, 2.0 m cut to 1.8 m, 5.1 m cut to 3.6 m, 3.9 m cut to 3.6 m
b No

Chapter review questions

1 **a** 1565 g **b** 80.5 kg
c 10.4 cm
2 Answers will vary but should be reasonably close to:
a 800 g **b** 4.4 m
c 200 L
3 **a** 6.5 mL **b** 10.2 cm
c 53.5 mm **d** 72 hours
e 177.444 mL **f** 907.2 g
g 1.255 km **h** 50 000 m^2
i 23.9°C **j** 84.9 L
4 **a** 8.06 mm **b** 11.18 cm
c 2.62 cm **d** 57.60 mm
5 **a** Yes **b** No
6 34.4 cm
7 **a** 225 mm^2 **b** 27 cm^2
c 50 cm^2 **d** 42 cm^2
e 201.1 mm^2 **f** 8.0 cm^2
g 30.9 cm^2 **h** 35 cm^2
8 50 cm^2
9 **a** 17.3 cm^2 **b** 26.0 mm^2
10 **a** 627 cm^2 **b** 236 cm^2
c 352 cm^2
11 **a** 27 000 mm^3 **b** 800 cm^3
c 540 mm^3 **d** 863.9 cm^3
e 904.8 cm^3 **f** 405 000 mm^3
g 1340.4 cm^3
12 35 342.9 L
13 **a** 2.7 g/cm^3
b 2496.4 kg/m^3 or 2.5 g/cm^3
14 **a** 6.5 g **b** 0.0325
c 3.25%
15 B
16 **a** 205 g
b 175 g
c Within acceptable range, not considered faulty

Revision of Chapters 9-13: Exam-style questions

Section A

1 C	**2** B	**3** C	**4** B	**5** B
6 C	**7** D	**8** A	**9** B	**10** A

Section B

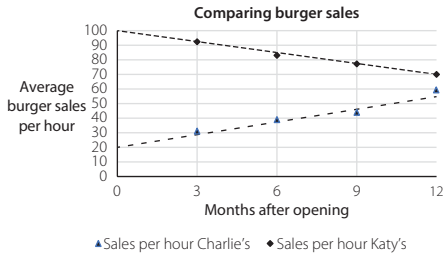
1 **a** Only month where her sales of cars at least 7 years old (30 cars) is greater than her sales of cars less than 7 years old (20 cars).
b June and December
c She should concentrate on cars <7 years old as this is where many more sales occur.
2 **a** 22 m **b** 221.5 m^2
c $24,365
3 **a** $57,768 **b** $1,155.36
c $9,672 **d** $398.24

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

4 a Charlie's: 40 hamburgers per hour; Katy's: 80 hamburgers per hour

b It is misleading to make Katy's graph about twice as wide as Charlie's, as this exaggerates the difference, when it is the height not the width that shows the sales values.

c



d Charlie's starts lower at about (3, 30) and increases over 9 months to about (12, 57), averaging an increase of about 3 burger sales per hour for each month. Katy's starts higher at about (3, 92) and decreases over 9 months to about (12, 70), averaging a decrease of about 2.5 burger sales per hour for each month. Possible reasons for Charlie's increase versus Katy's decrease could be having better burgers or service or prices.

e $y = 21 + 3x$ where y is the burger sales per hour and x is the number of months after opening

f 36 burgers per hour

g May be unrealistic

Revision Units 3 and 4: Exam-style revision

Section A

1 D	**2** A	**3** B	**4** A	**5** A
6 A	**7** C	**8** B	**9** B	**10** C
11 A	**12** D	**13** B	**14** A	**15** B
16 D	**17** B	**18** D	**19** B	**20** B

Section B

1 a i \$4.80 per kg **ii** \$4.67 per kg

b 20%

c 650 g

d 600 g flour, 420 g water, 12 g salt, 6 g yeast

2 a 25 years

b 30 years

c Median, as not affected by outlier of 65

3 a 343 **c** 34.3 m

b 26.4 hertz

4 a A trundle wheel is not a highly accurate measuring device, and a stopwatch can have operator error in starting and stopping the time measurement.

b 2.08 m/s

c The shape of Kabir's distribution is more widely spread out with values from 0.9 to 3.0 m/s, whereas Heath's results are more closely grouped from 0.9 to 2.3 m/s.

d Mean: Heath 1.45, Kabir 1.93; Median: Heath 1.35, Kabir 1.8; Range: Heath 1.4, Kabir 2.1; IQR: Heath 0.6, Kabir 0.9

e Kabir

f $\frac{1}{5}$

5 a $C = 300 + 1.5x$, $R = 3.5x$ where x is the number of mugs

b

	A	B	C
1	**Number of mugs, x**	**Production cost, \$$C$**	**Revenue from sales, \$$R$**
2	0	300	0
3	50	375	175
4	100	450	350
5	150	525	525
6	200	600	700
7	250	675	875
8	300	750	1050

c 150 mugs

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

6 a Number of females (70) is much greater than the number of males (20) so there will be a gender bias effect in the overall results; not clear whether a score of 1 represents the highest ranking or the lowest points out of five, and vice-versa for a score of 5.

b Very different to other 19 scores for the male group; female data evenly spaced

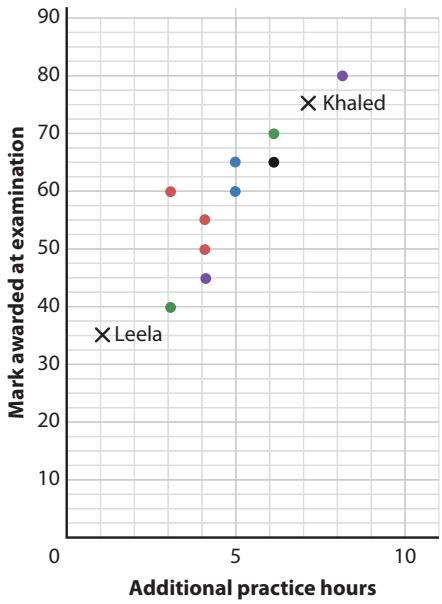
c Mean score by males is 1.95 and half the males give a score of 1; whereas mean score by females is 3.11 with an even spread of scores from 1 to 5. So the opinions by the females are more scattered than the opinions of the males. This data does not support the notion that soft and luxurious bedding matters more to females than males.

7 a 85.73 m^2

b 164.27 m^2

c $167,270

8 a



b Shows the result for each student as a separate dot

c Position of line may vary; using Excel, trend line is Mark = 6.5984 × number of additional practice hours + 27.541

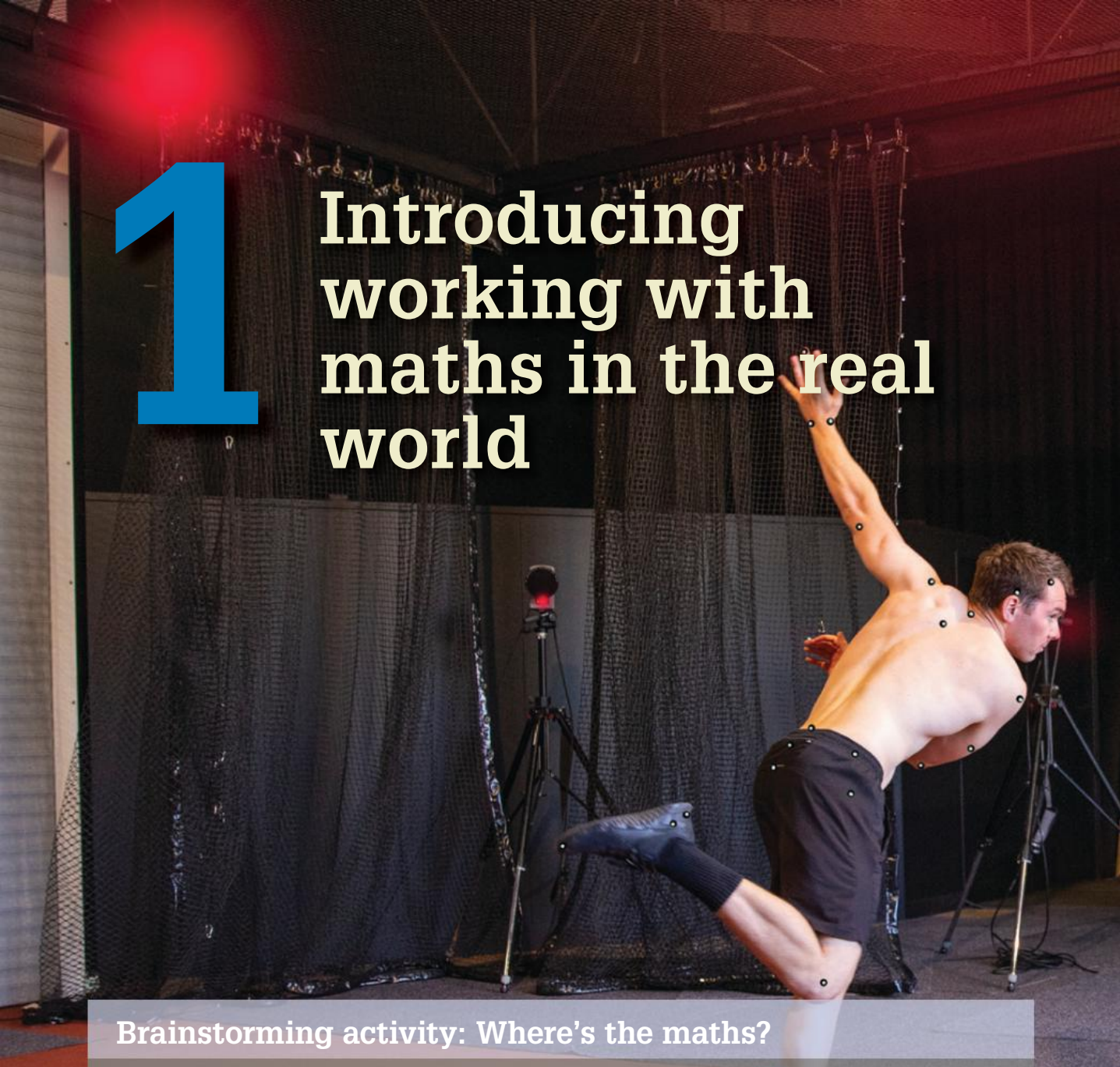
d Approx. 6.6 for each hour of additional practice

e About 41

9 a 700 cm

b Each slope length: 351 cm; platform length: 798 cm

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.



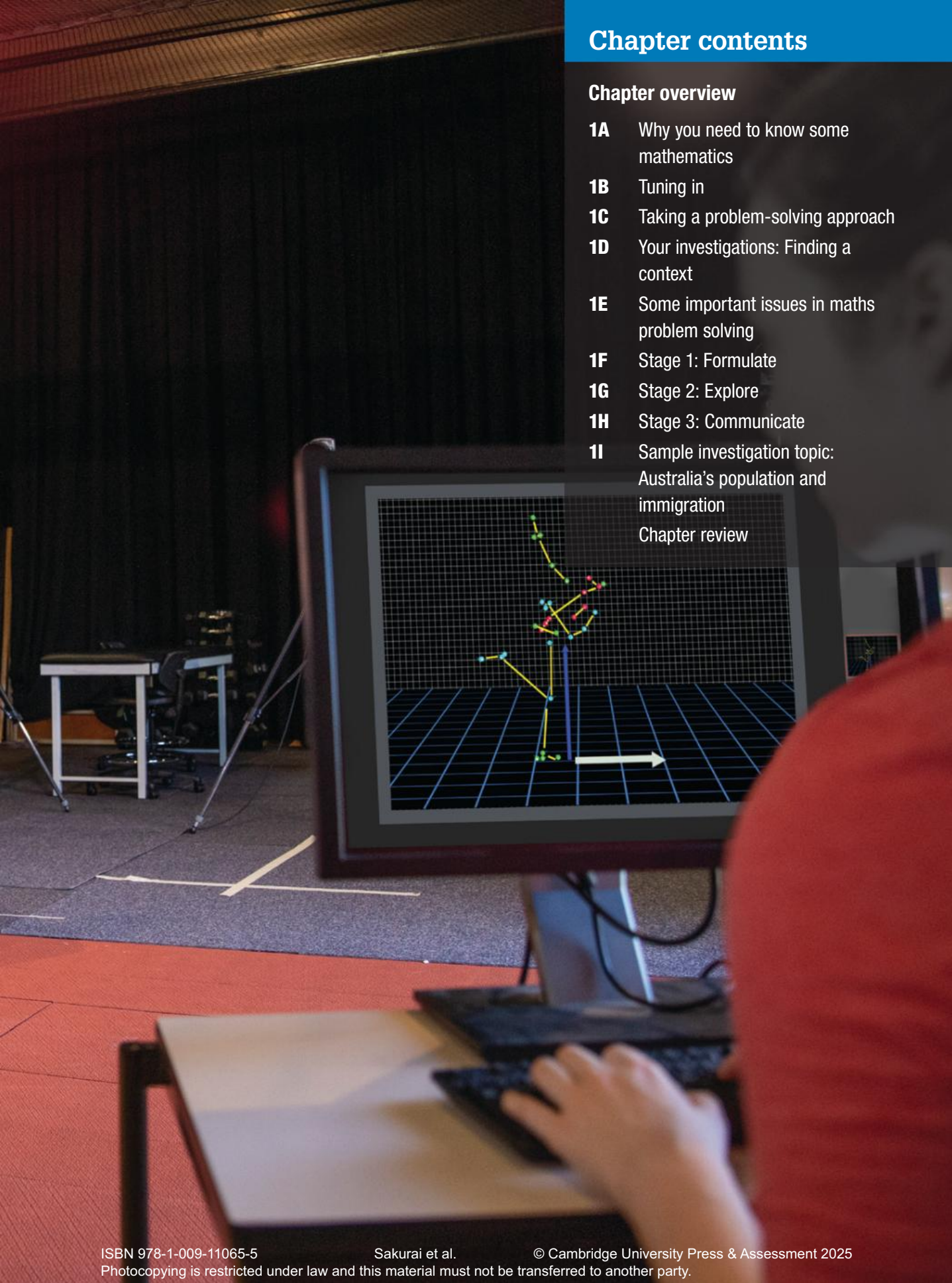
1 Introducing working with maths in the real world

Brainstorming activity: Where's the maths?

Using this photo as a stimulus, brainstorm how the mathematics required for this task is related to the content of this chapter. Prompt questions might be:

- What might be being investigated or researched?
- Can you think of some questions that they might want answered?
- What types of mathematics might be involved? For example:
  - Data
  - Chance and probability
  - Measurements such as time, distance and speed
  - Shape and design
- What calculations might be involved?
- What different tools, technologies or software might be used?
- What do you think the outcomes of such research would be? How might it be documented and written up or presented?

ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.



Chapter contents

Chapter overview

1A Why you need to know some mathematics

1B Tuning in

1C Taking a problem-solving approach

1D Your investigations: Finding a context

1E Some important issues in maths problem solving

1F Stage 1: Formulate

1G Stage 2: Explore

1H Stage 3: Communicate

1I Sample investigation topic: Australia's population and immigration

Chapter review

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Chapter overview

Introduction

The purpose of this chapter is to show you why you need mathematical knowledge and problem-solving skills to respond to problems set in contexts relevant to today's life and work. This involves not only knowing some maths, but more importantly knowing how to solve problems that are based in real-world situations. Sometimes these skills are named as 'numeracy'.

This ability involves a number of critical skills, including the following:

- identifying, deciding on, and planning and **formulating** what maths you need to use to solve a problem
- doing the maths – **exploring**, using and applying your maths knowledge and skills to find and review your solutions
- **communicating** the results and outcomes of your work.

This initial chapter also takes you through the steps required to undertake the three Investigations you are expected to complete as part of your studies. The investigations are a significant part of the formal assessment for VCE Foundation Mathematics.

Learning intentions

By the end of this chapter, you will:

- understand the importance of mathematics in both the workplace and daily life
- appreciate the advantages of a problem-solving approach for learning mathematics
- know what each stage in the problem-solving cycle entails
- understand why interpreting mathematical words and language is an essential skill for solving real-world problems
- recognise the usefulness of tools and technologies for solving mathematical problems
- appreciate the importance of reviewing and reflecting on your work
- understand the application of the three stages of the problem-solving cycle in undertaking Investigations.

Seems familiar? A note about this chapter

Some sections of this chapter are very similar to the material that is covered in the equivalent chapter in the Units 1 & 2 textbook. If you have worked through the Units 1 & 2 textbook already, and feel that you are very familiar with how the materials are structured and presented in these books, you could skim the first sections of this chapter (1A to 1D), reading any new or unfamiliar material, and then work your way through the remaining new sections (1E to 1I).

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

1A Why you need to know some mathematics

Fundamentally, you need to know some mathematics because maths is part of living and working in the real world, outside the school maths classroom.

Research is showing that the skills and knowledge needed to succeed in work, life and society have significantly changed in the 21st century, often driven by technological advances and an ever-increasing use of numerical and statistical information and data. Mathematics and numeracy skills are needed more than ever before to filter, understand and critically reflect on the enormous amount of data and information that we encounter every day.

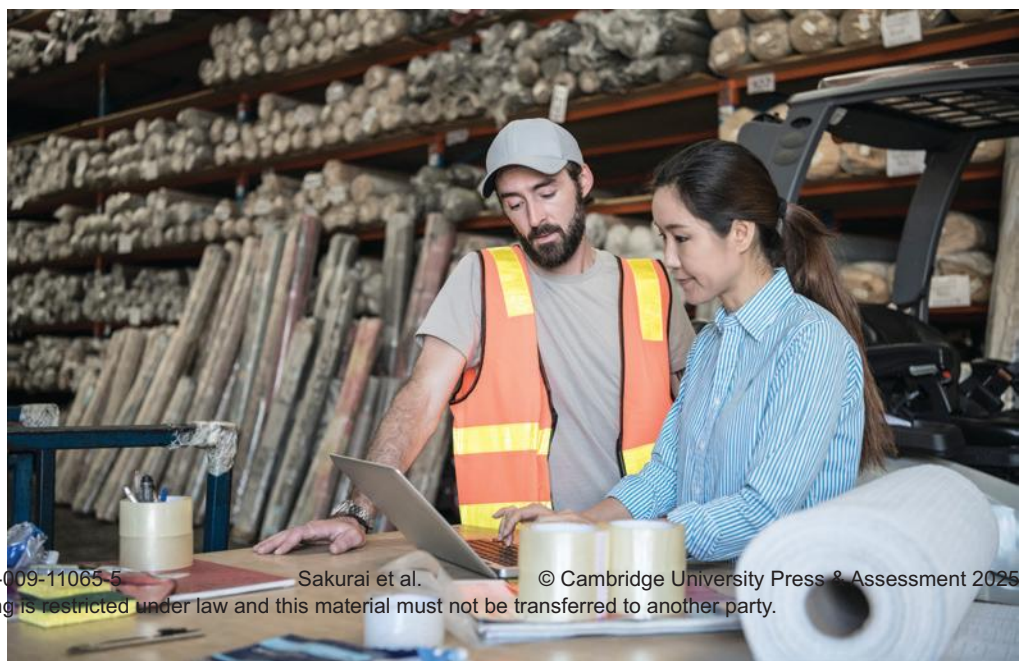
Our approach is to support you to develop a set of mathematical problem-solving skills and tools to respond to the problems you encounter in your personal, community and working life.

This approach has many advantages and benefits, including:

- providing a purpose for knowing and using your maths skills – and helping answer that perennial question: 'When am I ever going to use this?'
- having practical outcomes that you can use across a range of situations in your life – both inside and outside school
- helping you engage with and enjoy learning and doing maths.

What numeracy and maths skills do you need? What research tells us

One of the key outcomes of numeracy research, particularly for young people and adults, is that the maths-related tasks that people undertake in their lives involve much more than the basic maths skills and processes you learn in the maths classroom.



ISBN 978-1-009-11065-5 Sakurai et al.
© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

This is increasingly true in relation to your future work and potential careers. For example, in an Australian project undertaken by practising maths teachers where they studied workers across twelve different companies, the research found there were significant gaps between young people's maths and numeracy skills, and the needs of 21st century workplaces. Mathematics was considered extremely important by all the companies involved, and changing work practices were found to be generating new demands for mathematical skills. These skills included problem solving, efficiency, innovation and continuous improvement practices.

Here is what the report said about the type of maths knowledge and skills that were needed.

> *The application of mathematics in the workplace is not straightforward and goes well beyond a command of 'core' mathematical content. Workers perform sophisticated functions which require them to be confident to use mathematical skills in problem-solving situations and to see the consequences of the mathematics-related procedures* (AAMT & AIGroup, 2014).

As the brainstorming activity on the opening page of this chapter illustrates, there is a wide range of maths knowledge required in the workplace and in everyday life. These are encompassed in the four Areas of Study in the VCE Foundation Mathematics Study Design:

- Algebra, number and structure
- Data analysis, probability and statistics
- Financial and consumer mathematics
- Space and measurement.

The emphasis of the approach in this book is that maths knowledge and skills arise out of their practical use in real-world situations, where maths skills are needed to solve real problems. Our approach is based on the belief:

Not 'just in case' but 'just in time'.

In education a 'just-in-case' approach means that lots of content knowledge and processes are taught to students before they actually undertake or solve a task involving that knowledge. Whereas in a 'just-in-time' approach the teaching of the required knowledge and skills is only provided at the time the student starts to struggle with the application or use of that skill or the student indicates that they need help. A lot of traditional teaching has been built around 'just-in-case' learning which tends to not be a good fit for our 'just-in-time' world of work and life. We often learn tons of great stuff just-in-case we may ever need it in the future.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

1B Tuning in

Epic Success: Zero – nothing matters a lot in maths

You'd probably think that the number zero (0) was one of the first digits and numbers invented and used, but that's not the case. Without zero (0), modern mathematics as you know it, and a lot else, wouldn't exist. It's very difficult to imagine how you could have mathematics without a zero. In a positional number system (or place value number system), such as the decimal system you use now, the location of each digit is important. The difference between 100 and 1,000,000 for example, is where the digit 1 is located, with the symbols 0 serving as important and critical place marks.

Some people argue that without zero there would be no arithmetic, no decimals, no accounts, no computers! There'd be no modern-day calculus, which underpins modern engineering, automation and more.

The earliest known concept of zero was that of a placeholder – but no use of the current symbol of 0. Many ancient civilisations around the world discovered the need for a zero independently, including the Egyptians, the Mayans, the Sumerians and more. There is evidence of the use of a pair of angled wedges, and other **notations**, very early on, to show the placeholder role of a zero – but no 0 symbol or its use as part of other critical mathematical purposes.

It was much later that zero (0) was first used and documented. It is now believed that Indian mathematicians (for example, Aryabhata in the 6th century AD, and Brahmagupta in the following century), started to document and use our current 0 symbol and meaning for zero as a simple number with which to complete our place value, positional number system. But just as importantly, they treated 0 as an independent number with its own identity, which they then used in arithmetic operations and more.

You can easily search for information and the related history of the development of zero and its symbol on the internet.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Contexts where you need to use your maths knowledge

The following table has some examples of situations and tasks where you need to be able to use your maths knowledge and skills in different aspects of everyday life. These examples are mapped against the possible maths skills and knowledge that underpin the situation.

Situation	Maths needed
Population data. For example: • Investigate Australia's population. 	• Financial and consumer mathematics • Algebra, number and structure • Data analysis, probability and statistics
Sport and recreation. For example: • Investigate and report on the mathematics of a particular sport such as sailing. 	• Algebra, number and structure • Space and measurement
The environment. For example: • Research and investigate an aspect of climate change in Australia, and write a report based on a statistical analysis. 	• Data analysis, probability and statistics • Financial and consumer mathematics

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Situation	Maths needed
Car salespeople. For example: • Research, analyse and compare different ways that salespeople can be paid on commission 	• Financial and consumer mathematics • Algebra, number and structure
Landscaping or horticulture. For example: • Research and investigate a job or task that needs to be undertaken (such as paving a garden area). 	• Algebra, number and structure • Space and measurement

Discussion questions

1 Can you see that you need to know some maths in order to answer or investigate any of the above situations?

2 Do they tell you what maths you need to use to answer the questions and solve the problems, or do you need to work that out yourself?

3 Do some look easier than others to you? Why?

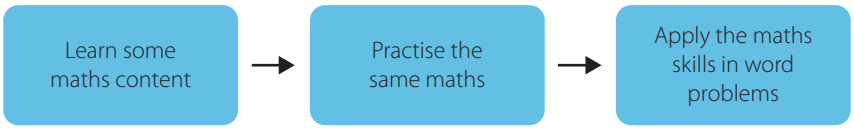
4 Are some of these of interest to you? Which ones and why?

5 Can you think of other examples like this in your life that you would like to investigate?

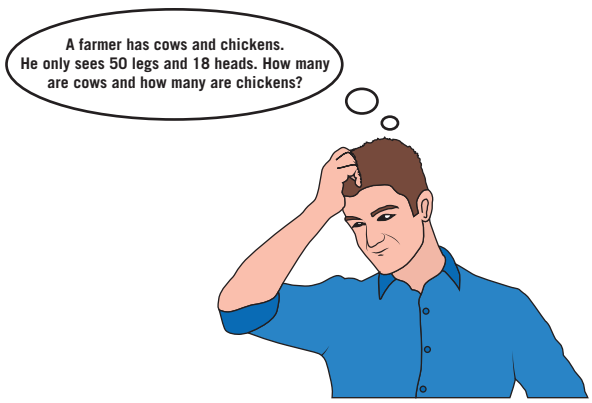
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

1C Taking a problem-solving approach

In the past in your maths classrooms, you probably followed this way of connecting maths with the real world:



This approach does not reflect how we use maths in the real world. In the real world, you are not told in advance what maths you need to use and apply to solve the problem at hand – **you** need to make that decision. Often the problems you meet in maths classes don't make any sense in the real world, as shown in the example below.



Word problems like this **don't connect** to how maths is actually used in real life. Or, as many a student would say: 'Who cares?'

As one of the teachers involved in the research mentioned earlier, said:

> *This is one of the most interesting aspects/concepts of this project. The relationship between workplace mathematical skills and school mathematics could be described as 'distant' at best – Teacher observation* (AAMT & AIGroup, 2014).

The process in the real world: starting with the context

The process in the real world requires a set of different skills. The problem-solving process in the real world starts with identifying the maths embedded in a context and the questions to be answered, followed by using and applying maths knowledge to solve the questions. The final stage is that you need to report on and summarise the outcomes and communicate them to others.

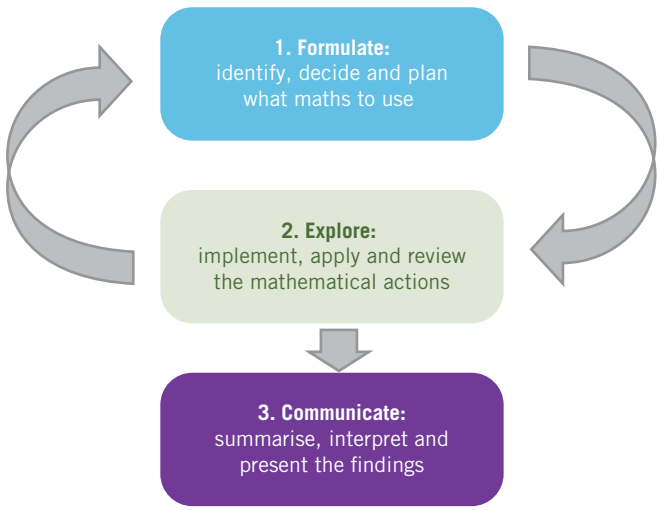
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

1 **FORMULATE**: Being able to identify, decide and plan what maths you need to use to solve a problem

2 **EXPLORE**: Doing the maths: using and applying your maths knowledge and skills to find and review your solutions

3 **COMMUNICATE**: Summarising, interpreting and presenting the results and outcomes of your work.

This is summarised in this diagram of our model for problem solving, which also matches how the Investigations are described in the VCE Foundation Mathematics Study Design. This problem-solving cycle is described briefly below.



The first stage is to *Formulate* the problem you are going to solve. This means that you need to have an overview of the context of the situation that you are investigating and decide what the mathematical questions, issues or problems of interest are that you might want to answer or solve.

The second stage, *Explore,* follows on from stage 1. This is where you need to implement the relevant mathematics that underpins your nominated investigation, and use and apply your maths knowledge and skills to solve the problem you have identified and planned in stage 1.

The third and final stage of the problem-solving cycle, *Communicate*, is to summarise, interpret and document, and *communicate* the results and outcomes of your investigation.

Each of the three stages is further elaborated on in sections 1F, 1G and 1H respectively.

The VCE Foundation Mathematics Investigation tasks

The formal investigations that you need to undertake over the year will be critical in ensuring you develop a satisfactory understanding of the content. Investigations are based around the above problem-solving cycle, and you need to explicitly address the

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

three stages in each of your investigations. A number of sample investigations will be introduced in this chapter as a means of illustrating what is required, and how you might proceed with your own investigations.

The three investigations you need to undertake for your formal assessment are designed to allow you to demonstrate your skills based around the three stages of the problem-solving process, which are the basis of your Investigations.

The box below is how the Investigations are described in the VCE Foundation Mathematics Study Design. These three components match the three stages of our problem-solving approach.

Assessment of levels of achievement

The student's level of achievement for Units 3 and 4 will be determined by a combination of School-assessed Coursework and an External assessment. The School-assessed Coursework will contribute 60 per cent and the examination will contribute 40 per cent to the study score.

Mathematical investigation

Each area of study is to be covered in at least one of the three mathematical investigations across Units 3 and 4.
There are three components to mathematical investigation:

Formulation

Overview of the context or scenario, and related background, including historical or contemporary background as applicable, and the mathematisation of questions, conjectures, hypotheses, issues or problems of interest.

Exploration

Investigation and analysis of the context or scenario with respect to the questions of interest, conjecture or hypotheses, using mathematical concepts, skills and processes, including the use of technology and application of computational thinking.

Communication

Summary, presentation and interpretation of the findings from the mathematical investigation and related applications.

© Victorian Curriculum and Assessment Authority 2022

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

The following sections will elaborate on each of these stages in more detail. But let's first look at an actual case study that will help us uncover a bit more about what each of these stages involves.

1C Tasks and questions

Thinking task: meet Graham

1 Have you seen or heard of Graham? The Transport Accident Commission (TAC) in Victoria undertook a project to highlight how susceptible the human body is to the forces involved in transport accidents. The TAC collaborated with a leading trauma surgeon, a crash investigation expert and a world-renowned Melbourne artist to produce Graham, an interactive lifelike sculpture demonstrating human vulnerability. You can learn more about Graham and how he was created by searching for 'Introducing Graham' on the TAC website.

Once you have viewed the information on Graham and listened to how he was created, work with a couple of other students to write up and document what the research was that Graham was designed around. Discuss what mathematics could be required for undertaking such a complex task.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Here are some prompt questions to help direct your discussions.

- What were the questions being researched and why?
- What types of different researchers were involved?
- What skills did the artist who created Graham have and need?
- What types of mathematics might be involved by all of these researchers and designers/artists?
- What calculations do you think were involved?
- What tools and technologies did they need to use?
- How were the outcomes of this research documented and written up and presented?
- What roles did each of the people play – the trauma surgeon, the crash investigation expert and the artist, Patricia Piccinini, in order to produce Graham?

Mathematical literacy

2 Considering the research, development, creation and promotion of Graham by the TAC, think about all the specialist language and **terminology** that has been referred to and used throughout. Write down any key terms or words you remember hearing about or reading when you studied the creation of Graham, especially any that relate to the world of mathematics (e.g. crumple zone, fracture, energy transfer etc.). List the words or terms and explain what they mean. Here are some prompt questions.

- In the initial research and work conducted by the trauma surgeon and the crash investigation expert, what types and sorts of maths language was used or referred to?
- How did Patricia communicate and present the results of the information about Graham to highlight how susceptible the human body is to the forces involved in transport accidents? What maths language was used – or how did she explain this to the general public?
- How did, and does, the TAC communicate and present the results of the investigation into the creation of Graham?

Application task

3 Consider the following scenario and answer the questions about using the recipe for making muffins.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Blueberry muffins
Makes 12 small muffins

Ingredients

$1\frac{1}{2}$ cups sifted self-raising flour
$\frac{1}{2}$ cup brown sugar
$\frac{3}{4}$ cup fresh blueberries
1 egg lightly beaten
$\frac{3}{4}$ cup milk
90 g melted butter
1 tsp grated lime rind (optional)

Method

- Preheat oven to 200°C. Grease muffin tray.
- Mix flour, sugar and blueberries in a bowl.
- In a separate bowl, lightly whisk egg, milk and butter together.
- Pour the liquid ingredients into the flour mixture and stir with a spoon until ingredients are just combined, do not over mix.
- Spray muffin pans with cooking spray and fill muffin pans with mixture Sprinkle the tops with the rind if using.
- Bake at 200°C for 20 minutes, until muffins spring back when lightly touched.
- Allow to cool for 5 minutes on a wire rack.

You and a friend want to make enough muffins for a group of ten friends who are coming for afternoon tea. Work out what you need to do, including thinking about these questions:

a How many muffins do you need to make? Is one muffin per person enough?

b How are you going to work out how much ingredients you need?

c Do you have enough of all the ingredients at home?

d Will you use any tools or equipment?

e How long do you need to allow for making the muffins?

f When do you need to start cooking?

g How will you know they are OK to eat and share with your friends?

h What's your backup plan if they are a disaster?

For each of the questions above, and your solution to the questions, categorise them into the table below against the three stages of the problem-solving cycle.

Formulate the problem	Explore solutions	Communicate the solution

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

1D Your investigations: Finding a context

The first and crucial task in undertaking a real-world investigation is to decide what the theme or context is that will be the topic for you to investigate and work on. It should be of interest to you and your fellow students. It could be a current popular topic, an issue of concern or interest, or related to work/study.

Some potential topics or areas where lots of maths is embedded are listed below.

• Arts and crafts	• Food	• Shopping
• Cars	• Gambling	• Sport
• Climate change	• Games	• Technology
• Clothing	• Music	• The environment
• Cooking	• Nature	• Travel and holidays
• Drinking	• Pets	• TV
• Families	• Photography	• Work and employment

Each of these will include many subtopics and areas of interest that can be explored in depth.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

You could also choose topics that relate to what you are learning in other subjects. This may also be related to your career interests, your VET studies, or school-based apprenticeships.

However, as the one topic may not be of interest to all students in your group, it is possible a few different options may help – like you have been offered two options for Investigations at the end of each chapter. Hopefully, your teacher will get you involved in the decision-making process, so that you feel ownership in some way of the topics you end up investigating.

Your teacher has a vital role to play though, with their knowledge and expertise about what investigations are achievable and manageable, and also what mathematics needs to be covered to meet the VCE Foundation Mathematics Study Design. Once the context has been selected, your teacher should ensure that the context has scope to cover the mathematical content from two or more of the four broad Areas of Study.

Investigations in this book

The table below is a listing of all the Investigations included in this book. You will need to discuss with your teacher which investigations are to be used for your formal assessments.

The four Areas of Study in the VCE Foundation Mathematics Study Design are:

- Algebra, number and structure (ANS)
- Data analysis, probability and statistics (DAPS)
- Financial and consumer mathematics (FCM)
- Space and measurement (SM).

Chapter & Investigation	ANS	DAPS	FCM	SM
Chapter 2 Investigation 1	✔			✔
Chapter 2 Investigation 2	✔		✔	✔
Chapter 3 Investigation 1	✔			✔
Chapter 3 Investigation 2	✔		✔	✔
Chapter 4 Investigation 1	✔			
Chapter 4 Investigation 2	✔		✔	
Chapter 5 Investigation 1	✔	✔		
Chapter 5 Investigation 2	✔	✔		
Chapter 6 Investigation 1	✔	✔		
Chapter 6 Investigation 2	✔	✔		

... continued

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

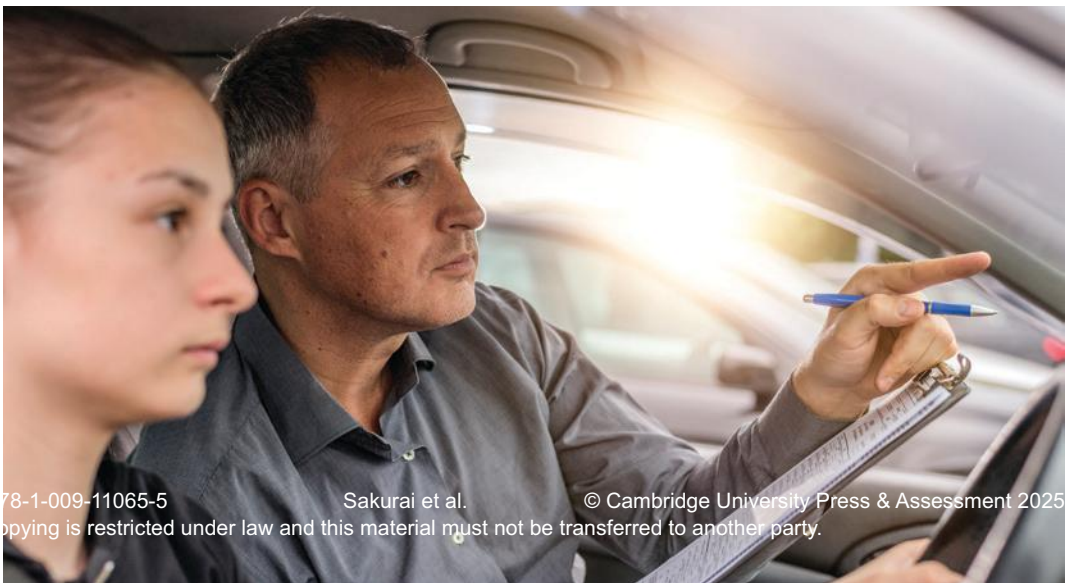
Chapter & Investigation	ANS	DAPS	FCM	SM
Chapter 7 Investigation 1	✔	✔		
Chapter 7 Investigation 2	✔	✔		
Chapter 8 Investigation 1	✔	✔		✔
Chapter 8 Investigation 2	✔	✔		
Chapter 9 Investigation 1	✔	✔	✔	
Chapter 9 Investigation 2	✔	✔	✔	
Chapter 10 Investigation 1	✔	✔	✔	
Chapter 10 Investigation 2	✔	✔	✔	
Chapter 11 Investigation 1	✔	✔	✔	
Chapter 11 Investigation 2	✔		✔	
Chapter 12 Investigation 1	✔			✔
Chapter 12 Investigation 2	✔			✔
Chapter 13 Investigation 1	✔		✔	✔
Chapter 13 Investigation 2	✔			✔

More examples of real-world contexts

Below are some other examples of contexts or situations from the world around us where you can use maths knowledge and skills to undertake tasks or investigations.

Cars – e.g. getting your licence

When you consider cars, for example, there are many areas that you could think about to investigate and research. One obvious one would be about all the steps and stages you need to undertake to successfully get your driver's licence.



ISBN 978-1-009-11065-5

© Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

The environment – e.g. solar power

Another important topic in the 21st century is that of the generation of electricity, and the potential to move from a reliance on coal power to alternative means of electricity generation. For example, you could investigate the use and development of solar power.

Climate change – e.g. coral bleaching

Another related topic is that of the impacts of climate changes. For example, you could investigate the impacts on the Great Barrier Reef, including coral bleaching.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Travel and holidays – e.g. bushwalking

You could investigate the maths behind going on holidays and travelling. This could be to do with travelling for a break somewhere or going bushwalking or bike-riding.

Sport – e.g. What are the differences in the playing fields of different sports?

Taking a different tack, you could investigate the maths sitting behind different sports. This could be to do with the rules of different sports, or be about the different shapes and dimensions of playing arenas, fields or courts.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

1D Tasks and questions

Thinking task

1 Work with a small group of fellow students to consider the above sample topics and think about what you could investigate or research. Construct a table like the one below to document your ideas and thoughts about potential problems to solve or questions to investigate. One has been done as an example for each topic.

Aim to name at least four more research questions or investigations for each topic.

Topic	Potential research questions or investigations
Cars	• What do you need to do to get your driver's licence?
The environment	• How much solar power is now generated in Australia?
Climate change	• Why and how does climate change make coral bleach? How extensive is it?
Travel and holidays	• What bushwalks are available in Gariwerd (Grampians) National Park? How long are they and how do you get there?
Sport	• What are the differences in the playing fields of two or three different sports?

Skills questions

Select one of the above sample topics or themes and answer the following questions.

2 Think about which VCE Foundation Mathematics Areas of Study you might need to use and apply. Remember, these are the four Areas of Study:

- Algebra, number and structure (ANS)
- Data analysis, probability and statistics (DAPS)
- Financial and consumer mathematics (FCM)
- Space and measurement (SM)

3 What mathematical tools, technologies, software or apps would you probably need to use to undertake the above investigation?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

1E Some important issues in maths problem solving

There are a number of other important issues when using a maths problem-solving approach. These include the following:

- interpreting and understanding the words and the language of mathematics – what we call *mathematical literacy*
- having a *toolkit* to dip into, including both analogue and digital or technological tools and devices
- *reviewing* and *reflecting* on the mathematics used.

These aspects are described more fully in the following sections.

Mathematical literacy

When you investigate real-world situations, you will need to engage with and understand the language and terminology of the context, alongside knowing about the meaning of the language and terminology of the world of maths that you will use to solve the problem.

The words and language of maths and numeracy are an important aspect you need to consider. You need to be able to read, interpret and understand the materials and information that is part of the situation or context to be able to identify the maths that you need to use. This is a literacy activity – hence, it is called *mathematical literacy*.

In relation to our problem-solving cycle, this is critical in each stage.

In *Stage 1: Formulate,* you need to read and comprehend the materials and information that the situation involves (you could also be listening/observing) and understand the context. You then need to identify what maths is embedded and decide what tasks or questions you might want to investigate and answer. This involves understanding the words, terms and language that underpin the context you are investigating.

In *Stage 2: Explore,* you need to use and apply your maths knowledge and skills – the words and terms you use in maths are critical. The more formal language of mathematics is crucial to the understanding and learning of mathematics and numeracy. There are two issues to be aware of here. First, sometimes formal maths words can be difficult to read and understand, such as isosceles, equilateral, quotient, denominator etc. Second, maths words can have different meanings in a maths context than in everyday life. They can be misunderstood because they can be confusing and misleading when you compare with how you use them in your non-maths life outside the maths classroom. In many cases, words have different specific meanings in how you use them in your maths classes compared with how you might use the same word in your everyday usage – but they might be related in some way. This can lead to confusion if you do not understand the way you use them in maths.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Below are a few examples of this different usage of terms and words.

Word	Meaning(s) in a maths context	Meaning(s) in an everyday life
Volume	The amount of three-dimensional space something takes up.	The degree of loudness or the intensity of a sound.
Formula	A rule written with mathematical symbols. It usually has: • an equals sign (=) • two or more variables (e.g. $A = l \times w$)	A recipe or prescription. A special nutritive mixture, especially of milk, sugar and water, in prescribed proportions for feeding a baby. Any fixed or conventional method for doing something.
Degree	A measure for angles. There are 360 degrees in a full rotation. A measure of temperature (how hot or cold it is).	A course of study at a college or university. The extent, measure, or scope of an action, condition or relation.
Rational	A **rational number** is a number that can be written as a fraction.	Having reason or understanding.

It is best to ask for help from your teacher, use a dictionary or search online to get an explanation until you are clear about what any specific words or terms mean. There is a table of Key vocabulary at the end of each of the later chapters in this book.

In *Stage 3: Communicate,* mathematical literacy is essential for clearly and efficiently communicating the outcomes and results of your mathematical investigation. There is the need to be able to use a range of different literacy skills to document and report on your results. This will often involve both oral and written language, and the use of both formal and informal mathematical visualisations and representations, much of which is dependent on literacy skills.

An important strategy to use is to read the task you are undertaking and all the associated materials, then express the problem in your own words.

Make notes that you understand, using your own language.

Using your toolkit

As part of Outcome 3 in the VCE Foundation Mathematics Study Design, you are encouraged to build and use a mathematical toolkit which you can dip into and use as you undertake your tasks. The aim is for you to become an efficient user of a wide range of appropriate mathematical tools – both analogue and digital or technological – to solve and communicate maths problems.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Throughout each of the chapters, you will refer to and be expected to keep adding new tools into your toolkit. This will include:

- existing traditional tools such as measuring equipment (e.g. tape measures, rulers, kitchen scales)
- calculators – handheld, online or on your mobile devices
- software applications, such as spreadsheets
- a range of new and emerging devices and applications from across different technologies (e.g. measurement, angle and level apps available on mobile phones or portable handheld devices).

It is hoped that as you work through this book, you will develop the skills and abilities to:

- use a range of analogue and digital or technological tools and devices to carry out mathematical procedures, computations and analysis
- use technology to visualise and represent information, such as to produce diagrams, tables, charts, infographics and graphs
- understand accuracy and error in measurements with different technologies and their implications for results
- reflect on and evaluate your use of tools and technology in relation to comparing your estimates to results.

Reviewing and reflecting

As the 21st century progresses, rapid technological, scientific, economic, and social changes and developments will increasingly require you to have more critical and reflective reasoning skills. You will also need the ability to recognise, interpret and understand mathematics, statistics and numeracy across different areas of life.

This is built into stage 2 in the problem-solving cycle, where it is suggested that you need to *review* and *evaluate* the outcomes of the maths you have done and critically reflect on how your results apply and fit in with the original context you were investigating. These processes are often referred to as contextual judgements.

Here are some questions you could think about when doing this.

- Are your results reasonable and relevant, especially when you compare them with your initial estimates? Are your answers and outcomes as you expected? Do they make sense?
- Are you happy to accept your results and solution? Or do you need to adjust your results or revise and redo some of your maths processes and calculations?
- Have you considered other factors, such as any social, environmental or economic consequences?

You will address these reflection skills throughout the tasks and activities in this book.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Check and reflect on your mathematical answers to problems – do not just accept the answers to your calculations. Check that they make sense in the real world! Use your other knowledge and experiences.

You need to develop a 'feeling' for numbers and quantities.

1E Tasks and questions

Thinking task

1 Reflect back on the development of Graham by the Transport Accident Commission (TAC) that you looked at earlier. Think about the technologies that would have been used throughout the research, development, creation and communication about Graham.

Talk to another student, or two, and discuss all the different tools and technologies that would have been used through the whole process of Graham's creation.

Mathematical literacy

2 Below is an example of some material where the maths is embedded – in this case, it shows the way you can work out the number of standard drinks in an alcoholic drink. You need to be able to read the words and interpret the information, including a number of mathematical pieces of information and representations.

CHECK YOUR DRINK LABEL FOR THE PERCENTAGE OF ALCOHOL BY VOLUME AND CALCULATE WITH THE FORMULA:

$$\text{NUMBER OF STANDARD DRINKS} = \frac{\text{Drink volume (mL)} \times \left(\frac{\text{alcohol content \% by volume}}{100}\right)}{12.50 \text{ mL}}$$

FOR EXAMPLE:

375 mL mid strength beer (2.7% alcohol) $= \frac{375 \times 0.027}{12.50 \text{ mL}} =$ **0.81** STANDARD **DRINKS**

150 mL glass of wine (11.5% alcohol) $= \frac{150 \times 0.115}{12.50 \text{ mL}} =$ **1.38** STANDARD **DRINKS**

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Complete the following table based on the information in the graphic on the previous page.

Type of mathematical information	Examples
Mathematical words	• Percentage of alcohol • •
Mathematical symbols	• % • •
Mathematical abbreviations	• mL • •
Different types of numbers	• 100 • •

Application tasks

Based on the above example about number of standard drinks, answer the following questions.

3 Explain how they used the formula for calculating the number of standard drinks to get the two sample answers of 0.81 and 1.38 respectively for the medium strength beer and the glass of wine. Consider the following questions.

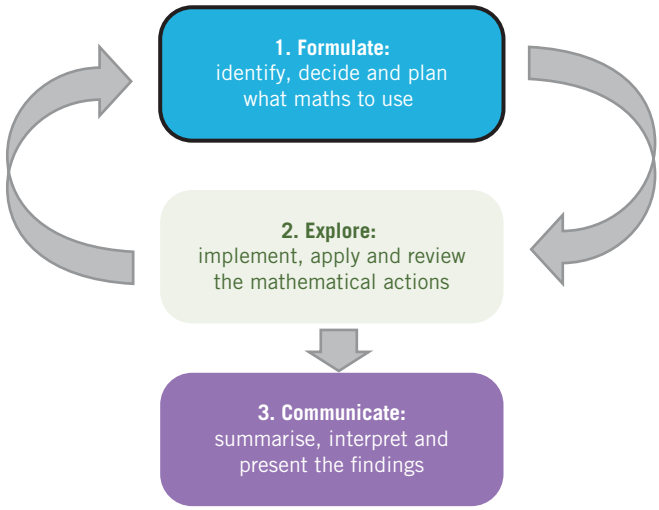
- **a** What operations and calculations did you need to undertake?
- **b** What technology and devices did you use to get the answers?
- **c** Did you need to round off the answers?

4 Calculate the number of standard drinks in each of the following. Round your answers to 2 decimal places if necessary.

- **a** A 750 mL bottle of wine with 12.5% alcohol
- **b** A 30 mL nip of whiskey with 37.5% alcohol
- **c** A 375 mL premix can of drink with 5% alcohol
- **d** A pot of 285 mL of beer with an alcohol content of 6%

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

1F Stage 1: Formulate



After selecting the topic or context you are going to investigate, the first key challenge in undertaking a mathematical investigation based around a real-world context is to decide what your key question or questions might be that you can realistically answer in the time that you have. This is all part of the **Formulate** stage.

Key issues in formulating your investigation

In this first stage, you need to move from the real-world setting to the world of mathematics and provide a plan on how to investigate your question using mathematics.

Key steps to work through in this stage include:

- Identify and interpret the mathematical information embedded in the selected context and materials.
- Decide on the purpose of the task and what questions you can pose and answer.
- Describe and define the mathematical operation(s), processes and tools you will need to use and apply to solve the problem. What mathematical knowledge and skills do you need to use to undertake and implement the task? Document these.
- Decide on what information you need to collect to undertake the investigation, and where you might get it from.
- Write up a plan of the activities to be undertaken to perform the mathematical actions.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

One good way to start the formulation stage of your investigation is to use brainstorming or a similar activity to get an initial idea of the possible various areas available for you to investigate. This can then be used to decide and plan on what mathematical questions can be addressed within your selected context and identify some specific issues that can be researched within your selected topic.

Brainstorming

Brainstorming is a creative way of problem solving that can be especially useful here as a way to think about a topic to see what areas might be worth investigating. You can brainstorm by yourself or in a group, but it is usually more effective and creative (and more fun) in a group. Often you create a mind map as part of your brainstorming.

You have probably undertaken these sorts of activities before.

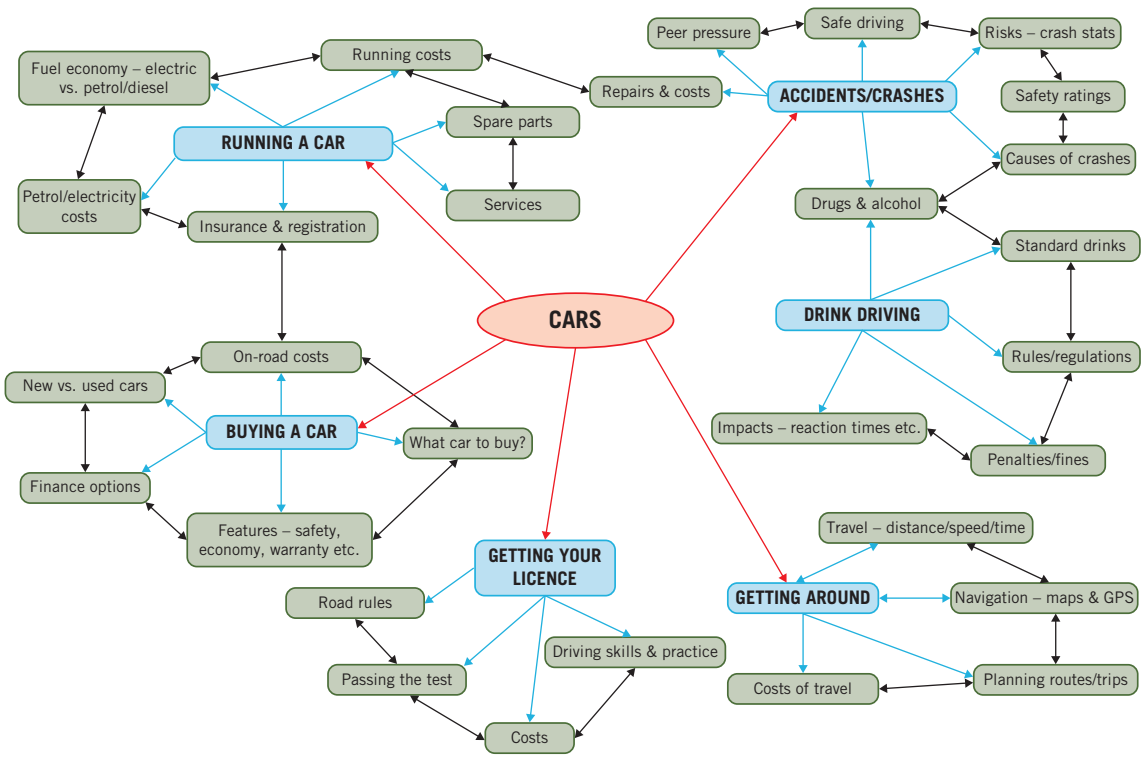
Brainstorming is a method that involves coming up with new ideas or trying to analyse a problem by discussing it with members of a group. Mind mapping is the method used to brainstorm ideas and note them down without worrying about structure and order. Mind mapping helps to see the connections and relationships between the ideas.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

You will use brainstorming/mind mapping here to help formulate problems to solve. There are different software packages and applications that you can use for documenting and recording this (if you haven't got one you know of, search on the internet or ask your teacher if they have one they recommend), or you can use paper or sticky notes.

A few apps to consider include *MindMeister*, *Miro*, *MindGenius*, *MindManager*, *Scapple*. The advantage of using software apps is that you can then create an image of your mind map to include in your report or presentation. Or you can also use presentation software, like Microsoft *PowerPoint*, which is what has been used here to create the mind maps.

Below is a sample of a brainstorm/mind map about the topic of cars.



Formulate the question or problem to be investigated

After doing a brainstorm, you should be able to focus in on your key question(s), hypothesis or conjecture that you want to investigate. It is a good idea to only take one part of your mind map to focus on and research – otherwise it will be too daunting and open-ended, and might take you a year's worth of investigative time!

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

A key challenge – narrowing your focus to one key question or conjecture

When investigating a situation in the real world, it is quite common to find that the type and scope of mathematics that can be brought to bear on the situation is broad and varied. Therefore, one of the key decisions to make is to narrow down your research questions – don't make your task too big or daunting – make it achievable.

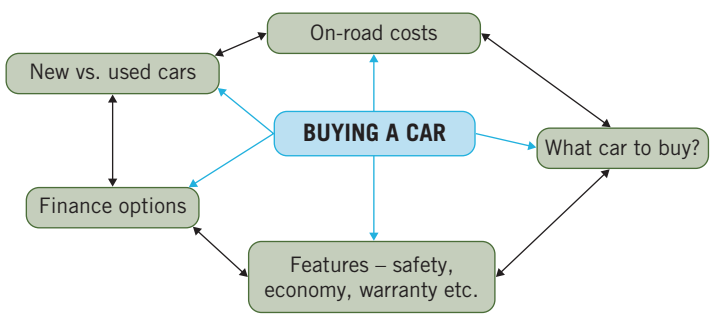
If you look at the Cars brainstorm example on the previous page, you can see there are multiple and separate, but connected, potential areas to address and think about: Buying a car; Running a car; Getting your licence; Getting around; Accidents/crashes and Drink driving – and you might think of even more. And for each of those, there is a range of different issues to address and research.

Hence, as part of your initial formulation of the problem, you need to decide what mathematical information and data is more readily accessible and can be used efficiently to answer your research question(s). Some points to consider when doing this include:

- Can you simplify the situation or problem to investigate it mathematically?
- What data and information is easily accessible or available, or can be collected or created?
- Maybe make some (reasonable) assumptions and simplify the context and the question(s) to be answered.

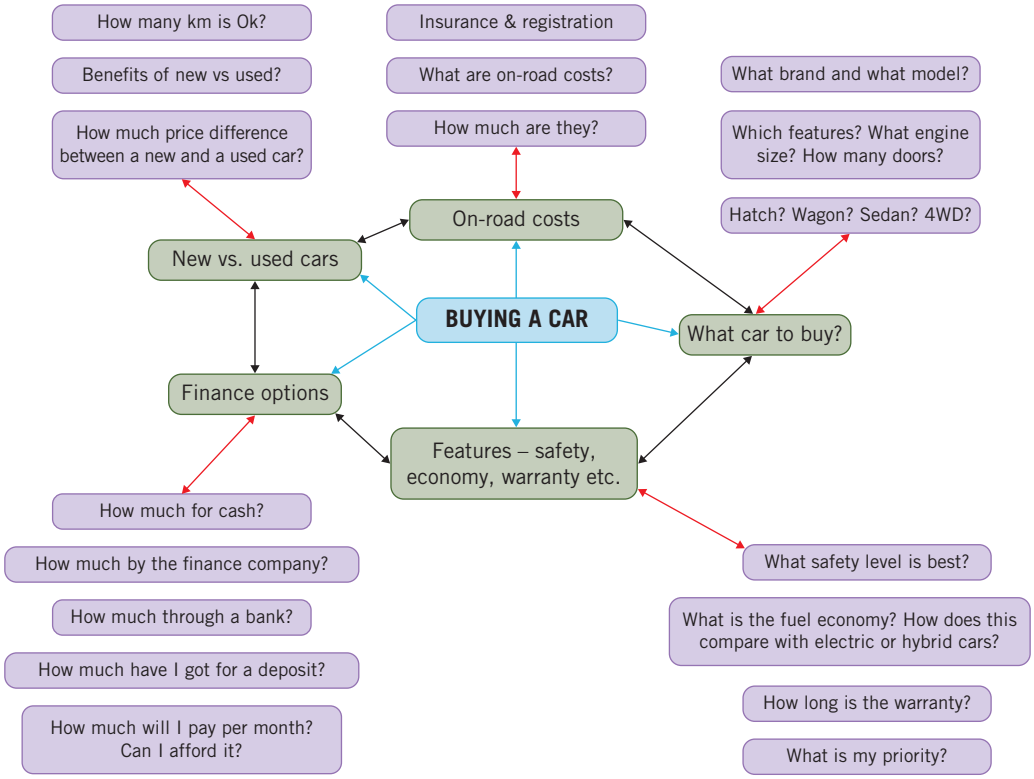
Example: *Buying your first car*

If you look at the Cars brainstorm on the previous page, you could take as your focus the issue of Buying a car, for example. Here is that section of the mind map:



To consider what you could then research and investigate about this topic, you could further brainstorm this section to add in different issues and aspects and what to consider investigating. A possible brainstorm of this is represented on the next page.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.



Back in the Units 1 & 2 textbook, one of the Investigations in Chapter 2 was about buying the car of your dreams, and you had up to $100,000 to spend. But that's probably not very realistic! Being more realistic, you would probably have a lot less than that to spend.

So, a potential question to investigate is what car could you REALLY afford to buy, and which one would you buy? Let's call it 'Buying your first car'.

Your key question might be:

- What car can I afford to buy as my first car, and why would I buy it?

Then you need to think about what information you might want to look at and what assumptions or simplifications you might make to attempt to answer that key question.

Based on the mind map above, you could consider these sub-questions or issues to help focus your research:

- preferred brand and model
- style of car (sedan, hatchback, wagon etc.)
- manual or automatic
- number of doors
- size of engine (capacity)
- age of the car and kilometres travelled

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- safety rating (ANCAP)
- fuel economy/consumption
- length of warranty
- cost of insurance.

Assumptions and simplifications, could include:

- Cost: How much you can afford – set a limit? Should you set both an upper and a lower limit?
- Are there other restrictions you could consider – like, less than 100 000 km on the clock? Or less than 10 years old? Fuel type or fuel efficiency? Or ANCAP safety rating?

Next step is to plan how you will answer your key question. Your plan for this **formulate** stage might involve the following steps.

- Set a price limit and agree on any other restrictions you want to make about the above criteria for your first car.
- Search online car sales websites and find ten different advertisements for cars that meet your criteria.
- Summarise the information about the car so that you can make comparisons to help you decide.
- Based on this, what is the mathematical knowledge and skills that you need to use to undertake and implement the investigation?
- What tools from your toolkit might you need to use to help you do this?

25 Compare Save

2012 Mazda 3 MPS
BL Series 2 Manual MY13

$14,500
Excl. Govt. Charges

- 158,000 km
- Manual
- Hatch
- 4cyl 2.3L Turbo Petrol

Buy from home

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

1F Tasks and questions

Mathematical literacy

1 In this first stage of the problem-solving cycle, you are using different words and language when deciding on your plan of how to undertake your investigation. Here are a few of those words:

- assumptions
- conjecture
- formulate
- hypothesis
- research.

In a small group, talk about these terms and what they mean.

Skills questions

Work with three or four other students to look at the Cars brainstorm from earlier. Discuss and come up with some responses to the following questions.

2 Review the brainstorm and mind map.

- Can you add in any other topics or issues you could consider that were not included?
- What are they? Are they a new key area or a sub-issue of one of the existing ones?

3 Select a new issue or a different existing one from the mind map (not the *Buying a car* issue though). In your small group, consider the following questions.

- What areas would you focus on?
- What are some issues or questions you could ask or would want to answer as part of your research?
- Could you make some assumptions or restrictions to simplify the issue or question(s) you will investigate and answer? Given any simplifications you make, which key question or issue would you investigate?
- Are there a number of sub-questions you might ask to help answer this? What are they?
- What information would you need to find and access to answer the main questions you decided to answer above?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

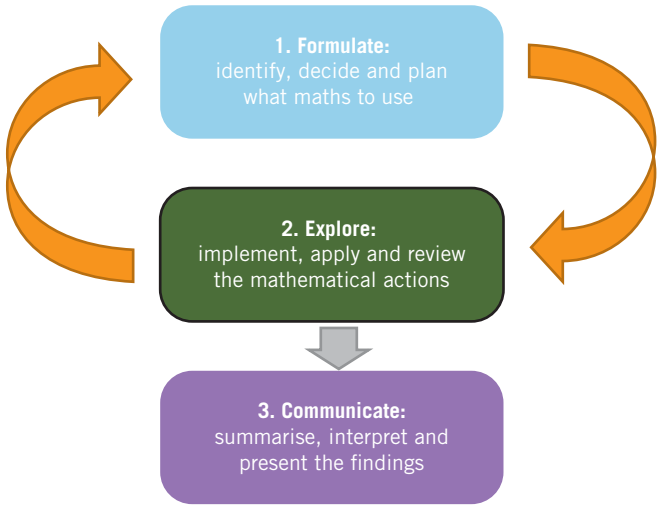
Application task

4 Work with three or four other students to brainstorm the new topic of 'Planning a trip'. What are all the different aspects of planning a trip or taking a holiday that you can think of?

- Create a mind map. You can do this using pen-and-paper or using an application. You can decide as a group. Based on your mind map, answer the following questions.
- How many different topics or areas are possible to cover under the broad context of planning a trip?
- Decide on the main focus of your investigation.
- What is the main, key question or issue you want to investigate or answer?
- Are there a number of sub-questions you might ask to help answer this? What are they?
- What simplifications or assumptions could you make to make the investigation easier to undertake and resolve?
- How will you proceed to answer the question(s)? What do you need to find out? Where from?
- What is the mathematical knowledge and skills that you need to use to undertake and implement the task? Document these.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

1G Stage 2: Explore



The **Explore** stage involves using your maths knowledge and skills to conduct and implement the mathematical research or investigation you have decided to pursue in stage 1.

This stage requires you to use a range of mathematical processes and problem-solving techniques to solve the problem you set out to investigate. This will include selecting and using appropriate tools, technology and digital devices to support you in doing this.

Undertaking the maths tasks

Key steps to work through in this stage include:

- Finding and elaborating the mathematical knowledge and skills that you need to use to undertake and implement the task
- Making sure you have found and collected all the information and data required to start the mathematical tasks
- Extracting and recording the relevant information from mathematical data, diagrams, graphs, plans, constructions etc.
- Identifying and using the best mathematical tools, including technology, to help you do the maths and find solutions
- Undertaking any estimations prior to starting the task

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- Implementing and applying the maths processes and calculations required to solve the problem and answer the questions you identified in stage 1
- Critically reflecting on and evaluating your maths outcomes and results – check if they feel correct or not, relative to your own personal and real-world knowledge.

Review and reflection

As stated above, part of this stage is that you should also *review* the outcomes of the maths as you go and *reflect* on how the results are progressing and see if they fit in with the context you started from in the real world. Think about:

- Do they make sense? Are the solutions about what you expected or not?
- Are there any implications and consequences you need to think about that you may not have considered?
- Do you need to adjust and change or redo your calculations, if necessary?
- Do you need to change the inputs and data you started with or found?
- Do you need to reconsider your original question(s) as you could not find the information required to solve the problem, or it is too open-ended?

The diagram shows that you may need to move back and forward between stage 1 and stage 2 when reflecting on and reviewing your calculations and results.

Stumbling blocks

If you find you are having difficulty in progressing and answering your question(s) and you meet a dead-end, you could consider the following:

- Can you rework and represent the problem in a different way, including organising it according to some known mathematical knowledge?
- Can you simplify the problem, making clear any assumptions you make?
- Can you recognise aspects of the problem that correspond with situations or problems you have met before – make links and connections. That's not cheating – that's being clever and transferring your knowledge and skills.
- Think about what technology is available to help you make it simpler and easier (such as a spreadsheet or application) to represent and work with the mathematical information and data embedded in your problem.
- Talk to your classmates and see what they think or ask your teacher for advice and support.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Example: *Buying your first car*

When looking at buying your first ever car, there were a number of key issues and questions posed.

- What car can I afford to buy, and why would I buy it?

Based on the plan for the **formulate** stage, outlined above, the aim was to research and find ten possible cars to choose from once there was agreement on the key criteria that were mentioned in the formulate stage. You needed to make decisions about what your critical criteria might be in order to help you select the ten cars. This could be, for example, the cost or how old the car is.

Based on these decisions, you will have decided, probably, that the key mathematical knowledge and skills that you needed to use to implement this investigation was to use the skills of calculating and comparing numbers. You probably also decided that the key tools from your toolkit that you need to use to help you do this would be a calculator and a spreadsheet for collating and comparing all the data. Spreadsheets are really useful for comparing sets of data – and using the *Sort* function is very helpful.

For example, you might initially set up a table, in a spreadsheet, for collecting the relevant information about the ten cars you find. This could be something like the following table.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Criteria	Car 1	Car 2	Car 3 etc.
Brand and model			
Style of car			
Manual/automatic			
Number of doors			
Size of engine			
Age of the car			
Kilometres travelled			
Safety rating (ANCAP)			
Fuel economy/consumption			
Length of warranty			
Cost			
Cost of insurance			

Based on the assumptions and the criteria agreed upon, it is then a matter of comparing each of the criteria for each of the ten cars, so that you can see which car best meets your criteria and finally making the decision about which car to buy.

In this, your implementation stage, you will need to make decisions such as:

- What criteria might be more of a priority? Why?
- Do I need to adjust any of my assumptions and restrictions? Why or why not?
- Were there any issues or problems with the mathematical knowledge and skills I used and applied? Do I need to change any of these processes or calculations I used?
- Do I need help or guidance with understanding some of the data or the mathematical processes involved? For example, in how best to sort data in a spreadsheet?
- Do I need to review my data collection? Do I need to find more cars to select from, for example?

1G Tasks and questions

Thinking task

1 Look at the investigation above about buying your first car and the steps you could take to decide on the best car to buy. Assuming you have found ten different cars online that meet most or some of your critical criteria such as cost etc.,

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

think about how you could use some of the features of a spreadsheet to support your analysis and comparison of the ten cars. Make a list of features you might use, including simple features like colouring cells, sorting columns of data etc.

- Which features might be the most useful? Why?
- How else might you prioritise the different cars you have found?
- What are some mathematical knowledge and skills that would be part of making your decisions about which car to buy?

Mathematical literacy

Work with a couple of classmates to discuss and share your understandings about the following questions related to the Explore stage of the problem-solving cycle.

2 Discuss the word 'explore' and what it can mean.

a What different meanings does the word 'explore' have?

b What does 'explore' mean here in relation to the problem-solving cycle?

3 One of the important aspects of undertaking the Explore stage and in doing and implementing the mathematical aspects of your investigation, is the use of what is referred to as your **mathematical toolkit**. This relates to Outcome 3 in the Study Design. The aim is for you to become an efficient user of a wide range of appropriate mathematical tools – both analogue and digital or technological – to solve and communicate the mathematical problems you are asked to solve. Discuss with your classmates some of the key words or terms in relation to using tools and technology and what they mean when studying maths:

- tools
- analogue versus digital
- symbolic expressions
- functionalities of technology
- handheld devices.

Application task

4 Find your mind map and your formulation of your ideas for undertaking your investigation into planning a trip from the previous section, and move into exploring how you are going to problem-solve and use your mathematical skills and knowledge to find your answer. Working with the same small group, consider the questions on the next page.

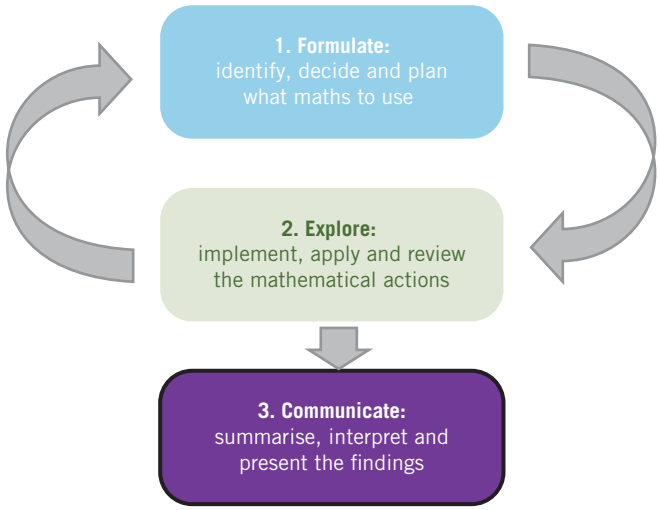
Note: You are **not** expected to undertake the work or do the maths here, just think about what you would need to do and how.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- Are your questions and potential sources of information still OK? Or do you need to review them and update them?
- Where would you access and find all the necessary mathematical information and data to answer your question(s)? Can you organise or collate the information? How? Write this up if you haven't already.
- What are the mathematically based questions you need to ask or would want to answer as part of your key question(s) about planning a trip?
- What maths skills and knowledge would you need to use to answer the question(s)? What calculations might you need to undertake? What other mathematical processes?
- What are your estimates of what the results might be? What do you expect to spend – what is your budget? Where do you think you can go, and for how long?
- What tools would you use to help solve your problem and implement the investigation? What technologies and software and applications might you use to support you in doing the work?
- How will you know and decide if your results and outcomes are reasonable, and you don't need to revise and adjust? What issues or results might affect the success of your research and investigation about planning a trip?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

1H Stage 3: Communicate



The **Communicate** stage of your investigation, the final stage, is where you need to report on and communicate your results. The task doesn't finish once you have done the maths.

This stage requires a summary of the work you did in stages 1 and 2 to be written or recorded, including your interpretation of any results and findings from your mathematical activities.

This can involve both oral and written language, and the use of formal and informal mathematical visualisations and representations including the use of different formats, media or technologies.

You need to think about what might be best to use for each of the following aspects of your results that need to be shared and communicated:

- the context and problem you are investigating
- your methodology and problem-solving approach
- the mathematical content
- the actual outcomes and results
- your review and evaluation of the results
- the highlights and important bits.

The way in which you communicate your maths findings will depend on the topic and the sort of investigation undertaken. Some might be more appropriate for a 10-minute talk, some a PowerPoint presentation, or maybe a video or a poster would be good.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Visual communication is a critical aspect for you to consider. This can include aspects such as:

- drawings and illustrations
- graphic design elements such as colour and typography
- other electronic resources such as interactive or dynamic items.

In a maths report or presentation, visual communication such as graphs and charts can be especially useful and sometimes can replace written material completely. Visual communication can be a powerful way of getting a message across and can be more powerful than verbal and non-verbal communication. Visual communication is also much easier and more varied now due to the developments in technology. This also means that visual communication can be much more creative.

Key steps

Key steps to work through in this stage include:

- Planning the most appropriate way to summarise and represent your results and outcomes.
- How are you best able to explain the results or solution(s) to your investigation using mathematics? This will depend on your topic and your original question(s).
- Deciding on what written or visual mathematical representations you will use to best document and report on the outcomes.
- Then selecting and using the most appropriate device and/or technology to represent and document the research and the results. This could include, for example:
    - an oral presentation supported by a PowerPoint
    - a video presentation
    - a large A2 poster or two or three A3 pages
    - a 2- or 3-page written report that incorporates a summary and visual representations such as charts, tables, graphs, formula etc.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key challenges

There are a number of challenges in creating your report or summary of your investigation. Below are a few points to keep in mind.

- Remember this is about **mathematics** – so remember to also focus on the maths content you have used and applied.
- Remember to include how you did your research and investigation. What maths did you use? What tools did you use?
- Identify the one (or two) core messages that are the focus of your report or presentation.
- Reduce the amount of text and use more visuals in your presentation and design.
- Don't include any information that doesn't immediately support your core results or outcomes.
- Use text to support and reinforce, not repeat, what you're saying.
- Use visuals (images/charts/diagrams/photos) to highlight the key message on each page/slide.
- Use text size, weight and colour to emphasise your key points and messages.
- Don't overdo your design – use your choices consistently and uniformly.
- You can search for and use or adapt report or presentation templates to help you get started.
- Dedicate some content or slides to the significant findings and results.
- Emphasise key points by highlighting key text and use of images or representations.

Example: Buying your first car

Going back to your investigation about buying your first car where you were answering this question:

What car can I afford to buy, and why would I buy it?

Your plan for communicating about this research question could be:

- creating a poster about your first car
- stating and showing your agreed criteria
- a summary of the key information about the cars you found online
- a summary of the conclusion about which car to buy and why – using some maths terminology and language.

The following image is a mock-up of a possible one-page poster about which car you'd buy as your reality car.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

My REALITY car!

A 2012 Toyota Corolla Ascent

My first set of KEY assumptions and criteria:

- Cost: < $10,000
- Mileage: < 150,000 km
- Age of car: made in 2006 at the earliest
- A small car of a known brand like Toyota, Mazda, Ford, Hyundai or Kia.

After some initial research and investigating online (the criteria above gave me hundreds of cars to look at and review), I amended my criteria to include:

- Brand: Toyota (my brother and sister both said Toyota was a reliable brand, and cheap, for your first car)
- Small engine size - so less than 1.8 litre
- The cars were available for sale around Melbourne.

This narrowed it down to less than 40 cars.

I used a spreadsheet to collate the key information about 10 different cars that met my criteria. Below is a copy of the data.

- I had to make sure all the numbers were in the same format in decimals and integers/whole numbers
- I then had to compare all the data I collected. I kept sorting the information in different ways - by price, by number of km, by the age of the car. Using the Sort function was a new tool for me. It was really helpful.
- I highlighted some of the important bits of data each time I sorted the data - green for what was good about the car, or orange for aspects that were not quite as good. You can see some examples below.It was really helpful.
- I decided I wanted to look at a car that was relatively new, had not done too many kms, and also cost less than $10,000.
- I ended up deciding to go for the 2012 Toyota Corolla Ascent to see if it would be OK as my first car - my REALITY CAR. It seemed to be a good compromise. My second choice would be the 2008 Toyota Yaris which was pretty cheap and would have saved me about $1500.

	A	B	C	D	E	F	G
	Model	Year	Manual or Automatic	Price	Mileage (km)	Type	Engine size (litres)
1	Toyota Corolla Ascent	2006	Automatic	$ 9,999	80563	Hatch	1.8
2	Toyota Yaris	2007	Manual	$ 7,000	75000	Hatch	1.5
3	Toyota Yaris	2008	Manual	$ 7,999	111471	Sedan	1.5
4	Toyota Yaris	2008	Automatic	$ 9,000	120000	Hatch	1.3
5	Toyota Yaris	2008	Automatic	$ 8,950	120822	Hatch	1.3
6	Toyota Corolla Ascent	2009	Automatic	$ 9,900	115000	Sedan	1.8
7	Toyota Yaris	2010	Manual	$ 8,500	141000	Hatch	1.5
8	Toyota Yaris	2011	Automatic	$ 10,000	120300	Hatch	1.3
9	Toyota Corolla Ascent sport	2011	Manual	$ 9,000	126300	Sedan	1.8
10	Toyota Corolla Ascent	2012	Manual	$ 9,000	115300	Hatch	1.8

My DREAM car!

1H Tasks and questions

Mathematical literacy

1 The main, different ways that you communicate to someone include:

- verbal communication
- non-verbal communication
- written communication
- listening
- visual communication.

Work with a couple of classmates to discuss and share your understanding of each of these types of communication.

Skills questions

2 Here is a table that lists some of the possible investigations mentioned earlier in this chapter. Make a list of how the results could be communicated and what sorts of representations might be relevant to use in a report.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Topic and key issue to investigate	How could this investigation be communicated?	What visual representations are relevant?
Cars • What do you need to do to get your driver's licence?		
The environment • How much solar power is now generated in Australia?		
Climate change • Why and how does climate change make coral bleach? How extensive is it?		
Travel and holidays • What bushwalks are available in Gariwerd (Grampians) National Park? How long are they and how do you get there?		
Sport • What are the differences in the playing fields of two or three different sports?		

Application task

3 Going back to your 'Planning a trip' brainstorm and your investigation, think about how you could communicate your investigation and your outcomes.

For example, are you going to just give a 10-minute talk, or are you going to do a talk supported by a PowerPoint presentation, or are you going to develop a video to share? Or maybe a poster would be an effective way to document or share your results. For each approach and depending on the content, you might need to consider different types of representations – are photos suitable, or do you need to present charts and graphs?

Write up a draft plan or outline (could be a sketch of a possible poster, for example) of how you will summarise and document the work and the outcomes of your investigation related to planning a trip.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

1I Sample investigation topic: Australia's population and immigration

This investigation is included to provide you with a model of what is possible based on brainstorming a topic and then deciding on what mathematical skills you need to bring to bear in answering some questions.

At this early stage of the year, the focus is on the questions that *could* be asked and showing some examples of the sorts of mathematical knowledge that can be utilised. This is because you have not yet been introduced to or learned the range of mathematical content that is included in the course – that will all be covered in the following chapters. *You can answer the questions if you wish, but you don't have to. They are there for you to see what is possible.*

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Introduction

Australia's current population is principally the result of immigration. However, the issue of immigration, and refugees, has been a controversial one, as has the critical issue of Australia's First Nations peoples. How does mathematical knowledge and skill help us to understand and interpret these issues?

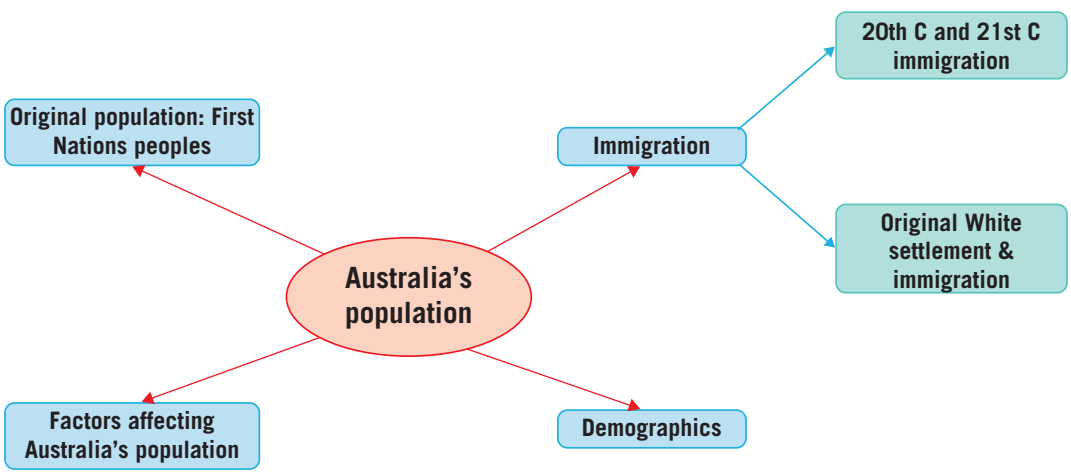
In the examples of possible investigations on this topic, there will first be an overview of the context and related background, including relevant historical or contemporary background. There will also be consideration of what questions could be posed and researched using your mathematical knowledge and skills.

Formulate the problem: Brainstorming

So, where to start this investigation on Australia's population and immigration? Let's begin the brainstorming process.

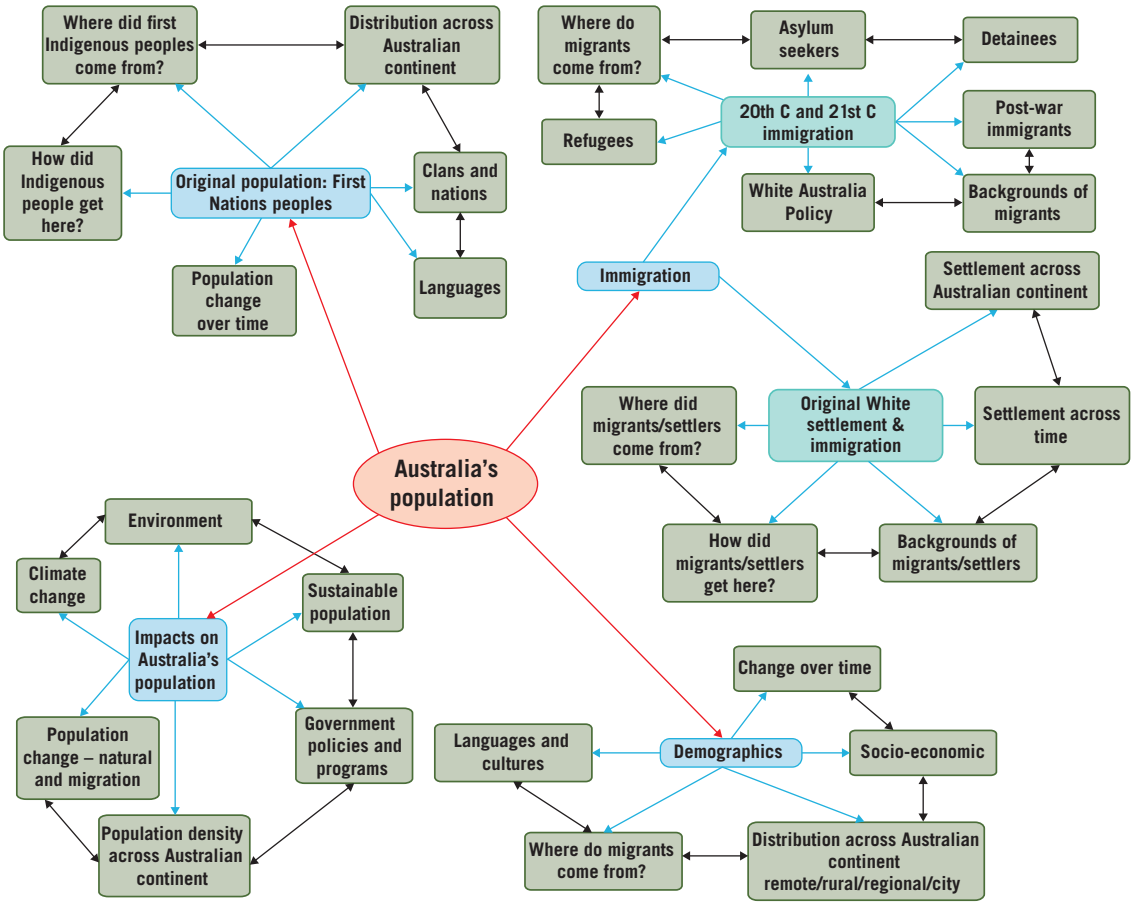
Start with some central ideas related to Australia's population. For example, what was Australia's original population – when was Australia first inhabited and by whom? What factors affect our population in Australia? Who were the first immigrants? What changed in relation to immigration in the 20th and 21st centuries? What are the demographics of Australia's population – that is, what are the characteristics of our population (such as age, race, gender, income etc.) Data from the 2021 Census provides an update on these questions.

Here is the big picture of some possible starting points for the brainstorm.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Then it is possible to look at any associated ideas related to each of these sub-topics. Here is a possible more detailed mind map.



Here are some possible questions that could be posed.

- How has Australia's population changed and grown?
- How large was the Indigenous Australian population when the First Fleet arrived? How has the Indigenous population changed over time? Where did the original Indigenous populations live? Has the distribution changed over time across different regions? What heritage makes you an Aboriginal or Torres Strait Islander?
- When and why did people immigrate to Australia?
- Who came in the First Fleet? How old were the people in the First Fleet?
- How quickly did Australia's population grow? Were there peaks in immigration numbers?
- Has our immigration policy been influenced by our wars in Vietnam and Afghanistan?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- Why are some immigrants placed in detention? How long is their detention?
- What are asylum seekers? What is the difference between the categories for permanent, skilled, family, refugee and humanitarian visas? What are the comparative numbers in each category?
- Do all asylum seekers come in boats? What percentage do?
- How do immigration rates vary around the world?
- Where do our immigrants come from? Has the source of immigrants changed over time?
- What percentage of Australia's population were born overseas or have a parent who was born overseas?

Can you add in more questions you might wish to investigate?

Once your mind map is fleshed out, you can proceed to develop possible questions and investigations related to each focal point and area of interest and make decisions about how mathematical skills and knowledge can be used to answer and understand the questions you have posed.

Four possible questions based on this broad topic are used below as examples of how you could start the process of an investigation.

A How has Australia's Indigenous population changed since the First Fleet arrived in 1788?

From some initial research, you can find out that at the time of the First Fleet, it is believed that there may have been about 750 000 Aboriginal and Torres Strait Islander people living in Australia. The First Fleet landed 980 people at Sydney Cove in 1788. While, for a variety of reasons, it is difficult to obtain absolute figures for the Aboriginal and Torres Strait Islander population over time, it is possible to find estimates of Indigenous populations to review and analyse. For example, have a look at the ResearchGate website to find estimates of the total Indigenous population in South Australia and Australia from 1788 to 2001.

B What has been the growth and changes in Chinese immigration to Australia?

In relation to finding available data and information about migration to Australia, you might become interested in finding out more about Chinese immigration (or any other nationality). However, in undertaking some initial research, you might find it difficult to access sufficient data on early Chinese immigration to Australia, and need to change your focus to more recent times as there is much data available about recent Chinese immigration.

For example, you can refer to the Australian Bureau of Statistics (ABS) and the Australian Parliament of Australia (APH) websites for information on migration to Australia.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

C Research and investigate the changes and growth of Dutch immigration to Victoria.

If you have an interest in a specific nationality, for example if you have family connections with the Netherlands, you can find out some data about the immigration of Dutch people into Victoria. Some information regarding Dutch immigration can be found on the websites for 'Origins – Museums Victoria' and the Migrant Information Centre (MIC), Eastern Melbourne.

In the early 19th century, a few Netherlands-born convicts were transported to Australia. A small number of free settlers also immigrated, and the gold rushes drew increasing numbers to Victoria from the 1850s. In later years, after World War II, the Netherlands government actively encouraged emigration to relieve housing shortages and economic distress. Hundreds of thousands of Dutch emigrated; with almost a third of those choosing to settle in Australia. However, if you cannot find good sets of data, you might need to change your focus to more recent times or change what you investigate.

D Where have our immigrants come from over recent decades, and how is this changing?

On the other hand, you may have become interested in Australia's more recent immigration. Australia is considered to be one of the world's major 'immigration nations' (together with New Zealand, Canada and the USA). Since 1945, over 7.5 million people have settled here, and Australia's overseas-born resident population is considered high compared to most other OECD countries.

For example, the table below and continued on the next page is available from the Australian Bureau of Statistics (ABS).

Australia's overseas-born population – top 10 countries of birth				
	2012		2022	
Country of birth	**'000**	**%**	**'000**	**%**
England	1 004.52	4.4	961.37	3.7
India	355.38	1.6	753.52	2.9
China	406.39	1.8	597.44	2.3
New Zealand	569.63	2.5	586.02	2.3
Philippines	206.11	0.9	320.30	1.2
Vietnam	212.14	0.9	281.81	1.1
South Africa	167.63	0.7	206.73	0.8

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Australia's overseas-born population – top 10 countries of birth				
	2012		2022	
Malaysia	136.57	0.6	176.21	0.7
Italy	200.35	0.9	161.56	0.6
Nepal	30.73	0.1	151.14	0.6
Total overseas-born	**6214.01**	**27.3**	**7680.45**	**29.5**
Australian-born	**16519.46**	**72.7**	**18332.62**	**70.5**
Total population	**22733.47**	**100.0**	**26013.06**	**100.0**

For a full set of data, not just the top ten countries, a file is downloadable from the ABS website. Look for the reference to this file: 'Estimated resident population, country of birth – as at 30 June, 1996 to 2022'. This file includes data from 1996 through to 2022.

Next steps: planning your investigation

Once you have done your initial research, like those possible questions listed above, and researched and found out what data is available about your interest in Australia's population and immigration, you need to firm up what you are going to research, and plan for how you will do this.

The first important issue is to consider what mathematical knowledge and skills are going to be required to undertake your research, and check in with your teacher that it meets the requirements of the study design for Units 3 and 4 Foundation Mathematics. Your research question here relates to data and statistics, so will need to cover what is described in the Data analysis, probability and statistics Area of Study. For example, this investigation will require you to be able to implement skills such as:

- development and specification of data collection requirements and methods
- collection and modelling of data, including the construction of tables or spreadsheets and graphs to represent data
- contemporary representations of data and graphs derived from technology
- long-term data and relative frequencies
- comparing and interpreting data sets and graphs, including using measures of central tendency and spread.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Once you have agreement with your teacher that your investigation topic and your sources of data are sufficient to proceed, you need to think about and write up a plan of your processes you will need to follow. For this, consider each of the following:

- Document where you will find the available data, and copy or download the data (you need to include this information in your report).
- Check the data is reliable and usable for your purposes, and 'clean' or sort the data as necessary.
- Review and refine your research questions, if necessary, based on your data.
- Decide how you are going to analyse the data. Include decisions such as:
    - How are you going to sort and collate the data: what categories are you going to look at? Over what variable and time periods, for example?
    - What types of graphs or charts of the data are you going to use for representing your data?
    - What other measures might you use for your analysis – measures of spread and central tendency?
- What mathematical tools, technologies, software or apps would you probably need to use to answer the above questions and undertake your investigation and use in your analysis?

Once you have prepared your plan, and have the okay from your teacher, you are ready to start undertaking the investigation, and move on to stage 2 of using your maths skills to explore the research question posed.

Example

Here is a possible plan for undertaking the research into Example D earlier: *Where have our immigrants come from over recent decades, and how is this changing?*

Data source and reliability

- The data used and downloaded was from the Australian Bureau of Statistics (ABS). It was sourced from: https://www.abs.gov.au/statistics/people/population/australias-population-country-birth/latest-release
- ABS data is reliable as ABS is Australia's official, national statistical agency and is the official source of independent, reliable data and information.
- The data was extensive, and the decision was made to restrict the number of countries studied – and the number of years of data analysed.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Final research question

- Where did our immigrants come from over recent decades? A comparison of ten of Australia's high immigration countries over the period from 2012 to 2022.

Note: The question was restricted due to the fact that there were data for 255 different countries in the ABS data spanning the years since 1996. It was decided to limit the data to ten countries comparing 2012 data to that of ten years later.

Plan for analysis of the data

- This analysis will focus on the more common, top ten countries in terms of overseas-born migrants to Australia in the years from 2012 to 2022. These will be named when the data is downloaded and analysed.
- Microsoft Excel will be used to document and analyse the data – this will be a small subset of the available ABS data.
- The data will be copied across from the original data source into a new Excel spreadsheet.
- It is anticipated that a number of different types of graphs or charts will be used for representing the data and for analysis and comparison. It is expected that this will include simple charts for some key visual representations. This will be decided once the analysis commences.
- It is expected that for some comparisons, measures of spread may be useful to use for comparisons and analysis, for example for comparing the same country over time.

Mathematical tools, technologies, software or apps to be used

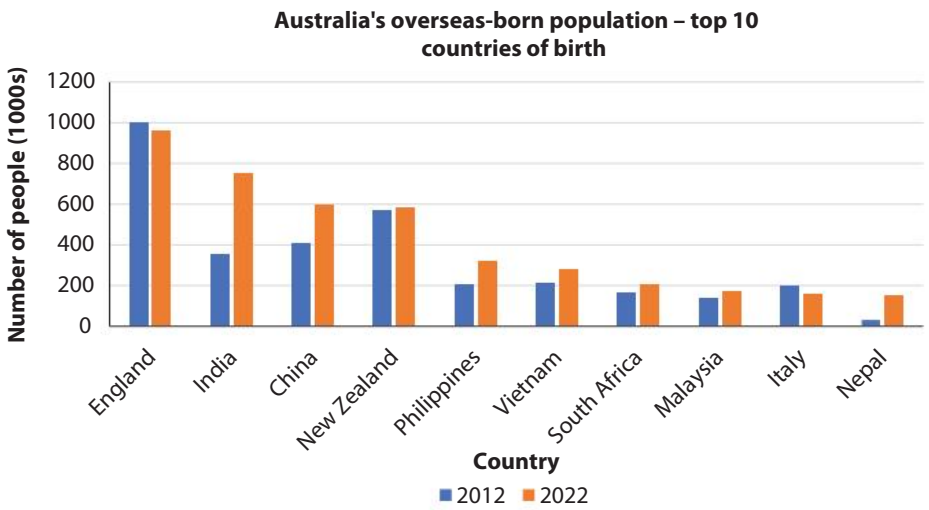
- The key mathematical tool to be used here will be spreadsheet software (Excel), but it is likely a calculator will be used too.

Explore the research question

Using Example D from page 50, one possible way of implementing the investigation using maths skills is illustrated over the next two pages.

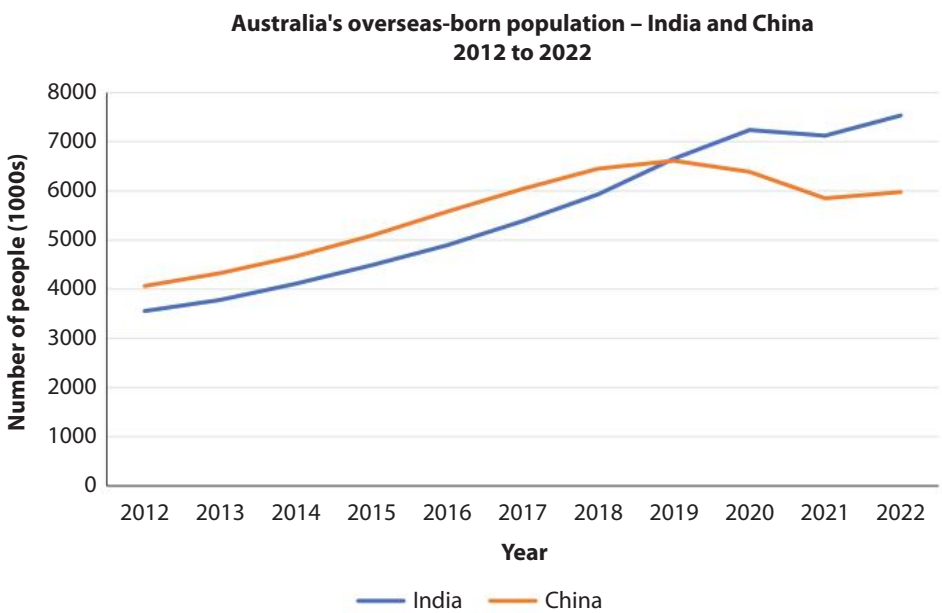
ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Here is a chart comparing the ten countries across the two years.



Based on this data, it seems that countries like England and New Zealand had similar numbers, whereas for countries like India and China there were quite a lot more people emigrating from those countries. So, it seemed sensible to look at these two countries in more detail.

Here is a graph for each year from 2012 to 2022 inclusive.



ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

This data shows that there is some interesting analysis that can be undertaken based on this data. You can also see in the graphs that there was an impact on the numbers of people coming into Australia from these countries from 2020 through to 2021 due to the COVID-19 pandemic. This shows how an investigation can follow different pathways once you start analysing and working towards answering your questions. There's a lot that can be investigated.

Communicate the results

When writing up the analysis and the results of the investigation you need to think about how you could best communicate the outcomes you found. You need to think about whether the following are the best options:

- a 10-minute talk, or a talk supported by a PowerPoint presentation
- develop a video to share
- a poster that documents or shares the key results (like an Infographic, given this investigation has a lot of data)
- a report that sets out the research you undertook and the outcomes you found.

For each approach and depending on the content, you might need to consider different types of representations. In this case, it is quite clear you will need to include charts and graphs.

The purpose is to explain the answer to your key *research question*, including any limitations on what you have been able to discover.

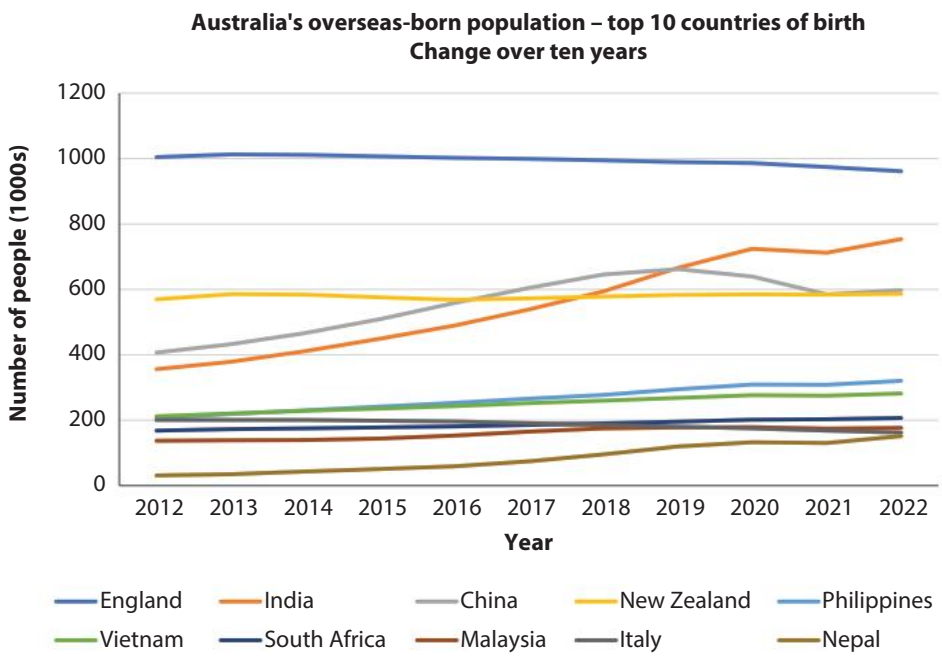
Where did our immigrants come from over recent decades?

A comparison of 10 of Australia's high immigration countries over the period 2012 to 2022

These graphs and tables show the data I found and analysed to answer my key question.

Based on this data, I was interested in the countries that had changed the most, compared to those that had not changed as much. To do this, I calculated the range for each country and then the percentage change (calculated out of the 2012 population numbers).

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.



This gave me the following data:

Country of birth	Range	Change + or –	% change
England	51 410	–	5.1
India	398 140	+	112.0
China	255 070	+	62.8
New Zealand	13 220	+	2.3
Philippines	114 190	+	55.4
Vietnam	69 670	+	32.8
South Africa	39 100	+	23.3
Malaysia	42 190	+	30.9
Italy	39 110	–	19.5
Nepal	120 410	+	391.8

My key summary conclusions about my analysis included:

- England, India, China and New Zealand are the main countries where overseas-born Australians came from in the period.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- The numbers coming from England and New Zealand are pretty constant – their change over the ten years was only small (5% and 2%), whereas some of the other countries had very large changes. For example, Nepal's numbers went up by almost four times (392%), and India's nearly doubled. The other countries that increased a lot included China and the Philippines.
- Countries where the numbers decreased quite a lot included England and Italy.
- The data also showed that there was an impact on the numbers of people coming into Australia from overseas countries from 2020 through to 2021 due to the COVID-19 pandemic.

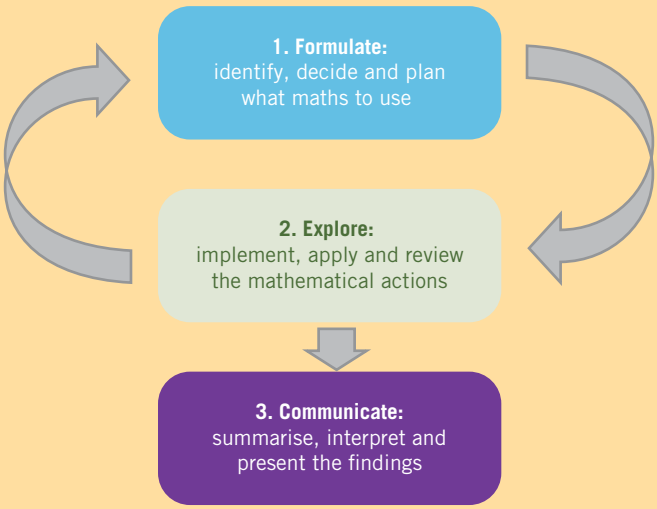
My reflections on the investigation

- I had to download two sets of spreadsheets from the ABS – the initial short ten-year comparison, and then after looking at that, I needed to download the full set of data to answer my question better.
- I did some initial analysis and created a few graphs in Excel to see what the data was telling me, and which graphs were best to use.
- This led me to looking at the data across each of the years from 2012 through to 2022 – and see which countries changed the most – or didn't change much. That's where I got the first graph from. I had to use Excel a lot to do this – to select and copy the data out for the top ten countries and for those 11 years (2012 to 2022). And then to label the graph properly. That took a lot of time.
- From that analysis I then decided to look at measures of spread (I used just the range) and the size and direction of the change too – this was so I could see which countries changed a lot, and those that didn't. This data is in the table on the previous page – again, I used Excel to do all this for me – it was a bit tricky, but I got help from my teacher who showed me how to do some of this.
- There was a lot of interesting data and stories to tell. I changed my focus as I worked with the data – I could have done other sorts of analysis and comparisons too. It is interesting to see and think about why these changes happen.
- Source of all my data: ABS: https://www.abs.gov.au/statistics/people/population/australias-population-country-birth/latest-release#data-downloads

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key concepts

- Maths-related tasks in the workplace and in daily life are sophisticated and require strong problem-solving skills.
- This textbook emphasises practical application of maths to solve real-world problems, using a '**just in time**' approach, as opposed to the '**just in case**' approach many of you will have experienced in your previous maths classes.



- In the real world, we start with a problem in a context. We then apply the **problem-solving cycle**, which consists of three stages: **Formulate**, **Explore** and **Communicate**.
  - During the **Formulate** stage, we extract the maths required to solve a problem from real life or work.
    - This requires us to interpret the given information mathematically, decide what questions we need to pose and answer in order to solve the problem, and plan what maths skills and tools we will use to answer these questions.
  - During the **Explore** stage, we use mathematical processes and problem-solving techniques to implement the investigation, select and use appropriate technology, and review the results to ensure they make sense.
    - Often, we are required to move back and forth between the Formulate and Explore stages as we reflect on our results.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

- During the **Communicate** stage, we interpret, summarise and present the mathematical findings of our investigation.
  - This involves deciding on the best way to communicate the results, which may involve spoken or written communication, formal or informal representations, and different technologies.
- In VCE Foundation Mathematics, the **Investigations** that you need to undertake over the year as part of your formal assessment are based around the problem-solving cycle, and you need to explicitly address the three stages in each of your investigations.
- **Mathematical literacy** refers to your ability to understand maths words and notation, and it is crucial throughout the problem-solving cycle.
- You will progressively add to your **mathematical toolkit** for solving problems and communicating the results.
- **Reviewing and checking** our results is an essential part of the problem-solving process. This might include checking reasonableness or ensuring that you have accounted for all factors that might affect your problem.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Success criteria and review questions

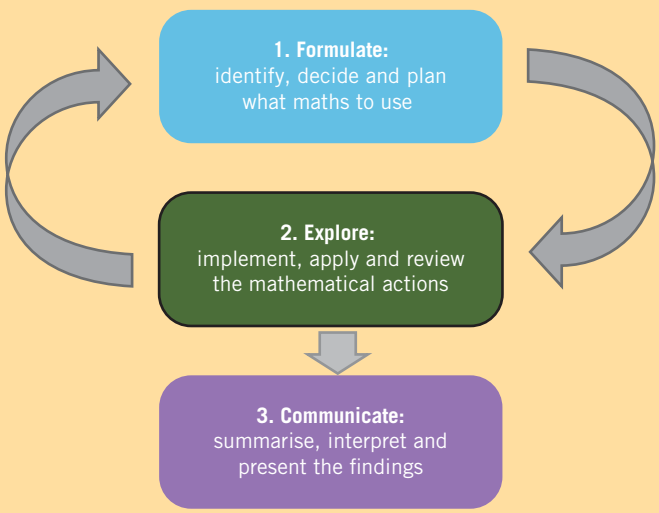
☐ I understand about taking a problem-solving approach to learning maths.

1 Describe the following features of taking a problem-solving approach to learning maths in school.

- **a** How does it differ from how maths is often taught in secondary schools?
- **b** How does it connect to the real world outside the maths classroom?
- **c** What do you see as the benefits and challenges of taking a problem-solving approach in maths?

☐ I understand the stages of the problem-solving cycle.

2 The problem-solving cycle is shown here.



- **a** Explain the different parts of the problem-solving cycle.
- **b** Describe one example of a problem-solving task from your own life that goes through the problem-solving cycle.
- **c** Explain and show how your task or problem fits the **Formulate** stage of the problem-solving cycle.
- **d** Explain and show how your task or problem fits the **Explore** stage of the problem-solving cycle.
- **e** Explain and show how your task or problem fits the **Communicate** stage of the problem-solving cycle.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

☐ I understand that language and literacy skills are important in problem solving using maths.

3 In relation to the mathematical literacy aspects of problem solving in mathematics:

- **a** Name at least **four** different words you use in maths where the way you use the maths word is different from how you use it outside the maths classroom, and describe how their meanings are related, if they are.
- **b** Which of the three stages in the problem-solving cycle (formulate, explore, and communicate) are most reliant on using and applying your literacy (reading, writing and oral communication) skills? Why?

☐ I understand that knowing how to use a range of tools and technologies to assist you to solve problems is important.

4 In relation to using tools and technology:

- **a** Name some technologies, including software and applications, that you have used to undertake mathematical processes such as when measuring, drawing, collating, summarising, calculating
- **b** Name some different ways you can use technology to represent or document mathematical or statistical information
- **c** What do you see as the key advantages of using technologies when using and applying mathematics?
- **d** What do you see as the key disadvantages of using technologies when using and applying mathematics?

☐ I understand that being able to reflect on and review your results and outcomes in maths is important and critical.

5 In relation to being able to reflect on and review your results and outcomes:

- **a** Why is it important to reflect on and review your results?
- **b** Provide at least one example, in maths or in other areas of your study or life, where reflecting on and reviewing some outcomes of some actions ended up making you alter, adapt or change what you had done? Why and how?

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Key vocabulary

Here is a list of this chapter's key maths terms and their meanings.

Term	Meaning
Assumption	Information that is simply assumed to be true, without checking if that is the case.
Brainstorming	A creative way of problem solving that can be especially useful as a way to think broadly about a topic and see what areas might be worth pursuing to investigate.
Communicate	Summarising, interpreting and presenting the results and outcomes of your work. *From the Study Design:* Summary, presentation and interpretation of the findings from the mathematical investigation and related applications.
Conjecture	An opinion or conclusion based on incomplete information.
Criterion / Criteria	A principle or standard by which something may be judged or decided.
Explore	Using and applying your maths knowledge and skills to find and review your solutions. *From the Study Design:* Investigation and analysis of the context or scenario with respect to the questions of interest, conjecture or hypotheses, using mathematical concepts, skills and processes, including the use of technology and application of computational thinking.
Formulate	Being able to identify, decide and plan what maths you need to use to solve a problem. *From the Study Design:* Overview of the context or scenario, and related background, including historical or contemporary background as applicable, and the mathematisation of questions, conjectures, hypotheses, issues or problems of interest.

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.

Term	Meaning
Hypothesis	A proposed explanation based on limited evidence that serves as a starting point for an investigation.
Mind mapping	A method used to brainstorm ideas and note them down without worrying about structure and order. Mind mapping helps to see the connections and relationships between the ideas. See also *brainstorming*.
Notation	The system of written symbols used to represent numbers or amounts in mathematics.
Prioritise	Determining the relative importance of items or tasks and which ones should be done first.
Research	Systematic investigation and study to establish facts and reach new conclusions.
Research question	The key question that defines the direction and intended outcome of a mathematical investigation.
Terminology	The technical language used in a subject, where the meaning may differ from everyday use, e.g. 'volume' as the space filled by an object (mathematics) vs. the loudness of sounds (everyday).

ISBN 978-1-009-11065-5 Sakurai et al. © Cambridge University Press & Assessment 2025
Photocopying is restricted under law and this material must not be transferred to another party.