FOUNDATION MATHEMATICS VCE

VCE UNITS 1 & 2

CAMBRIDGE SENIOR MATHEMATICS

DAVE TOUT | JUSTINE SAKURAI | PAMELA MCGILLIVRAY | JIM SPITHILL

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About the authors

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).

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.

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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.

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.

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Introduction

Cambridge Senior Mathematics for VCE Foundation Mathematics Units 1 & 2 provides a wholistic approach to teaching and learning Units 1 and 2 of the VCE Foundation Mathematics course. The underpinning philosophy of this book, and of the companion book for Units 3 and 4, 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.

Each chapter begins by introducing students to the topic through introductory activities, examples of 'epic fails' 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.

Within each chapter, 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, incorporating mixed practice for activating memory pathways to strengthen cognitive understanding; 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.

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

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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 glossary of key vocabulary are provided at the end of each chapter.

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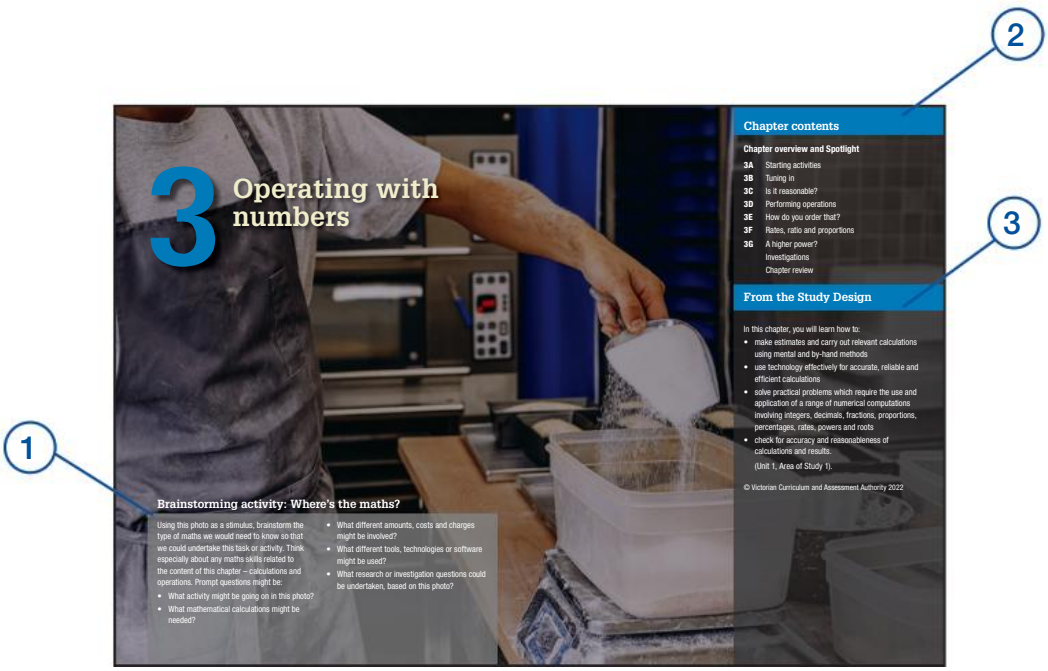
Guide to this resource

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 study design are covered by the chapter

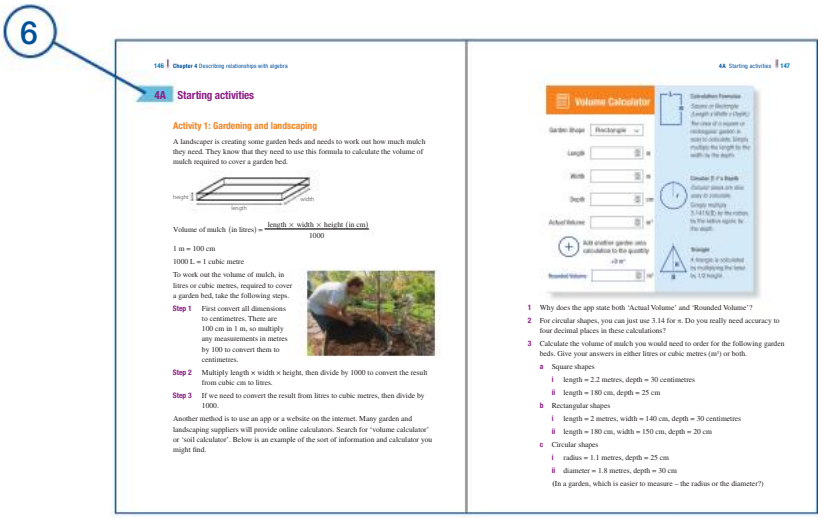


4 **Learning Intentions** at the start of the chapter set out what a student will be expected to learn in the chapter

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

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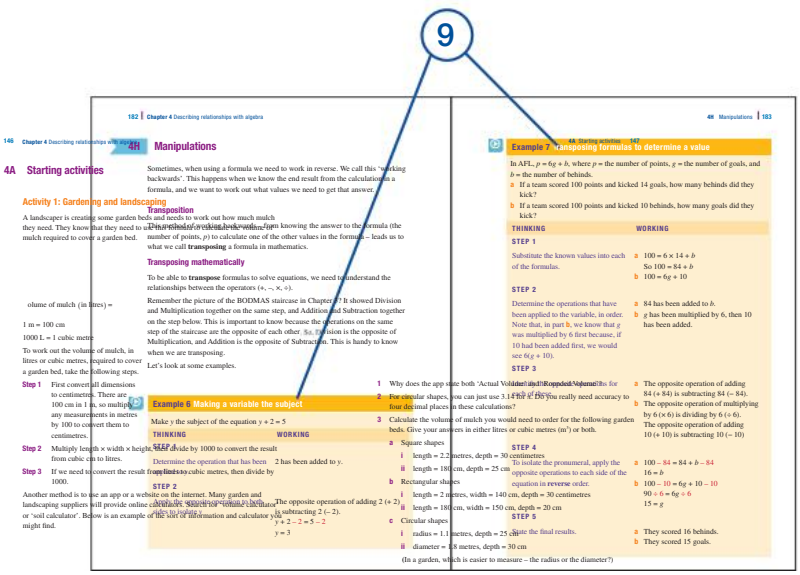
6 **Starting activities** act as pre-tests to assist the teacher to ascertain their students' understanding of prior knowledge before beginning the chapter; marking rubrics are provided in the Online Teaching Suite



7 A **'Tuning In'** section in each chapter includes an 'Epic Fail' demonstrating the importance of good mathematics, and revision of requisite prior knowledge for the chapter.

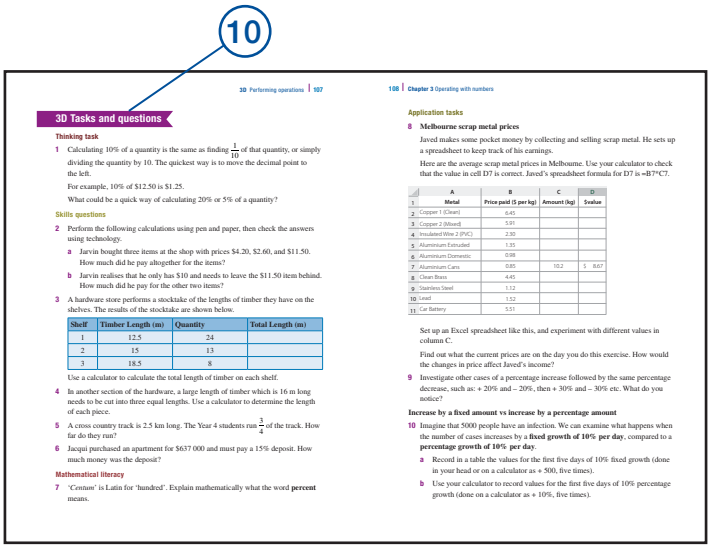
8 **Context-first approach** in each lesson allows for authentic, meaningful connections to be made with the mathematics right from the start of the lesson

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

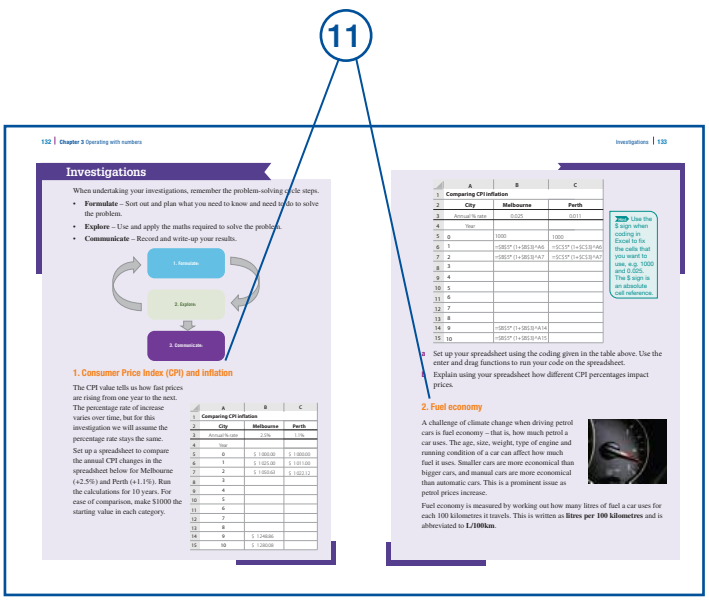


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10 **Tasks and questions** in each section replace traditional exercises, and include a Thinking Task, Skills questions, Mathematical Literacy activities, and Applications questions.



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

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

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

INTERACTIVE TEXTBOOK

15 **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

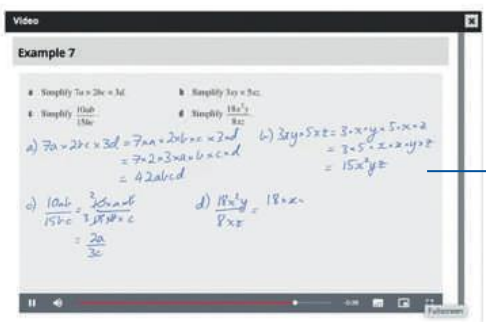
16 Self-assessment: students can self-assess their own work and send alerts to the teacher.

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

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

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

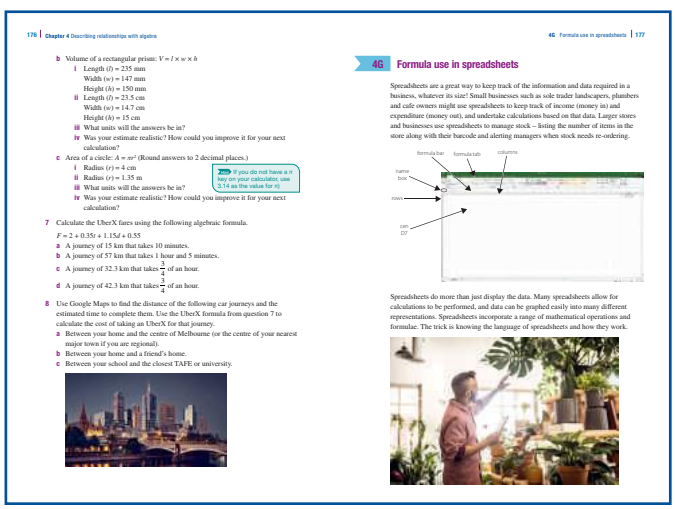




18

DOWNLOADABLE OFFLINE TEXTBOOK

20 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.



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ONLINE TEACHING SUITE

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

22 **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

23 **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

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

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

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1 Working with maths in the real world

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. Prompt questions might be:

- What might this person be doing?
- What numbers and calculations might they need to use?
- What measurements and calculations would they need to undertake?
- What about costs and charges?
- What about the design and shape of the watch or the route?
- What about times and schedules?
- What about shape and design or directions?
- What different tools, technologies or software might be used?
- Do you think they might need to use any formulae?

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Chapter contents

Chapter overview

1A Why you need to know some mathematics

1B Tuning in

1C What do you need to know and be able to do?

1D The way forward – The problem-solving cycle

1E Some critical issues in maths problem solving

Chapter review

From the Study Design

In this chapter, you will learn how to:

- identify and recognise how mathematics is used in everyday situations and contexts, making connections between mathematics and the real world (Units 1 & 2, Outcome 2)
- extract the mathematics embedded in everyday situations and contexts and formulate what mathematics can be used to solve practical problems in both familiar and new contexts (Units 1 & 2, Outcome 2)
- represent the mathematical information in a form that is personally useful (Units 1 & 2, Outcome 2).

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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. We sometimes refer to these skills as 'numeracy'.

This ability involves a number of critical skills, including the following:

- identifying, deciding on and planning what maths you need to use to solve a problem
- doing the maths – using and applying your maths knowledge and skills to find and review your solutions
- communicating the results and outcomes of your work.

You also need underpinning skills related to the following:

- interpreting and understanding the words and language of mathematics – what we call 'mathematical literacy'
- using a broad range of tools, including analogue, digital and technological tools and devices
- reviewing and reflecting on your mathematical actions and tasks.

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 both analogue and digital tools for solving mathematical problems
- appreciate the importance of reviewing and reflecting on your work.

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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.



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What numeracy and maths skills do you need? What the 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 that we learn in the maths classroom.

This is increasingly true in relation to your future work and potential careers. For example, in an Australian project undertaken by practising maths teachers, the research found 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.

This 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'.

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1B Tuning in

Epic fail: how many concrete-mixer trucks?

The following is based on a true story.

An apprentice named Dave was laying a small concrete slab. Dave measured and set up the slab ready for laying the concrete. Using his measurements, he calculated that he needed **75 cubic metres (m^3)** of concrete.

His supervisor asked Dave to check his calculations again before completing his order for the concrete, just to make sure he was happy with ordering that amount of concrete. Dave was still sure the amount required was correct.

Knowing that Dave's answer was actually incorrect, the supervisor asked Dave to think about how many concrete mixer trucks he would need for the 75 m^3 of concrete.





Discussion questions

1 Investigate how much concrete a medium-sized concrete mixer truck might carry. Share your answers.

2 After agreeing with his supervisor that a medium-sized truck holds about 5 m^3, Dave needed to work how many truckloads he would need. Make the calculation for Dave.

(Did you get 75 ÷ 5 = 15 truckloads!?)

... continued

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3 This finally made Dave realise that his calculations were wrong – he had put the decimal point in the wrong place in some of his measurements. Dave re-checked and worked out that the correct answer was 0.75 m^3 and not 75 m^3.

4 There is a lesson here! Explain to a partner the process Dave went through to realise his calculations were wrong.

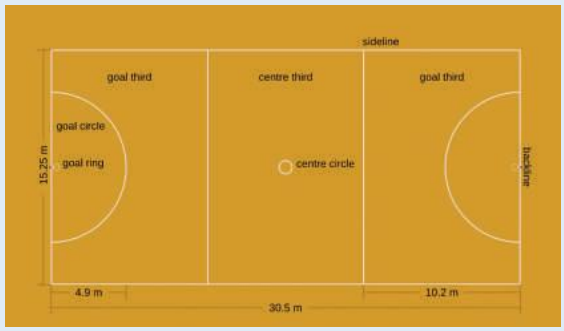
Check and reflect on your answers to maths problems – don't just accept the answers to your calculations. Check that they make sense in the real world! Use your knowledge and experience. You need to develop a 'feeling' for numbers and quantities: that 75 m^3 of something is HUGE!

Situations where your maths knowledge can be used

The table below has examples of situations where your maths knowledge can be used.

Situation	Maths needed
Cooking: • Catering for and costing a meal for 20 people. Deciding what to buy and how much it will cost. • Purchasing ingredients for a selected recipe and cooking (and eating) the food. 	• Algebra, number and structure • Space and measurement
Sport: • Updating the existing AFL ladder after the most recent round of game results. 	• Algebra, number and structure

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Situation	Maths needed
Sport: • Comparing the playing areas of different sports that are played on outside fields and courts. 	• Space and measurement
Travel: • Planning a trip to a Victorian city using public transport – determining times of departure, travel duration and fares. 	• Algebra, number and structure • Space and measurement
Work: • Determining how many litres of milk is required for a busy week in a cafe. 	• Algebra, number and structure • Space and measurement

... continued

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Situation	Maths needed
Fashion/Music: • Undertaking a survey of people's musical preferences, analysing the data and presenting the results. 	• Data analysis, probability and statistics
Cars: • Finding and comparing at least two different used-cars and documenting the differences, including the costs of paying for the cars 'on terms'. 	• Financial and consumer mathematics

Practice questions

1 Can you see that you need to know some maths in order to investigate some 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 it out yourself?

3 Do some look easier to you than others? Why?

4 Are some of these of interest to you? Which ones and why?

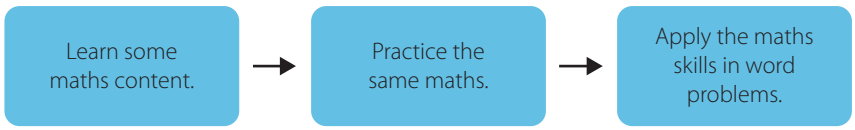
5 Find at least three other examples like this in your life that you would like to investigate.

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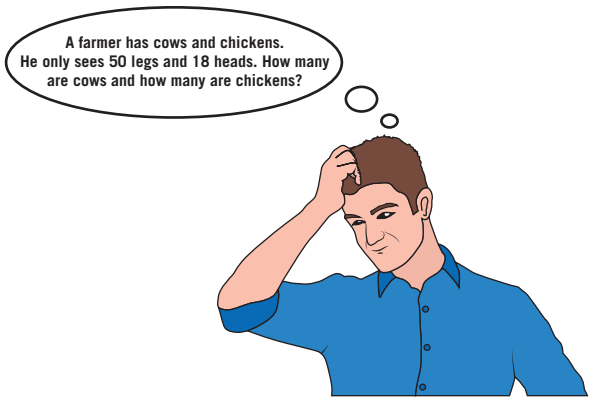
1C What do you need to know and be able to do?

To investigate maths in real-world situations, what do you need to be able to do?

In the past in your maths classrooms, you probably used the following 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 to solve the problem at hand – **you** need to make that decision. Often the problems 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).

Taking a problem-solving approach

The process in the real world requires a set of different skills, undertaken in the reverse order. We **start with maths** embedded in a context and move on from there to pose and solve a mathematical problem.

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In the VCE Foundation Mathematics course of study, we use situations based in the real world as the starting point for the maths.

A problem-solving process is used throughout this book.

1C Tasks and questions

Thinking task

1 Work with a couple of other students to discuss and share your thoughts and feelings about how you solved maths problems in your maths classes at school. Reflect on the various examples and situations presented in sections 1A and 1B and compare them with your experiences in learning maths in school up to the end of Year 10.

Think about issues and questions such as the following.

- How was maths taught to you?
- Were you aware of how the maths you were learning was connected to the real world?
- Did you sometimes **start** with solving a problem based in the real world – outside the classroom?
- Did you think maths was interesting, relevant or useful? Why? Why not?
- Were you able to use your maths skills outside of school? Where and when did you use them?

Mathematical literacy

2 In VCE Foundation Mathematics, we use a number of specific terms to describe the maths content that will be covered. These terms are:

- Algebra, number and structure
- Data analysis, probability and statistics
- Financial and consumer mathematics
- Space and measurement.

Discuss and share your understanding of what these terms mean. Are there terms that don't mean much to you? If so, research what they mean or ask your teacher. Translate these terms into words that mean something to you and the group.

Create a poster that shows what you think each of these four labels mean.

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3 Discuss what you think is meant by **problem solving** in maths. How does a problem-solving approach connect to the world outside the maths classroom?

Skills question

4 Think about the following situations and the type of maths knowledge and skills you might need.

- **a** Going out to dinner.
- **b** Playing your favourite sport.
- **c** Getting your driver's licence.
- **d** Following a recipe to cook some food.



- **e** Saving up for something special (and expensive) that you want to buy.
- **f** Reorganising your bedroom at home and moving the furniture around.
- **g** Working out how you are going to meet a friend at a location on the weekend and what time you will meet.

Application task

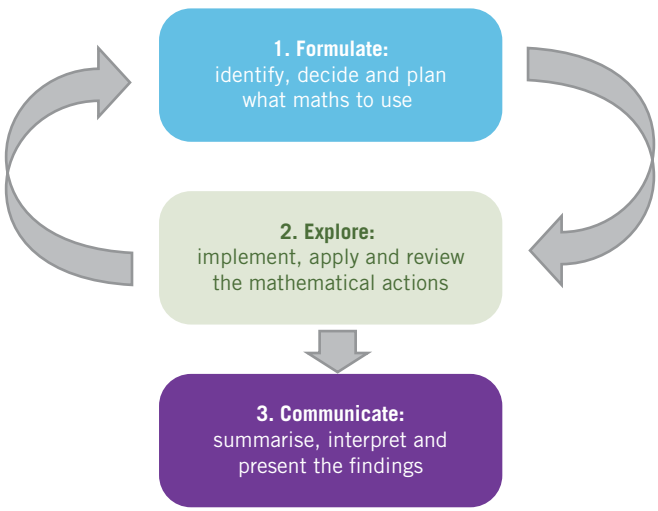
5 Choose one of the scenarios in the question above and then brainstorm the problem-solving and maths skills and knowledge you think might be needed to undertake the activity. Include not only the maths content but also other skills, such as reading and researching information, using technology and apps, using measuring tools and any writing or drawing you might need to produce.

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1D The way forward – The problem-solving cycle

The maths problem-solving process in the real world starts with working out what maths you might need to solve a problem. Then, the next step is to *do* the maths (where you apply your maths skills and knowledge). You need to be able to make sure the solutions are reasonable and reflect on how the maths result fits in with the real world (like with Dave and his 75 m^3 of concrete). Then the last step is to summarise the outcomes and communicate them to others.

This is presented in the diagram below of the problem-solving model, which also matches the description in the Investigations area of the VCE Foundation Mathematics Study Design. The problem-solving cycle is described in full below.



1. Formulate

When maths problems are embedded within real-world contexts, you need to first change the messy, real-world situation into a mathematical problem. We call this stage of the problem-solving cycle **Formulate**.

This stage requires you to find, identify and name the maths, and make decisions about how best to set out and solve the task.

Key steps to work through this stage are:

- identify and interpret the mathematical information embedded in the problem
- decide on the purpose of the task and what questions you need to pose and answer
- decide which of the mathematical operations, processes and tools you will need to solve the problem.

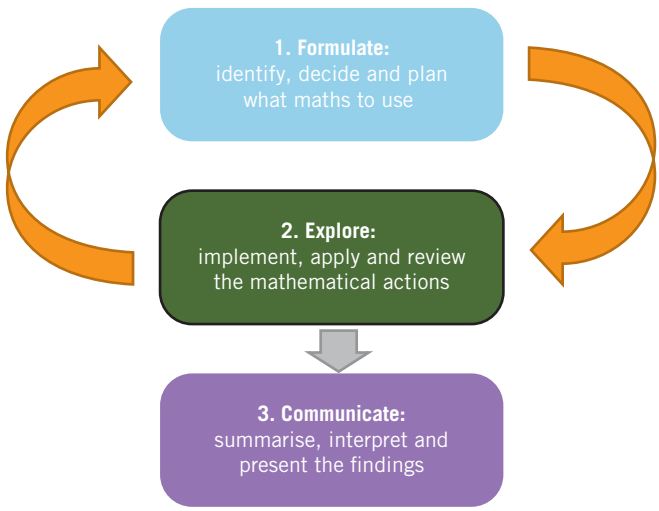
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2. Explore

The **Explore** stage involves using your maths knowledge to solve your problem. It involves using mathematical processes and problem-solving techniques. This includes using appropriate technology or software.

For example, you may need to calculate, solve formulas, use tables and graphs; use maps, diagrams and plans; follow or give directions; represent geometrical objects in 2D and 3D or analyse data.

As part of this stage, you should also *review* the maths outcomes and reflect on how the results fit in with the original real-world context. Do you need to adjust your answers or revise some of your maths calculations? The diagram below shows the need to move backward and forward between the **Formulate** stage and the **Explore** stage when reviewing your results.



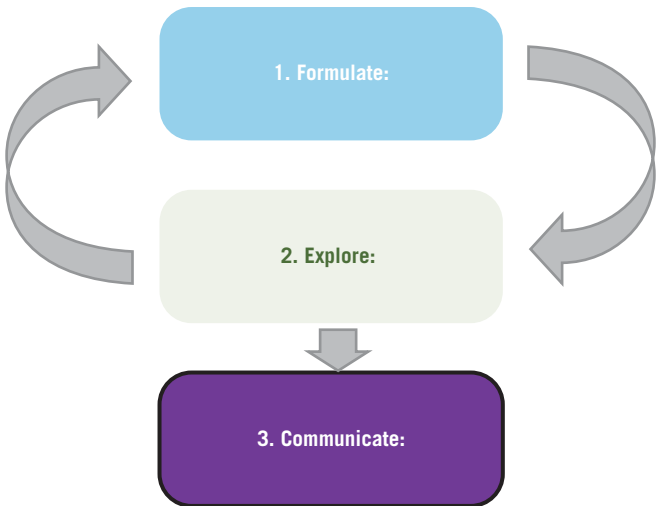
Key steps to work through this stage include the following:

- Do the maths that you identified in the Formulate stage.
- Undertake any estimations before you start.
- Use the best technology, tools and apps to help you complete the task.
- Check your estimations and calculations to see if the results are as expected.
- Review the reasonableness of your results and change if necessary.
- Reflect on whether your answer makes sense in the real world. You are solving a real-world problem after-all! (Remember Dave and the concrete mixers in this chapter's 'Epic Fail'!)

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3. Communicate

Usually, when you undertake a problem-solving task that involves maths, you need to communicate your results. The task simply doesn't finish once you have done the maths. This will often include different formats, media and technologies.



Key steps to work through this stage include the following:

- plan the most appropriate way to summarise your results
- decide on written or visual mathematical representations to best use the maths in the real world.

1D Tasks and questions

Thinking task

1 Think of a problem that you recently had to overcome. Outline how you approached and solved the problem.

For example: My cat had hot ears and was unhappy and lethargic. I decided that the cat was unwell, so I called the vet and made an appointment. At the appointment, the vet prescribed some antibiotics, and now my cat is recovering.

Skills questions

2 For the following scenarios:

i **Formulate** (state) the potential problem.

ii **Explore** some possible solutions.

iii Explain how you might **communicate** the result to someone.

a Your car is leaning to one side, providing a rough and uncomfortable ride, and you recently drove over some glass on the road.

b You borrow your parents' car, but there is no fuel.

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c You are out late in the city at night, and you cannot find an Uber and have missed the last train.

d You are at home and the power seems to have stopped because the TV and toaster do not work. The lights are working, however.

e Your boss calls and asks you to work a whole day tomorrow, but you have already made plans with your friends.



f You open the flour from the pantry and notice some small bugs wiggling in the flour.

g You order something online, but four weeks later the parcel has not arrived.

Mathematical literacy

3 Make a list of all the different ways that you might **communicate** the solution of a problem to someone.

Next, place a tick beside all the ways that you might communicate the results of a mathematical problem.

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Application task

4 Consider the following scenario and answer the questions.



You and three friends go out for dinner, and you decide to share the bill evenly. The restaurant does not allow spilt bills though, so one of the group pays the total bill using their credit card.

a How are you going to work out how much each person owes?

b Will you use any technology? An app?

c How will you transfer or give the money to the person who paid?

d How soon do you need to repay the money?

e How will your friend know that you have paid them back?

f For each question above and your solution, categorise them into the table below.

Formulate the problem	Explore solutions	Communicate the solution

5 Think of another scenario that has occurred in your life recently where you had to solve a problem. Write the steps you took to identify and solve the problem using the table below.

Formulate the problem	Explore solutions	Communicate the solution

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1E Some critical 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 mathematical words and language – what we call *mathematical literacy*
- having a toolkit to dip into, including both analogue and digital technological tools and devices
- reviewing and reflecting on the mathematics used.

Each of these aspects are described more fully in the sections below.

Mathematical literacy

The words and language of maths and numeracy are very important to all three stages of our problem-solving cycle.

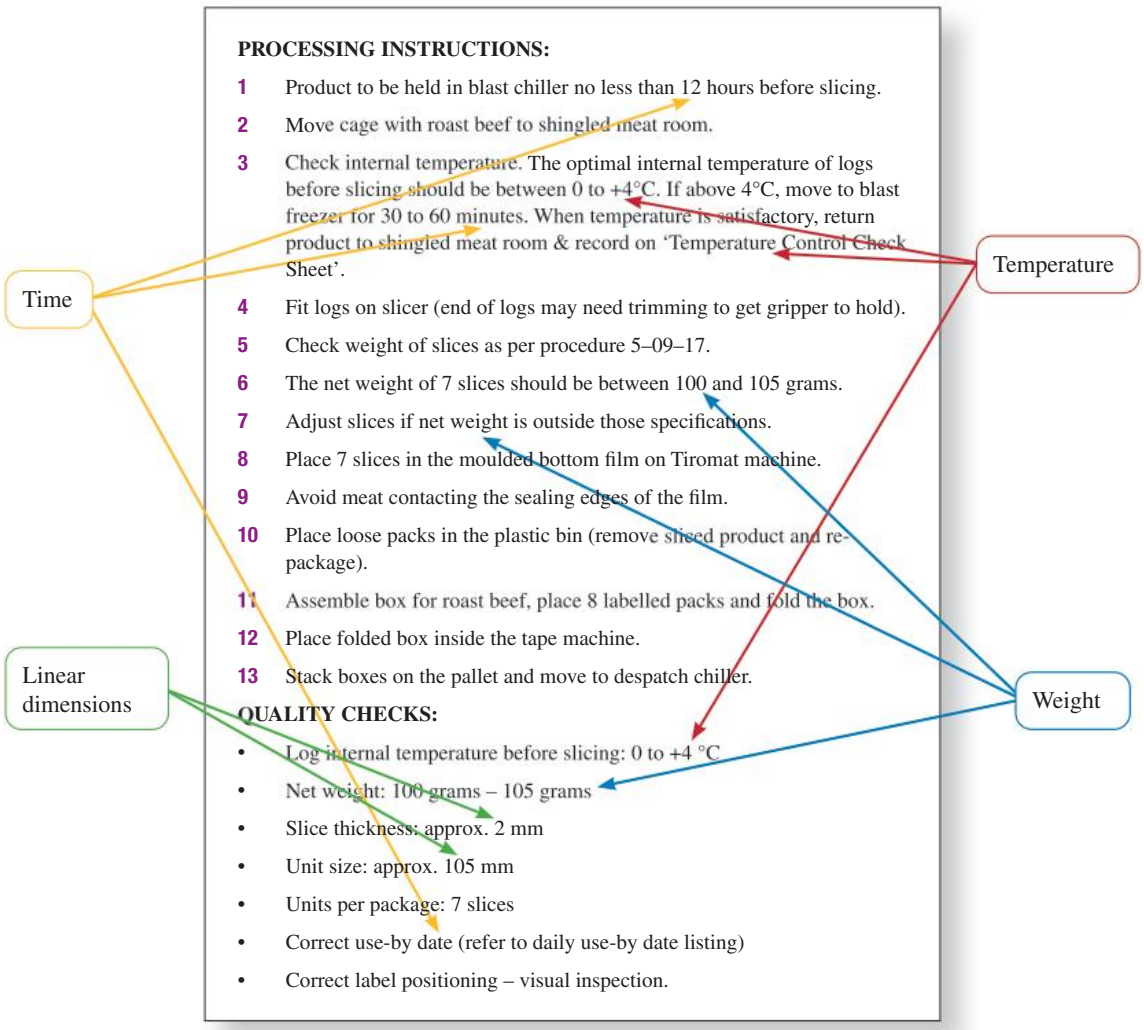
Stage 1: Formulate

You need to be able to read, interpret and understand the information that is part of the situation to identify the maths you need to use.

On the following page is a workplace example where the maths is embedded in the written material. In this case, it is a standard operating procedure for making roast beef. The measurement aspects of this process require reading skills to understand what they mean.



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The language of maths in the real world is embedded within materials. In the above example, we need to be able to read and understand the following:

- words and expressions such as 'internal temperature' and 'net weight'
- symbols such as ° and ±
- abbreviations such as mm, C and kg
- numbers such as 12, +4, 0.001

For our problem-solving cycle, in the first stage it's important to formulate the problem and decide what you need to do. This requires the following.

- Read and comprehend the problem and understand the context.
- Extract the relevant maths and formulate it as a maths problem.

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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.

Stage 2: Explore

In Stage 2, the mathematical words and terms we use are critical. The formal language of mathematics is also crucial to understanding mathematics and numeracy. There are two issues to be aware of.

First, some formal maths words can be difficult to read and understand, such as isosceles, equilateral, quotient and denominator.

Second, maths words can be misunderstood because they can have a different meaning to how we use them in our lives outside the maths classroom. This can lead to confusion if you don't understand the way we use them in maths.

Here are some examples.

Word	Meaning in a maths context	Meaning in everyday life
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.
Odd	Any integer or whole number that cannot be divided exactly by 2.	Differing markedly from the usual, ordinary or accepted.
Rational	A rational number is a number that can be written as a fraction.	Having reason or understanding.
Volume	The amount of three-dimensional space something takes up.	The degree of loudness or the intensity of a sound.

Ask for help from your teacher, use a dictionary or search online to get an explanation if you are unclear about the meaning of specific words or terms.

Stage 3: Communicate

This stage of the problem-solving cycle requires maths literacy. To **communicate**, we need to use a range of different literacy skills to document and report on our results. This will involve oral and written language and formal and informal maths representations.

Throughout each chapter, you will find sections that are about the words and language we use for that topic – they are referred to as **Mathematical Literacy** activities.

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Using a range of tools from 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 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.

The table below describes this Outcome in the VCE Foundation Mathematics Study Design.

On completion of this unit, the student should be able to select and effectively use a wide range of appropriate technologies and digital representations to solve and communicate mathematical problems set in practical contexts. Students should become productive and informed users of technology as a vehicle for information gathering and sharing and be able to adapt to emerging technologies into the future. (© Victorian Curriculum and Assessment Authority 2022.)

Key knowledge	• The conventions for representations of mathematical information using technology. • Awareness and knowledge of contemporary technological and online digital media, including software and applications based on computers, tablets, calculators and hand-held devices. • Relevance, appropriateness and validity of the use and application of technology. • The numerical, graphical, symbolic, geometric and statistical functionalities of a range of technologies. • The conditions and settings for effective application of a given technology and its functionality.
Key skills	• Use technology to carry out computations and analysis, and produce diagrams, tables, charts and graphs which model situations and solve practical problems. • Interpret, evaluate and discuss the outputs of technology, including reflecting on and evaluating the technology used and the outcomes obtained relative to personal, contextual and real-world implications. • Use technology to communicate the results of working mathematically. © Victorian Curriculum and Assessment Authority 2022

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Throughout each of the chapters, you will be expected to keep adding tools to your toolkit. These will include the following:

- existing traditional tools, such as measuring equipment (e.g. tape measures, rulers and kitchen scales)
- software applications, such as spreadsheets, mortgage calculators, online calculators
- a range of new devices and applications from across different technologies (e.g. measurement, angle and level apps available on mobile phones or portable hand-held devices).

Reviewing and reflecting

Rapid changes to work from advances in technology, science and economics require people to have estimation and reasoning skills.

In Stage 2 of the problem-solving cycle, we *review* and *evaluate* the outcomes of the maths we have done and reflect on how our results fit with the original investigation. These processes are often referred to as contextual judgements.

Here are some questions to think about when doing this.

- Are your results reasonable and relevant, especially when compared with your initial estimates? Are your answers and outcomes as you expected? Do they make sense? (Remember Dave and the concrete slab!)
- Are you happy to accept your results and solutions? 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 social, environmental or economic consequences?

These reflection skills will be covered throughout the tasks and activities in this book.

1E Tasks and questions

Thinking task

1 Use this book to answer the following questions.

a How many chapters are in the book?

b Are the chapters grouped together in some way? If so, how? Into major sections?

c What are the names of the sections that are the same in every chapter?

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d Are there any appendices? What is the purpose of the appendices?

e Open the book to any double page in the middle of a chapter.

i Where are the page numbers located on the pages?

ii How do you know which chapter you are in?

Skills questions

2 The Formulate stage of our problem-solving cycle involves being able to read, interpret and understand the information in your own words.

Here is a description from a Red Cross website about why blood donations are tested. Re-write the text in everyday language, as if you are explaining it to a friend.

Why we test blood

Safety is our number one priority. All of our policies and guidelines are based on the latest medical research and what it tells us is safest for donors and patients. The people who receive blood are often already quite sick. This makes them more likely to be infected by viruses, bacteria and other nasties and to have a higher chance of worse outcomes if they do.

So, to protect them we do a lot of testing to make sure everything's OK first. By screening our donors and testing every donation, we've minimised the risk of receiving an infection through donated blood in Australia. In fact, it's now considered extremely rare – a chance of less than one in a million.

Source: Australian Red Cross Lifeblood website

3 Look back at the Standard Operating Procedure chart for processing roast beef on page 20. What do each of the following mathematical references mean?

a 0 to +4°C

b 30 to 60 minutes

c 5 09 07

d Net weight of 7 slices

e Net weight 100–105 grams

f Scales accuracy ±0.001 kg (How many grams is this?)

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Mathematical literacy

4 Confusion can happen when the meaning of words in a maths problem is different to their meaning in everyday life. We saw some examples in the table on page 21.

Dual meanings are not unique to maths. In Australian Rules Football, the word **behind** has a specific meaning that is different from its everyday use. Think of a familiar activity or situation – for example sport, creative arts or public life – and identify some words that have a **double meaning**. Summarise your findings in a table like the one below.

Word	Specific word meaning	Meaning in everyday life

Application task

5 The way in which you *communicate* your maths findings will depend on the method of your presentation. For example, creating a poster requires different planning to making a YouTube video.

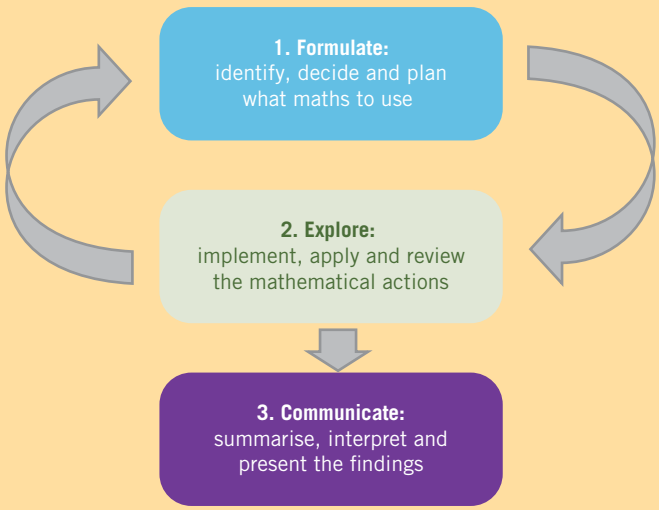
For the text on page 24, 'Why we test blood', communicate the information using a written or illustrative method, such as a social media post.



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Key concepts

- Maths-related tasks in the workplace and in daily life can be sophisticated and may 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.

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  - 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.
  - During the **Communicate** stage, we interpret, summarise and use the maths in real life or work.
    - 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.
- **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.

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Success criteria and review questions

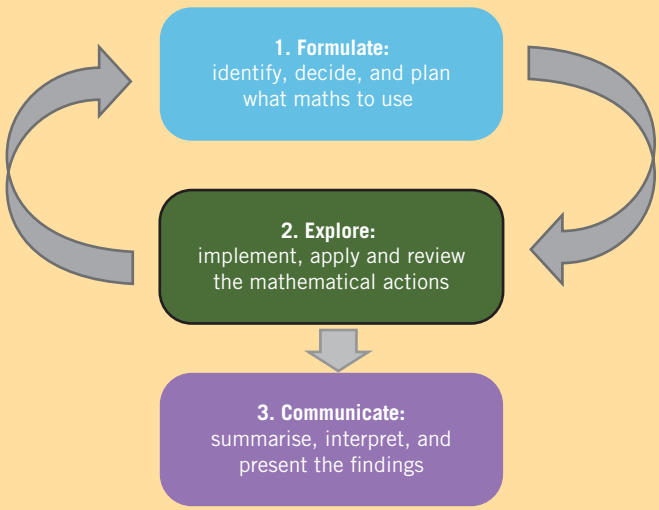
☐ I understand about taking a problem-solving approach to learning maths.

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 can 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** Give one example from your own life.
- **c** Explain how your example fits in with the problem-solving cycle.

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☐ I can identify correct or incorrect ways of *formulating* a numeric problem.

3 Two friends meet at a cafe. They each have a coffee (cost $4) and a muffin (cost $3).
Identify whether or not each of the following correctly represents the total cost.
Answer 'correct' or 'incorrect' for each expression.

a $4 + 3 + 4 + 3$ **b** $4 + 4 + 3 + 3$ **c** $4 + 3 \times 2$
d $4 \times 2 + 3 \times 2$ **e** $(4 + 2) \times 3$ **f** $2 \times (4 + 3)$

Which method do you prefer to use in cases like this?

4 I can identify different words that refer to the same operation in maths.
For each maths operation symbol, most of the words are a match, but one word is not a match. Which word is **not** a match in each case?

a + SUM, ADD, TOTAL, LESS
b – DIFFERENCE, SUBTRACT, PLUS, FROM
c × MULTIPLY, TAKE AWAY, DOUBLE, PRODUCT
d ÷ HALVE, FRACTION, EXTRA, PART

5 I can use different methods for *communicating* a maths result.
Which of the following methods have you used to describe a maths result?
There is no 'right' or 'wrong' answer here, but the list might suggest approaches for use later this year.

a Choose from a list in a multiple-choice question.
b Write a number in an answer space.
c Write a word or phrase in an answer space.
d Draw a diagram or graph to match a description.
e Read a value from a graph.
f Answer a question orally in a class discussion.
g Present a talk in class – alone or with others.
h Design and make a poster to show in class.
i Make and present a PowerPoint slide show, or similar.
j Engage in a debate about a maths topic.
k Make and present an audio podcast about a maths topic.
l Make and present a video about a maths topic.
m Any other approaches you have used.

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2 Numbers, numbers everywhere



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 numbers and calculations might they need to use?
- What numbers are used for scoring purposes?
- What statistics and data are used for monitoring and reporting player performance?
- What about costs and charges?
- What about times and schedules?
- What about the dimensions of the court?
- What different tools, technologies or software might be used?
- What research or investigation questions could be undertaken, based on this photo?

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Chapter contents

Chapter overview and Spotlight

2A Starting activities
2B Tuning in
2C Numbers you meet
2D Understanding place value
2E Percentages
2F Choosing the right calculation
Chapter review

From the Study Design

In this chapter, you will learn how to:

- solve practical problems which require the use and application of a range of numerical computations involving integers, decimals, fractions, proportions, percentages, rates, powers and roots
  (Unit 1, Area of Study 1).

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Chapter overview

Introduction

In today's society, we are bombarded with numerical information – numbers appear everywhere. Numbers are in the media and the news, and they are embedded in sports and in game results and player performances. When we drive a car, when we go shopping, when we make measurements – numbers and calculations are involved.

This chapter looks at how critical it is to understand numbers when we read and interpret maths in real life. It is important to be able to recognise and decide what calculation or operation is required when we need to solve a problem, so we will also look at how to make those decisions.

Learning intentions

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

- understand the numbers we encounter in everyday life, including integers, positive numbers, negative numbers, fractions, percentages, decimals and rates
- write numbers using appropriate conventions
- understand the place value of numbers and what each digit means
- convert between equivalent fractions, decimals and percentages
- use mathematical operations such as addition, subtraction, multiplication, division, and exponentiation
- apply the problem-solving cycle to complete investigations related to the topics contained within this chapter.

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Spotlight: Chris Thorne

An interview with a veterinarian

Tell us about the work you've done and what you do now.

A rural science career was what I imagined. I wasn't sure that it had to be veterinary science, but once I had seen some work experience in a veterinary clinic, I liked the idea of being a vet.

What maths do you use regularly in your job? Could you give some examples?

All dosages of drugs depend on the mass of the animal, whether that be a worming tablet, antibiotic or anaesthetic drug. If you get a decimal place wrong on an anaesthetic induction drug, that patient's not going to wake up. Chemo drugs are done on surface area, as you get fewer toxicity effects, so there's a table that translates the body weight into surface area.

Every couple of minutes in your work, you will be making a maths calculation in your mind. Your memory gets better, and you get quicker at the arithmetic through repetition. What you do every day becomes basic, like riding a bike.

Here's an example. This patient is 10 kg. The dose rate is 10 mg per kg twice a day. So the patient needs 100 mg twice a day. I have tablets available in 200 mg or 400 mg and I need seven day's treatment. Therefore, it's going to be half of a 200 mg tablet twice a day. I need seven tablets.

What is the most useful tool or piece of technology that you use regularly in your job?

Instead of having a piece of paper in which you write the patient's chart and the medications, you now have a digitised patient chart. Once you enter a patient's weight and required drugs, it calculates the prescribed doses by the body weight and writes for you the recommended dose. So it's a double check that you've got the right dose.

Has your attitude towards learning mathematics (or learning in general) changed over time?

Once I realised I was committed to a career path, I did a lot more work than I did at school because I was more motivated. I think knowing what you want to do changes how you feel about it – 'This stuff that I'm learning will have an application if I want to do cool things.'

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2A Starting activities

Activity 1: Numbers, numbers everywhere

The examples below show how numbers are part of the information we come across in our daily lives – at home, in the media, in the community and at work.

Patty Mills' basketball career

The world of sport is full of numerical information. Here is some information about First Nations basketballer Patty Mills.

Patty Mills

Patrick Sammie Mills

(Patty Cakes, Pat Stacks)

Position: Point Guard and Shooting Guard • **Shoots:** Right

6-1, 180lb (185cm, 81kg)



SUMMARY	G	PTS	TRB	AST	FG%	FG3%	FT%	eFG%	PER	WS
2022-23	40	6.2	1.1	1.4	41.1	36.6	83.3	52.9	10.6	0.4
Career	860	9.0	1.7	2.3	42.6	38.9	85.4	54.0	13.5	35.7

Per Game **Bold** indicates league leader

Regular Season | Playoffs

Season	Age	Tm	Lg	Pos	G	GS	MP	FG	FGA	FG%	3P	3PA	3P%	2P	2PA	2P%	eFG%	FT	FTA	FT%	ORB	DRB	TRB	AST	STL	BLK	TOV	PF	PTS
2009-10	21	POR	NBA	PG	10	0	3.8	1.0	2.4	.417	0.2	0.4	.500	0.8	2.0	.400	.458	0.4	0.7	.571	0.1	0.1	0.2	0.5	0.0	0.0	0.4	0.6	2.6
2010-11	22	POR	NBA	PG	64	0	12.2	2.1	5.1	.412	0.7	2.1	.353	1.4	3.0	.451	.483	0.6	0.7	.766	0.3	0.5	0.8	1.7	0.4	0.0	1.0	1.0	5.5
2011-12	23	SAS	NBA	PG	16	3	16.3	3.9	8.1	.485	1.5	3.5	.429	2.4	4.6	.527	.577	0.9	0.9	1.000	0.3	1.5	1.8	2.4	0.6	0.1	1.6	0.9	10.3
2012-13	24	SAS	NBA	PG	58	2	11.3	1.9	4.2	.469	0.9	2.2	.400	1.1	1.9	.550	.577	0.3	0.3	.842	0.2	0.7	0.9	1.1	0.4	0.1	0.7	0.9	5.1
2013-14	25	SAS	NBA	PG	81	2	18.9	3.8	8.2	.464	1.7	3.9	.425	2.1	4.3	.500	.565	0.9	1.0	.890	0.4	1.7	2.1	1.8	0.8	0.1	0.8	1.4	10.2
2014-15	26	SAS	NBA	PG	51	0	15.7	2.5	6.6	.381	1.2	3.6	.341	1.3	3.0	.429	.473	0.6	0.8	.825	0.4	1.1	1.5	1.7	0.5	0.0	0.7	1.1	6.9
2015-16	27	SAS	NBA	PG	81	3	20.5	3.2	7.6	.425	1.5	4.0	.384	1.7	3.6	.469	.525	0.6	0.7	.810	0.3	1.6	2.0	2.8	0.7	0.1	0.9	1.3	8.5
2016-17	28	SAS	NBA	PG	80	8	21.9	3.4	7.8	.440	1.8	4.4	.414	1.6	3.3	.474	.558	0.8	1.0	.825	0.3	1.5	1.8	3.5	0.8	0.0	1.3	1.4	9.5
2017-18	29	SAS	NBA	PG	**82**	36	25.7	3.4	8.3	.411	1.9	5.0	.372	1.5	3.3	.470	.523	1.3	1.4	.890	0.3	1.6	1.9	2.8	0.7	0.1	1.3	1.6	10.0
2018-19	30	SAS	NBA	PG	**82**	1	23.3	3.4	8.1	.425	1.9	4.9	.394	1.5	3.2	.475	.545	1.1	1.3	.854	0.3	1.9	2.2	3.0	0.6	0.1	1.1	1.6	9.9
2019-20	31	SAS	NBA	PG	66	1	22.5	3.9	9.1	.431	2.3	6.1	.382	1.6	3.0	.533	.560	1.5	1.7	.866	0.3	1.3	1.6	1.8	0.8	0.1	0.8	1.6	11.6
2020-21	32	SAS	NBA	PG	68	1	24.8	3.7	9.0	.412	2.4	6.3	.375	1.3	2.7	.500	.544	1.0	1.1	.910	0.3	1.4	1.7	2.4	0.6	0.0	1.0	1.2	10.8
2021-22	33	BRK	NBA	SG	81	48	29.0	4.0	9.8	.408	2.8	7.0	.400	1.2	2.8	.429	.551	0.6	0.7	.814	0.2	1.7	1.9	2.3	0.6	0.2	0.9	1.4	11.4
2022-23	34	BRK	NBA	PG	40	2	14.2	2.2	5.2	.411	1.2	3.4	.366	0.9	1.9	.493	.529	0.6	0.8	.833	0.2	0.9	1.1	1.4	0.4	0.1	0.8	0.8	6.2
Career			**NBA**		**860**	**107**	**20.4**	**3.2**	**7.6**	**.426**	**1.7**	**4.5**	**.389**	**1.5**	**3.1**	**.479**	**.540**	**0.8**	**1.0**	**.854**	**0.3**	**1.4**	**1.7**	**2.3**	**0.6**	**0.1**	**1.0**	**1.3**	**9.0**
10 seasons		**SAS**	**NBA**		**665**	**57**	**20.8**	**3.3**	**7.8**	**.430**	**1.8**	**4.5**	**.389**	**1.6**	**3.2**	**.487**	**.543**	**0.9**	**1.1**	**.867**	**0.3**	**1.5**	**1.8**	**2.4**	**0.7**	**0.1**	**1.0**	**1.3**	**9.4**
2 seasons		**BRK**	**NBA**		**121**	**50**	**24.1**	**3.4**	**8.3**	**.409**	**2.3**	**5.8**	**.393**	**1.1**	**2.5**	**.445**	**.546**	**0.6**	**0.7**	**.820**	**0.2**	**1.4**	**1.7**	**2.0**	**0.5**	**0.2**	**0.9**	**1.2**	**9.7**
2 seasons		**POR**	**NBA**		**74**	**0**	**11.1**	**2.0**	**4.8**	**.412**	**0.7**	**1.9**	**.358**	**1.3**	**2.9**	**.447**	**.482**	**0.5**	**0.7**	**.741**	**0.3**	**0.4**	**0.7**	**1.5**	**0.4**	**0.0**	**0.9**	**0.9**	**5.1**

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Using bleach

In the home or at work, chemicals come with information and instructions.



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Practice question

1 Using the two scenarios above, find examples of each of the following types of numbers. (These answers can be shared with the class later in a class discussion.)

- **a** Whole numbers (also known as integers)
- **b** Decimals
- **c** Fractions
- **d** Percentages
- **e** Ratios
- **f** Proportions
- **g** Rates



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2B Tuning in

Understanding numbers and what they mean is critical. If you calculate numbers and get answers, you always need to check they are correct and that they make sense. One common mistake can be getting the decimal point in the wrong place – like we saw with the concrete mixer story in Chapter 1!

Epic Fail 1: The Third Pound Burger Flop in America



In the 1980s, the American fast-food chain A&W decided to try to compete with McDonald's Quarter Pounder hamburger by releasing and advertising its own numerically named hamburger – the **Third Pound burger**. The Third Pound burger was larger in size but was offered at the same price as the Quarter Pounder. It even outperformed the Quarter Pounder in blind taste tests. The A&W advertisers pushed these two facts hard in their 'Third is the Word' advertising campaign and expected big sales, considering the burger's larger size.

However, the Third Pound burger flopped, and A&W stopped making the burger shortly after its launch. A&W's owners were dumbfounded – why would consumers choose to buy a smaller burger for the same price of their bigger Third Pound burger?

A&W did some research and ran focus groups to discover the reason for the hamburgers failure. The result was a shock – most participants thought one-third $\frac{1}{3}$ of a pound was actually smaller than one-quarter $\frac{1}{4}$. In other words, consumers failed to understand the maths and mistakenly thought they were buying **less** meat for the same price.

Why, you might ask?

Many consumers thought that because 4 is bigger than 3, then $\frac{1}{4}$ must be bigger than $\frac{1}{3}$! A&W overestimated the public's ability to understand the maths. As a result, their message was misunderstood and the burger failed.

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Epic Fail 2: Is dishwashing powder really worth more per kilogram than silver?

Silver is worth about $1000 per kg. So, do you think this unit price in $ per kg of $7386.55 per kg for dishwashing liquid is correct?



Discussion questions

1 The unit price should have been $8.79 ÷ 1.19 = $7.38(655) per kg! Out by a factor of 1000 (three decimal places).

2 What do you think they did wrong?

Check mathematical information and numbers you see in the real world – don't assume that the answer you get to your calculations is correct.

Check that your answers make sense. Use your maths knowledge and your other knowledge and experiences!

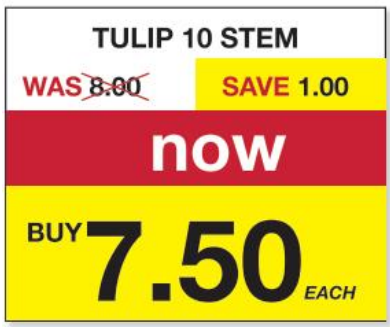
Develop a 'feeling' for numbers and quantities: that $\frac{1}{3}$ is bigger than $\frac{1}{4}$ and that dishwashing liquid is not worth more per kilogram than silver!

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Practice questions

1 Find the 'maths mistakes' in the following.

a



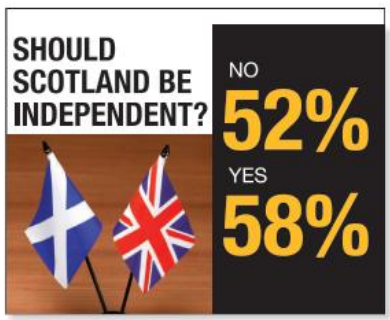
b



c



d



e



f



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2C Numbers you meet

In this section, we'll explore the most common numbers we meet in our daily lives.

Take a close look at the weather forecast below, which contains lots of different types of numbers. What types of numbers can you see?

MT HOTHAM 7-DAY WEATHER FORECAST

Hover Your Mouse Over Any Forecast Item To Identify Its Source

	Tue Sep 21		Wed Sep 22		Thu Sep 23		Fri Sep 24		Sat Sep 25		Sun Sep 26		Mon Sep 27	
Summary	Cloudy		Frost then sunny		Possible shower		Windy with snow		Snow		Frost then sunny		Frost then sunny	
Maximum	–2°C		5°C		4°C		4°C		–1°C		4°C		6°C	
Minimum	–6°C		–3°C		0°C		1°C		–6°C		–6°C		–2°C	
Chance of Rain	50%		10%		50%		90%		20%		5%		10%	
Rain Amount	<1mm		<1mm		<1mm		1-5mm		<1mm		<1mm		<1mm	
UV Index	Moderate		Moderate		High		High		Moderate					
Frost Risk	Severe		Severe		High		High		Severe		Severe		Severe	
	9am	3pm	9am	3pm	9am	3pm	9am	3pm	9am	3pm	9am	3pm	9am	3pm
Wind Speed	34 km/h	23 km/h	23 km/h	19 km/h	31 km/h	27 km/h	37 km/h	34 km/h	28 km/h	24 km/h	23 km/h	16 km/h	28 km/h	23 km/h
Wind Direction	SSW	SW	SW	WNW	NNW	NNW	NNW	NW	SW	SSW	ESE	WNW	N	NNW
Relative Humidity	87%	87%	90%	84%	96%	87%	87%	93%	77%	70%	69%	63%	74%	68%
Dew Point	–6°C	–4°C	–1°C	2°C	1°C	2°C	0°C	2°C	–8°C	–6°C	–5°C	–2°C	–1°C	0°C

The numbers we see regularly in daily life can be the following.

- **Whole numbers** like 22, 450, $400 000.
- **Negative numbers** like –6 or –8.
- **Fractions** like $\frac{4}{5}, \frac{1}{2}$.
- **Decimals** like 0.3, 43.6.
- **Percentages** like 10%, 17.5%.
- **Rates** like 34 km/h, 7.1L/100km, $7,386.55 per kg.

Numbers can be in dollars, such as $5 million or $500 000. They can be written using digits, like 450, $\frac{3}{4}$, 5th or 0.05, or written using words, like two, half or ten thousand.

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Digits are the figures 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. These ten digits make up all our numbers. Where the digit is, or its **place** in the number, tells us what the number actually is. This is called **place value**, which we will cover in 2D.

Whole numbers and integers

Whole numbers are exact numbers – they are for whole numbers of things and are used for counting things. Whole numbers are all the counting numbers including zero. These are some examples of whole numbers.

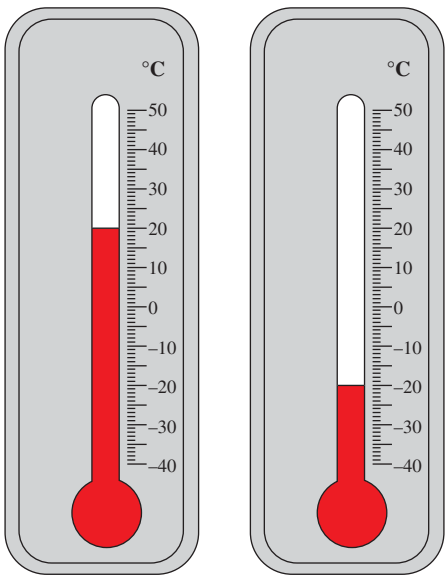
- Five (5) chillies.
- Seventy-six (76) points in an AFL football game.
- 90 072 (ninety thousand and seventy-two) people – the number of people at the MCG at a Grand Final.
- 26 million people – the population of Australia.



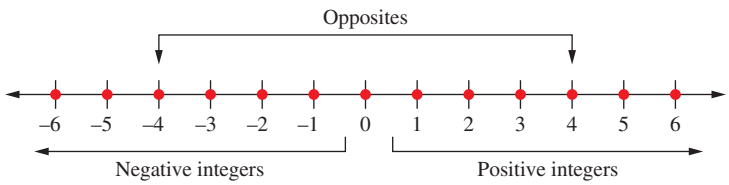
In mathematics, integers are **whole numbers** including **positive** and **negative** numbers and **zero**. The opposite numbers to positive whole numbers are called negative whole numbers.

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For example, we use negative numbers to measure temperature. Below we see a positive temperature on the left of +20°C and a negative number on the right of –20°C, which is 20° below zero.



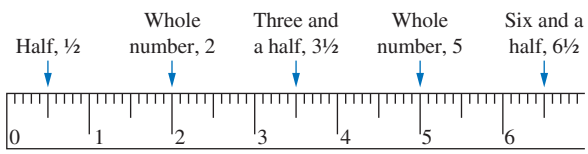
Positive whole numbers and negative whole numbers can be shown on a number line, like the one shown below, with zero (0) in the centre.



You should remember that fractions and decimals are **not** integers.

Fractions

Whole numbers are exact amounts or marks on the number line, just like on a ruler or tape measure. The numbers that lie between the whole numbers, like $\frac{1}{2}$, $\frac{1}{4}$, $\frac{3}{4}$, are called **fractions**.

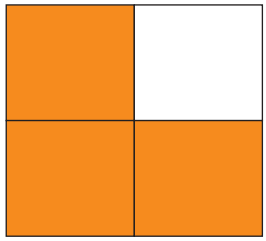


Fractions are written with one number over another number like this:

$\frac{3}{4}$ or sometimes like this $3/4$

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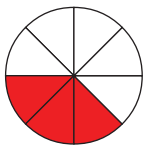
The bottom number of a fraction (called the **denominator**) tells you how many parts the whole has been broken up into, while the top number (the **numerator**) tells you how many of these parts you have.



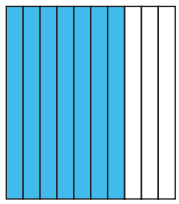
Numerator → 3
Denominator → 4

Here are some examples.

Here is $\frac{3}{8}$ ('three eighths')



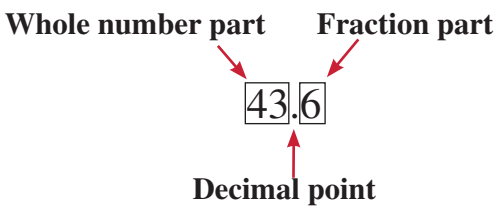
Here is $\frac{7}{10}$ ('seven tenths')



Decimal numbers

Decimal numbers, like 0.3 and 43.6, are made up of a **whole number** part and a **fraction** part. The **decimal point** separates the whole number part on the left from the fraction part on the right.

Example: 43.6 (forty-three point six) is a decimal number made up of the whole number part (43) and the fraction part $\left(0.6 \text{ or } \frac{6}{10}\right)$.



We will look at this in more detail later, as this relates to what we call place value.

Writing numbers: some conventions to follow

When we write decimal numbers and very big numbers, we need to keep the following things in mind.

Commas, full stops or spaces?

In Australia, we often use the **comma** (**,**) or a space to separate **thousands**, which makes large numbers easier to read.

So, for example, Australia's population was 26 527 541 people as at 15 June 2023. Using commas, this is often written as 26,527,541.

Australia uses a **point** (**.**) as the **decimal** separator. For example, a number such as thirty thousand, two hundred and twelve point seven five would normally be written as 30 212.75 or 30,212.75

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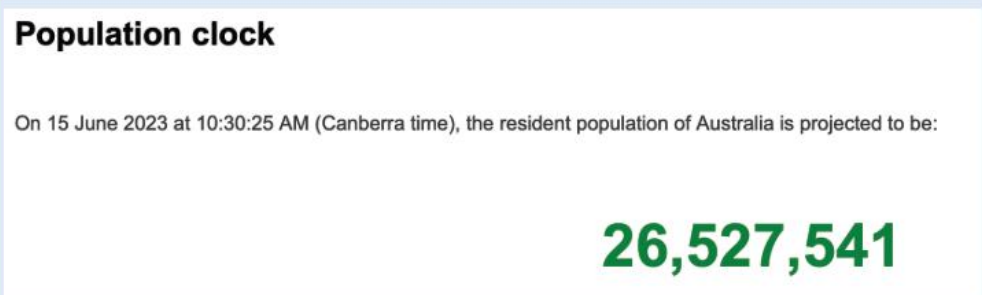
In Europe and some other countries around the world, however, the opposite is true. **Points** are used to separate large numbers, and **commas** are used for decimals. So, for example, the above number of 30,212.75 would be written as 30.212,75 – confusing, especially if you move or travel from one country to another where the system changes.

International Systems of Units (SI) – Trying to make things clear

To help overcome the confusion, the **International Systems of Units (SI)** recommends that **a space** should be used to separate groups of three digits, and both the comma and the point should be used to denote decimals. So, the above number under the SI system would be formally written as either 30 212.75 (which is how we would write it in Australia) or 30 212,75 (if we were living in Europe).

Here are examples of how you might see large numbers written.

Real-world uses of commas
From the Australian Bureau of Statistics (ABS) website



Source: Australian Bureau of Statistics (ABS) website

Using the SI system

Following the SI system, this number would be written this way.

26 527 541

2C Tasks and questions

Thinking task

1 Using your favourite social media sites, take screenshots of five examples of different types of numbers.

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Skills questions

2 Write the following common fractions using numerals.

a one half **b** one quarter **c** two quarters

d one third **e** two thirds **f** three quarters

g one fifth **h** three fifths

3 Using **all** of the following digits, answer the following questions.

5 8 9 3 4 2 9 1



a What is the smallest number that you can write?

b What is the largest number that you can write?

c Write five numbers starting with 9, using the digits.

d Write the same five numbers, using words.

4 Draw number lines that show where the following numbers are placed. The first one is done for you.

a –4

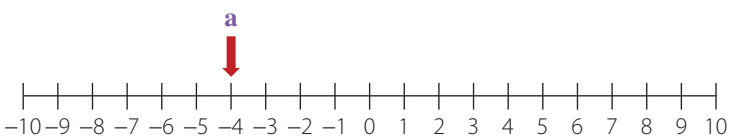
b 16

c –1.5

d 4

e –100

f 36.7



Mathematical literacy

5 Draw a sketch showing the fraction $\frac{5}{8}$.

Explain the different parts of the fraction, and give the mathematical term for each part.

Application tasks

6 Read the following news article. Identify and explain all the numbers you find in the article.

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The high-speed physics of how bobsled, luge and skeleton send humans hurtling faster than a car on the highway

John Eric Goff

Professor of Physics, University of Lynchburg

5 February 2022

Gravity and energy



Gravity is what powers bobsleds down the ice-covered tracks in bobsled, luge and skeleton events. The big-picture physics is simple – start at some height and then fall to a lower height, letting gravity accelerate athletes to speeds approaching 90 mph (145 km/h).

This year's races are taking place at the Yanqing National Sliding Centre. The track is roughly a mile long (1.6 km), drops 397 feet of elevation (121 meters) – with the steepest section being an incredible 18% grade – and comprises 16 curves.

Racers are dealing with a lot of kinetic energy and strong forces. When athletes enter a turn at 80 mph (129 km/h) they experience accelerations that can reach five times that of normal gravitational acceleration. Though bobsled, luge and skeleton may look easy, in reality it is anything but.

Aerodynamics

Most tracks are around a mile long (1.6 km), and the athletes cover that distance in just under a minute. Final times are calculated by adding four runs together. The difference between the gold medal and silver medal in the men's singles luge at the 2018 Winter Olympics was just 0.026 seconds. Even tiny mistakes made by the best athletes in the world can cost a medal.

Source: Excerpt from The Conversation.

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2D Understanding place value

Our number system is a base ten or decimal system – it works by using 10 digits (0, 1, 2, 3, 4, 5, 6, 7, 8 and 9). We use these ten digits to make up all our numbers. Each digit in a number is related to its next digit by being 10 times bigger or one-tenth as big – the value goes up by 10 times as you go left (× 10) or down by 10 times as you go to the right (÷ 10).

Where the digit is, or its **place** in the number, tells us what the value of that digit actually is. This is called **place value**.

The first digit in a whole number (that's the one just to the left of the decimal point) is worth 1 (sometimes we call it units).

The next one across on its left is worth 10 times more (× 10).

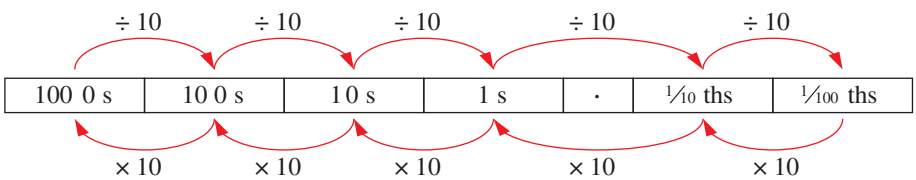
The next one across on its left is worth 10 times more again (× 100).

The next one across on its left is worth 10 time more again (×1000), and so on.

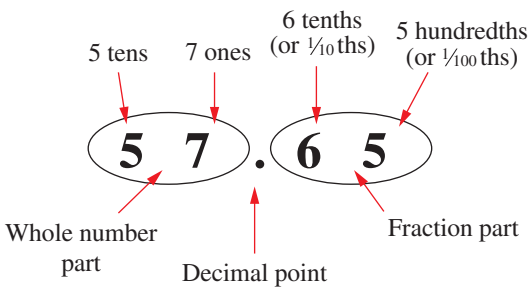
We divide by 10 when we go across into the decimal fractions from the left to the right.

The first decimal place after the decimal point is therefore 1 divided by 10, which is tenths $\left(\frac{1}{10}\text{ th}\right)$.

Then the second decimal place is one-tenth as big again, which is hundredths $\left(\frac{1}{100}\text{ th}\right)$.

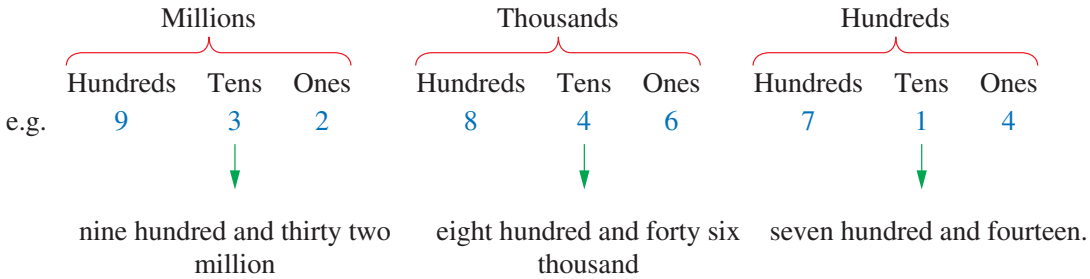


Consider the number **57.65**. This number has a whole number part (before the decimal point) and a fraction part (after the decimal point).



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



With decimal numbers, we can say them in two ways.

1. As digits. e.g. **7.6** is seven point six
   5.25 is five point two five
2. As fractions. **7.6** is seven and six tenths
   5.25 is five and twenty-five hundredths.

2D Tasks and questions

Thinking task

1 Make up a very large number (excluding infinity!) and write it down.

Read your number aloud.

Can you think of a shorthand way of writing your number?

Skills questions

2 Write the following numbers out as if you would say them. For example, 398 476 would be three hundred and ninety-eight thousand, four hundred and seventy-six.

a 657 **b** 800 723 **c** 576 002

d 3 576 912 **e** 56 376 213 **f** 987 455 322

3 Write the following decimals out as you would say them.

a 1.5 **b** 6.75 **c** 9.32

d 8.935 **e** $1,099.34 **f** $675.42

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Mathematical literacy

4 Here is a place-value chart to help remind you of the place value for decimal numbers. Complete the table by writing in either the number in words or the missing digits. The first two are done for you.

1000s	100s	10s	1s	•	$\frac{1}{10}$ th	$\frac{1}{100}$ th	Number in words
	1	4	5	•	7		one hundred and forty-five point seven
5	7	8	2	•	6	1	five thousand, seven hundred and eighty-two and sixty-one hundredths
	2	5	7	•	7	5	
				•			seven hundred and thirty-one point five eight
9	3	7	3	•	9	9	
				•			seven thousand, four hundred and twenty-six and five tenths
4	3	4	5	•	6	7	
				•			nine thousand and forty point eight seven
				•			two thousand, two hundred and twelve and five hundredths

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Application tasks

5 Find out which number meets **all** the clues.

a

Mystery number 1 – What number am I?

My digits can be 0, 1, 2, 3, 4, 5, 6, 7, 8 or 9.

I can have a decimal point, too.

Here are my clues:

- I am greater than 10.
- My units digit is double my tens digit.
- My three digits add up to eleven.
- My tenths digit is an odd number.
- My decimal part equals a half.
- I am less than 100.

What number am I?

b

Mystery number 2 – What number am I?

My digits can be 0, 1, 2, 3, 4, 5, 6, 7, 8 or 9.

I can have a decimal point, too.

Here are my clues:

- I am less than 6.
- I have four different digits.
- I am just bigger than 5.
- I have a zero in my number.
- I have almost 50 thousandths.
- Two of my digits are 4 and 9.

What number am I?

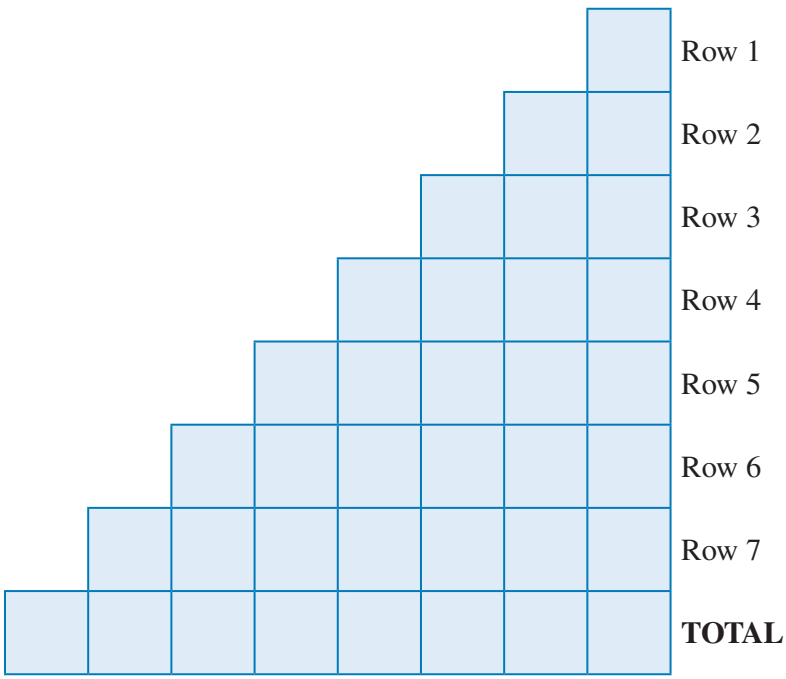
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6 Play the following dice game.

Any number of players is allowed. Use a pre-printed sheet to play this game.

- The aim of the game is to get the highest total at the end of the round.
- Roll a dice and call the number out to the group.
- Each row must be completed before moving down to the next row.
- Decide where to put the number in the row. Aim for the highest total number possible.

Number dice game





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2E Percentages

In our daily lives, we regularly find percentages. Here are some examples.



Team		P	W	L	D	%	Pts
1	Geelong	22	18	4	0	144.2	72
2	Melbourne	22	16	6	0	130.5	64
3	Sydney	22	16	6	0	127.9	64
4	Collingwood	22	16	6	0	104.3	64
5	Fremantle	22	15	6	0	117.0	62





Percentages or 'percents' are used when we compare things or want to see how much things change. Percent means 'per hundred' or 'out of a hundred'. We use the symbol **%** for percentages.

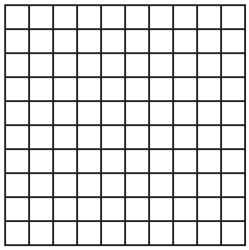
So, 10% means 10 out of 100, 25% means 25 out of 100, 50% means 50 out of 100 and so on.

We can often write these percentages as fractions.

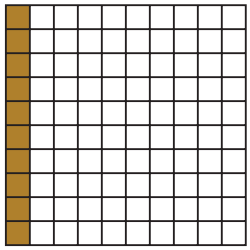
10%	10 out of 100	$\frac{10}{100}$
25%	25 out of 100	$\frac{25}{100}$
50%	50 out of 100	$\frac{50}{100}$

To help us understand or see something, a picture or diagram helps.

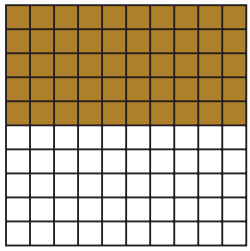
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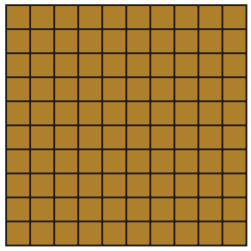
We can use a grid that is 10 by 10 = 100 as a picture for representing percentages.



So, the coloured part above represents 10%, which is the same as 10 out of 100, or 1 column out of 10 columns (so 10% is the same as $\frac{1}{10}$).



This picture represents 50%, which you can also see from the diagram is the same as a half.



100%

Equivalent fractions, decimals and percentages

We often change between fractions, decimals and percentages, especially with common fractions like $\frac{1}{2}$ and $\frac{1}{4}$. To do this, change the fractions into tenths or hundredths. For percentages, work out what fraction they are out of 100.

These are called **equivalent** fractions, decimals and percentages.

Example 1 Equivalent fractions, decimals and percentages

Find the equivalent fraction and percentage of $\frac{1}{2}$

THINKING	WORKING
STEP 1	
To find the decimal equivalent consider $\frac{1}{2}$ of 10	$10 \times \frac{1}{2} = 5$ $\frac{1}{2} = \frac{5}{10}$ = five tenths Five tenths = 0.5
STEP 2	
To find the equivalent percentage consider $\frac{1}{2}$ of 100	$100 \times \frac{1}{2} = 50\%$

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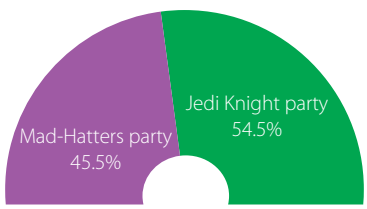
Example 2 Equivalent fractions, decimals and percentages

Find the equivalent fraction and percentage of $\frac{1}{4}$

THINKING	WORKING
STEP 1	
To find the decimal equivalent consider $\frac{1}{4}$ of 100	$100 \times \frac{1}{4} = 25$ $\frac{1}{4} = \frac{25}{100}$ = twenty five hundredths twenty five hundreds = 0.25
STEP 2	
To find the equivalent percentage consider $\frac{1}{4}$ of 100	$100 \times \frac{1}{4} = 25\%$

Using percentages for comparisons

Let's look at one of the examples at the start of this section to illustrate how this works.



In the chart about the poll results about people's voting intentions in an election, you can compare the results easily.

It shows that 45.5% of people prefer the Mad Hatters Party compared to 54.5% for the Jedi Knight Party.

We can use our knowledge of percentages and their equivalent fractions to make comparative statements such as:

- 'Less than half or 50% of the people intend to vote for the Mad Hatters.'

or

- 'More than a half of people surveyed were in support of the Jedi Knights.'

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This survey on perspectives about climate change uses percentages, and their equivalent fractions.

A survey on climate change received 10,000 responses from Australians aged under 30. Of the respondents, 93% said the government was not doing enough to address climate change. The vast majority had little faith in the nation's political leadership to address the issue. Nearly three in four said they would vote for or support political leaders taking bold action on climate change. Just 11% felt as though their vote actually mattered. Beyond climate change, the report found 66% of young people were feeling increasingly anxious and uncertain about their future.

Percentages and their equivalent fractions are summarised to make comparative statements about young people's views. For example:

- We can interpret 93% as a bit more than 9/10, or more than 9 people out of every 10 were concerned about inaction on climate change.
- In the sentence that says 'Nearly three in four said they would vote for or support political leaders taking bold action on climate change', we can interpret that as being the same as about $\frac{3}{4}$ of the people held that view.

It is a curious fact that a 10% increase followed by a 10% decrease does *not* take you back to the original value. Try 100 + 10% – 10%. Also try 100 – 10% + 10%. The answer is 99, which is a 1% decrease overall.

2E Tasks and questions

Thinking task

1 Make a list of all the places that you see percentages in the world around you. Think of shopping, work and leisure. Find some examples of each and save images or take photos to illustrate the different percentages to share with the class.

Skills questions

2 Copy and complete the table below to write the fractions as decimals and percentages.

Fraction	As a fraction out of 10 or 100	As a decimal	As a percentage
$\frac{1}{2}$	5 out of $10 = \frac{5}{10}$ or 50 out of $100 = \frac{50}{100}$	0.5	50%

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Fraction	As a fraction out of 10 or 100	As a decimal	As a percentage
$\frac{1}{4}$	25 out of $100 = \frac{25}{100}$	0.25	25%
$\frac{3}{4}$			
$\frac{1}{5}$			
$\frac{1}{10}$			
$\frac{2}{5}$			
$\frac{3}{10}$			
$\frac{7}{10}$			

Mathematical literacy

3 Research and document the meaning and derivation of the term '**percent**'. Include information that covers the following questions:

- **a** Where does the word come from?
- **b** What is the difference (in meaning) between the words *percent* and *percentage*?
- **c** What other words or terms use the same or a similar derivation? (For example, 'cents' as in money.)

4 A store is having a sale. The discounts are at different percentages as shown in this advert. The colour coding indicates which discount you receive.



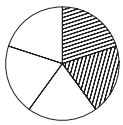
- **a** What are each of these discounts equivalent to as fractions?
- **b** If you bought something at this sale, which discount or discounts would save you at least half of the original price?

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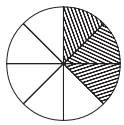
Application tasks

5 Write the following as fractions, decimals and percentages.

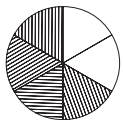
a



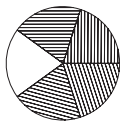
b



c

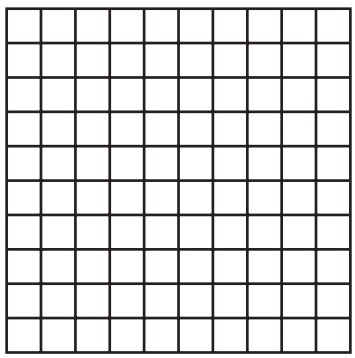


d



6 Shade the following percentages onto a 10×10 grid, then give the equivalent fraction and decimal.

a 25%
b 60%
c 33.33%
d 40%
e 75%
f 16%





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7 Here is the forecast of rain for a town for a week.

	Tue Sep 21	Wed Sep 22	Thu Sep 23	Fri Sep 24	Sat Sep 25	Sun Sep 26	Mon Sep 27
Chance of rain	50%	10%	50%	90%	20%	5%	10%
Rain amount	< 1 mm	< 1 mm	< 1 mm	1-5 mm	< 1 mm	< 1 mm	< 1 mm

a Order the days from their lowest percentage chance of rain to the highest percentage chance of rain.

b Which days have their percentage chance of rain being greater than a half?

c Which day or days have their chance of rain being equal to one fifth $\left(\frac{1}{5}\right)$?

d Which day or days have their chance of rain being closest to one quarter $\left(\frac{1}{4}\right)$?

8 Here are the results of a survey undertaken by a group of students.

100 people were in the survey. The students found the following out about the 100 people they surveyed:

- 48 were born overseas
- 45 identified as female, 47 as male, and 8 as non-binary
- 40 were younger than 21, 45 were aged over 21, 15 were older than 50
- 65 had completed Year 12, and 35 had a university degree
- 26 of them do not have a job.

a Convert the information in each statement to a percentage or percentages.

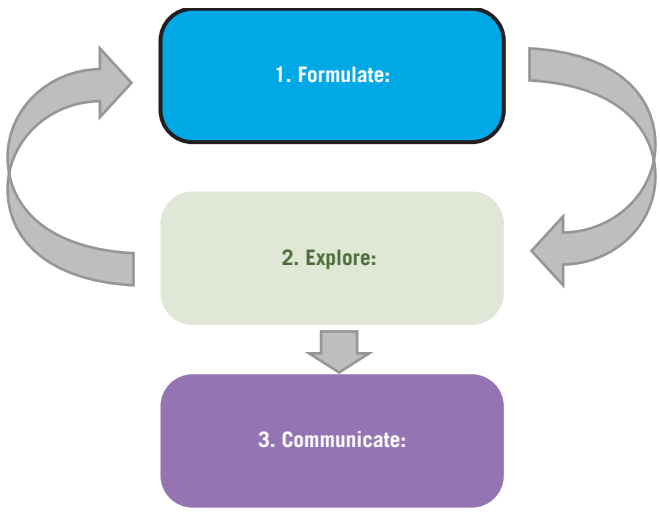
b Write a paragraph about the date that summarises the statements, with sentences that use percentages and, where it makes sense, equivalent fractions. (For example: 'Nearly half of the people were born overseas'.)



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2F Choosing the right calculation

It is critical to understand calculations when we read and interpret numerical and quantitative information. We need to know, for example, when to use addition (+) or subtraction (–) or multiplication (×) or division (÷), which are the four main maths operations. Similarly, we need to know how to work out calculations with fractions (e.g. $\frac{1}{2}$ or $\frac{3}{4}$) or percentages (e.g. 10%, 25% or 2.75%) or rates (e.g. $12.50/kg).
This relates directly to the first stage in our problem-solving cycle – Formulate.



When solving a problem in the real world, the first thing we need to do is understand the context of the problem and decide **which maths** we need to use – what we call **formulating** the problem.

Knowing which operation to use

Let's do a recap of the different maths operations and their meanings and symbols.

An operation is a mathematical process. The most common ones are add, subtract, multiply and divide (+, –, ×, ÷).

But there are many more, such as squaring a number, finding a square root of a number, cubes and powers.

Here are some explanations of the common operations.

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Mathematical operation	What it is	Example
Addition (+)	To add is to join two or more numbers (or things) together. Addition is finding the total or sum by combining two or more numbers.	11 + 3 = 14 is an addition.
Subtraction (–)	Subtraction is taking one number away from another. Note: Addition and subtraction are opposite (inverse) operations. Doing + 3 followed by – 3 takes you back to the starting value of 11.	14 – 3 = 11 is a subtraction.
Multiplication (×)	The basic idea of multiplying is repeated addition. As well as multiplying by whole numbers, we can also multiply by fractions, decimals and more.	5 × 3 = 5 + 5 + 5 = 15.
Division (÷)	Division is sharing or grouping a number into equal parts. It is the result of equal sharing or grouping. *Sharing* Sharing 12 apples between 3 people means that each person gets 4 apples each: 12 ÷ 3 = 4. *Grouping* How many groups of 3 apples can be made from 12 apples? There would be 4 groups of 3 apples: 12 ÷ 3 = 4. Note: Multiplication and division are opposite (inverse) operations.	12 ÷ 3 = 4.
Squares	To square a number means to multiply it by *itself*. The name square is used because this is the calculation needed to find the area of a *square* shape. The symbol is the digit 2, written as a superscript.	$3.5^2 = 3.5 \times 3.5 =$ 12.25, which can be read as "3.5 squared is 12.25."

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Mathematical operation	What it is	Example
Square roots	The square root finds what number multiplied by itself equals a given value. The symbol is $\sqrt{}$. Note: Square and square root are opposite (inverse) operations.	$\sqrt{12.25} = 3.5$, which can be read as 'The square root of 12.25 is 3.5.'
Cubes	To cube a number means to multiply it by itself *three times*. The name *cube* is used because this is the calculation needed to find the volume of a cube. The symbol is the digit 3, written as a superscript.	$5^3 = 5 \times 5 \times 5 = 125$, which can be read as '5 cubed is 125'.

Using technology

This table shows how the common operations from above are represented in spreadsheets such as Excel. These are important symbols and terms when you use spreadsheets to do calculations, especially with larger sets of numbers or data.

Mathematical operation	Spreadsheet symbol or term	Excel formula	Excel displays
Addition	+ (plus sign)	=3+3	6
Subtraction	– (minus sign)	=3–1	2
Multiplication	* (asterisk)	=3*5	15
Division	/ (forward slash)	=6/3	2
Square	^2	=5^2	25
Square root	SQRT	=SQRT(25)	5
Brackets	()	=(2+4)/3	2

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2F Tasks and questions

Thinking task

1 Think of five different expressions that will give the answer of 83.

Use at least three operations to get to this number.

For example, $(20 \times 4) + 5 - 2 = 83$

Skills questions

2 Copy and complete the following table.

Mathematical operation	Spreadsheet symbol or term	Excel formula	Solution
Addition		=819+327	
	–	=1902–785	
	*	=323*5	
Division		=774/43	
Square		=12^2	
	SQRT	=SQRT(196)	
Powers or Exponents		=8^3	
	()	=(14+31)/3	

Mathematical literacy

3 In doing calculations, there are maths words that we need to understand. For example, in adding 25 to 32 we might say '25 **plus** 32' or '25 **added** to 32' or simply '25 **and** 32'. But we can also say 'the **total** of 25 **and** 32' or 'the **sum** of 25 **and** 32'. The same happens with the other calculations too – we can use different words.

Here is a list of the four common maths calculations and the symbols used to represent them. The list shows some of the words used to describe the calculations.

Calculation	Words
add (+)	plus, add, and, sum, total
subtract (–)	take away, minus, subtract from, difference, less
multiply (×)	multiply, times, by, lots of
divide (÷)	divide, into, how many __ in __?

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a Do you use any other words for these calculations not included in the lists above? Which ones?

b Ask other people what words they prefer to use for each calculation.

Application task

4 Take a look at the advertisements below for kitty litter and answer the following questions. (Note: you don't need to do the calculations, just think about the question and state the correct operation.)



$13

ExquisiCat crystals Cat Litter 6kg

$2.17 per kg

686070



24-Litre

$18

SAVE $5

Advanced Scoop Cat Litter 24-Litre

183885



24-Litre

$20

SAVE $5

WORLD'S BEST CAT LITTER 24-Litre

84C per litre

8407130



$15

SAVE $5

ExquisiCat Enviro-Friendly Pine Litter 24/7 Performance Cat Litter 6.35kg.

$2.37 per kg

624129



$18

SAVE $5

Scented Clumping 4kg Save 4.50 per kg

724667

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a How much would it cost to buy the ExquisiCat Crystals Cat Litter and the Scented Clumping Litter?

Which operation do we need to use?

i + **ii** – **iii** × **iv** ÷

b How much would it cost to buy three packets of the ExquisiCat Enviro-Friendly Pine Litter?

Which operation do we need to use?

i + **ii** – **iii** × **iv** ÷

c Write down two examples from everyday life where you have needed to use an *addition* or *subtraction* calculation.

d Write down two examples where you have needed to use a *multiplication* or *division* calculation.

e Write down two examples where you have needed to use more than one operation, in the correct order, in a *multi-step* calculation.

f Compare your examples from above with other students in the class.

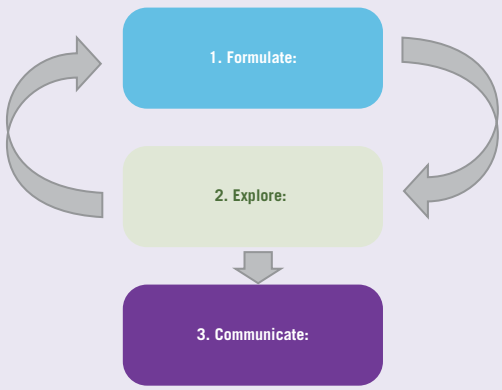


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Investigations

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 Interpreting and understanding numbers

Choose an investigation topic with information that interests you that involves many different types of numbers. You can choose from the list of topics discussed in this chapter which is shown below, or pick your own topic based on your interests.

- Sports information about basketball player Patty Mills
- Instructions for mixing bleach
- Weather forecasts

Analyse and discuss the different types of numbers that are embedded in the information on your topic, including the numbers which you need to read and understand.

Compile a report about the information on your topic that answers the following questions.

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a **What topic did you choose?**

Include a copy of the information on your topic in your report with the hyperlink to the source of your data.

- What was the information about?
- Why did you choose it?

b **What type of numbers did you find?**

- Write about and describe each type of number that was in the information (such as integers, fractions, decimals and percentages).
- What types of numbers discussed in this chapter were *not* used?

c **What calculations can you undertake using the information?**

The last part of the investigation is to decide on what mathematical operations and calculations you could undertake using your information. You don't need to do the calculations, just decide what operations and calculations could be done. Explain what further information could be discovered by applying the following operations:

- addition **and** subtraction
- multiplication **and** division
- calculating with fractions **and** percentages.

2 The car of your dreams

Your task is to create a report 'about deciding on and buying your dream car.' The format of your report is up to you.

a What dream car would you buy? Include the price and a photo.
b Explain why you chose this dream car over others.
c Research and list at least six detailed specifications of this car.
d Research the cost of comprehensive car insurance for your dream car in Victoria.
e Research the registration costs of this car.
f Include any other pertinent information about this car in your report.

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Key concepts

- **Integers** are whole numbers that don't have any fractions or decimal parts. Integers can be greater than zero (**positive**), equal to zero, or less than zero (**negative**).
  - Examples of integers include −2, −1, 0, 1, 2, 3, and so on.
- **Place value** is the value of a digit in a number based on its position
  - The value of each digit is ten times smaller than the digit to its left.
  - When we say numbers, we note that they occur in a pattern of hundreds, tens and ones.



- **Fractions** let us represent parts of a whole. They consist of a **numerator** (the top number) and a **denominator** (the bottom number).

$$\frac{\text{numerator}}{\text{denominator}}$$

  - The numerator represents how many parts are being considered, whereas the **denominator** represents how many equal parts make up the whole.
  - For instance, $\frac{3}{4}$ represents three parts out of four, where four parts is equal to one whole.
- **Decimals** (e.g. 3.01) are another way of representing parts of a whole. The decimal point separates the whole number from its fractional part.
  - Each digit after the decimal point represents a value that is ten times smaller than the digit to its left (e.g. 0.1 is one tenth, 0.01 is one hundredth).
- **Percentages** are fractions out of 100.
  - For example, $25\% = 0.25 = \frac{25}{100}$
- We can **convert** between fractions, decimals and percentages.
  - One way of doing this is to first convert the number into tenths and hundredths. This makes it easier for us to write the number in the desired form.

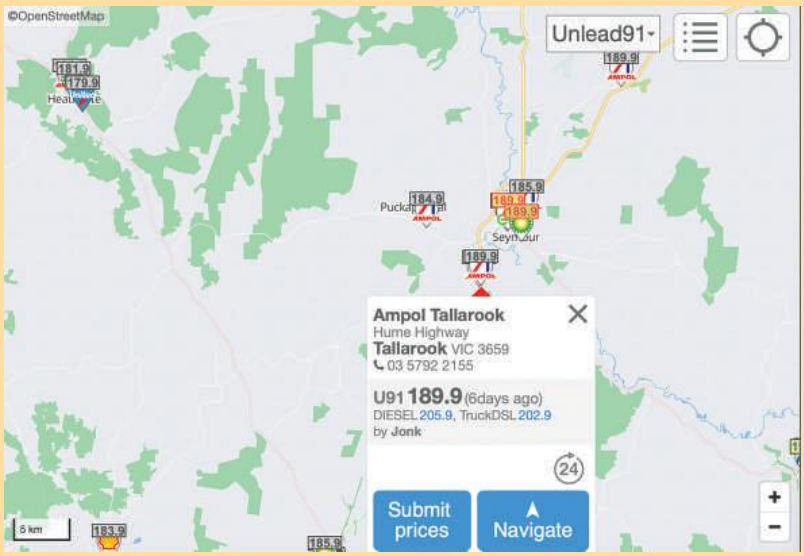
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Success criteria and review questions

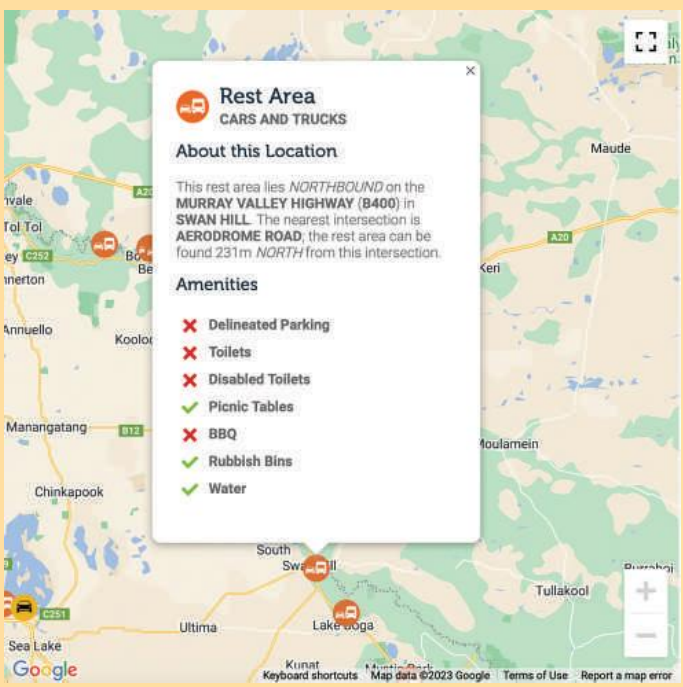
☐ I can identify whole numbers.

1 Find the whole numbers in the different scenarios.

a



b



Source: VicRoads website

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☐ I can write fractions and decimals.

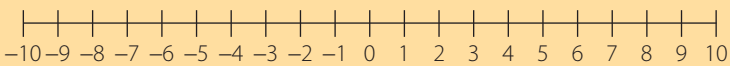
2 Write the following as fractions.

a one half
b one quarter
c one third
d one fifth
e three fifths
f two thirds

3 Write the following as decimals.

a one and a half
b five and three quarters
c six point seven five
d eight hundred and twenty-three point one four
e four tenths
f one and seventy-five hundredths

☐ I can identify integers.



4 Read the number line to identify the following numbers.

a 9
b –3
c +42
d –6
e 13

5 Place the following numbers on a number line.

a 4
b 0
c –7
d 13
e –8

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☐ I can write large numbers.

6 Write the following numbers as words.

a $23

b $63.99

c 289 765

d $367 899

e 567 654 232

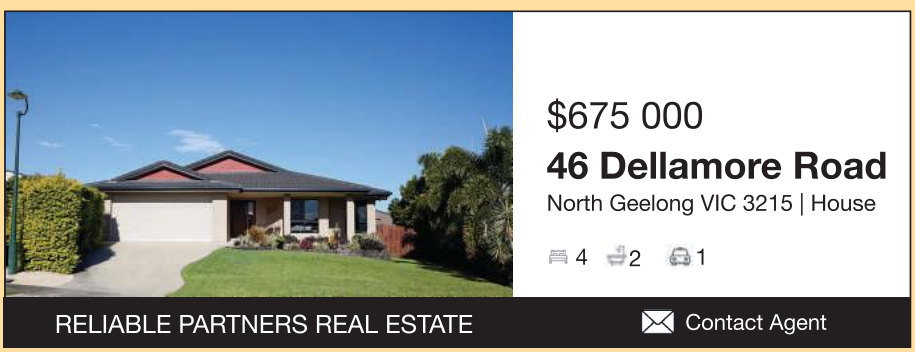
f 198 546 789

g $1 002 989

h



i



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☐ I can write fractions as decimals, and decimals as fractions.

7 Write these fractions as decimals.

a $\frac{1}{2}$ **b** $\frac{1}{3}$

c $\frac{3}{4}$ **d** $\frac{1}{5}$

e $\frac{4}{5}$ **f** $\frac{1}{10}$

8 Write these decimals as fractions.

a 0.25 **b** 0.5

c 0.75 **d** $0.\overline{6}$

e 0.2 **f** 0.4

g 0.6

☐ I can identify rates.

9 Write the following rates in words.

a potatoes at $4/kg

b km/hr

c m/s

d L/km

☐ I can perform mathematical operations on a calculator and on a spreadsheet.

10 Using a calculator, perform the following operations to find a solution.

a $5 + 4 \times 7$ **b** $9 \times (3 + 18)$

c $3^2 + 4$ **d** $\sqrt{16} + 9$

e 4^3 **f** $\sqrt{49} + 23 - 6 \times 3$

11 Using a spreadsheet, perform the following operations to find a solution.

a $(7 \times 9) + 2$

b $32 + 94 - 17$

c $8^2 + 3^2$

d $\sqrt{81} + (42 \times 3)$

e 2^5

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Key vocabulary

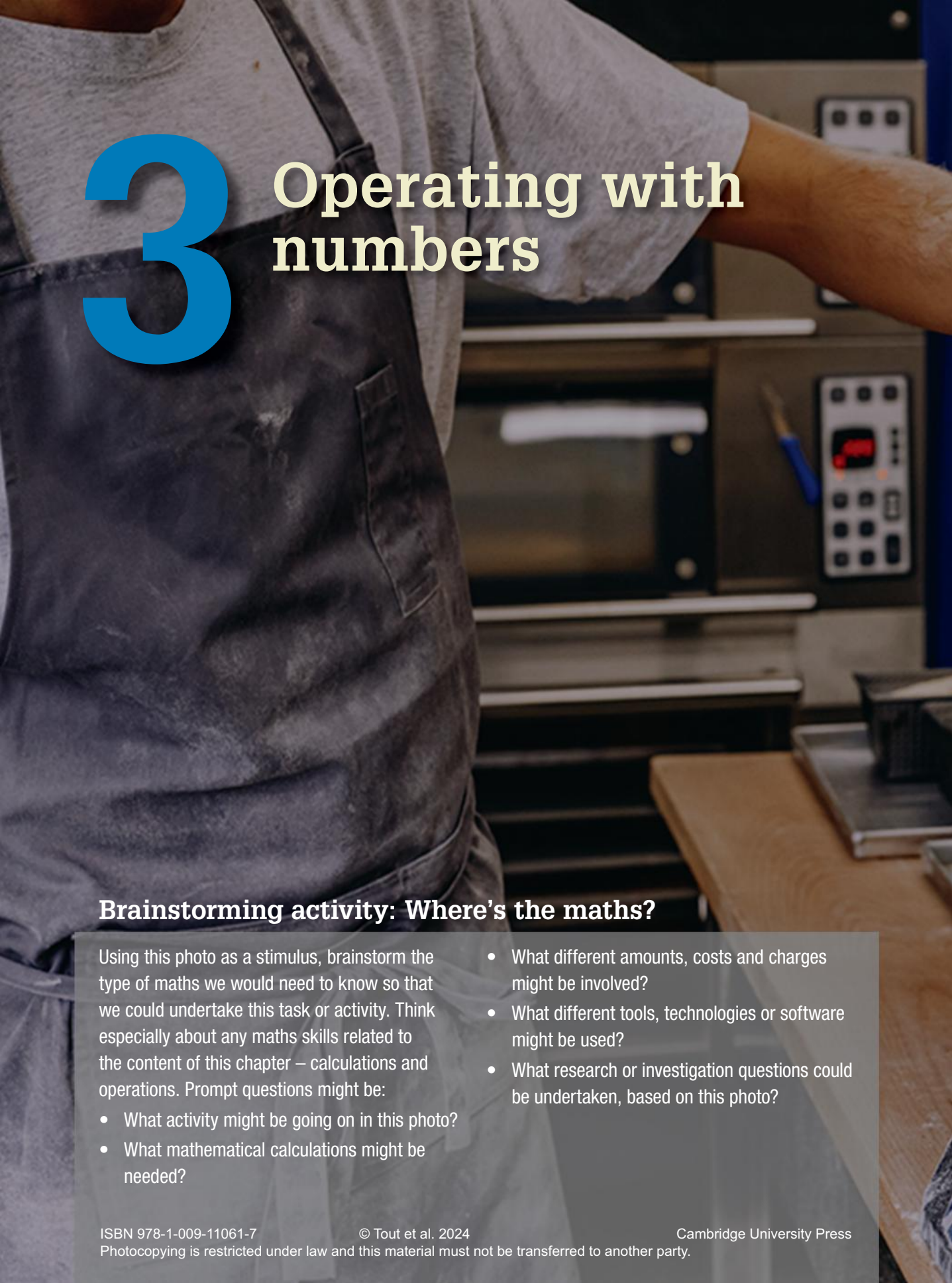
Here is a list of this chapter's key maths terms and their meanings.

Term	Meaning
Addition	Addition is finding the total or sum by combining two or more numbers.
Brackets	() [] or {} Brackets are used to keep parts of a sum together.
Cube	To cube a value means to multiply it *by itself three times*.
Decimal number	Decimal numbers are made up of a **whole number** part and a **fraction** part.
Decimal point	The **decimal point** separates the whole number part on its left from the fraction part on its right in a decimal number.
Denominator	The bottom number of a fraction which shows how many parts the whole has been broken up into.
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.
Division	Division is sharing or grouping a number into equal parts. It is the result of 'fair' or 'equal' sharing or grouping.
Fraction	Fractions are parts of a whole number and are the numbers that lie between whole numbers, e.g. $\frac{1}{2}, \frac{1}{4}, \frac{3}{4}$.
Integer	Integers are whole numbers and include positive and negative whole numbers and zero.
Inverse operation	The opposite operation that reverses or undoes an original operation. Multiplication and division are opposite (inverse) operations, as are addition and subtraction.
Multiplication	Multiplication means repeated addition of a number – to add groups of the same number together: e.g. $3 \times 5 = 5 + 5 + 5$.

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Term	Meaning
Negative number	Negative numbers are less than zero (0). The opposite numbers to positive whole numbers are called negative whole numbers.
Numerator	The top number in a fraction which shows how many of these parts you have.
Parentheses	see *Brackets*
Percentage	Percent or percentage 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 the number actually is. This is called place value, e.g. in 5712, the value of the 7 is seven hundred, but in 5.712, the value of the 7 is seven tenths.
Positive number	Positive numbers are greater than zero (0).
Rate	Rates involve the measurement of two different variables, and we use rates to compare quantities.
Square or squaring	To square a value means to multiply it *by itself*. *Square* means the same as *to the power of 2*.
Square root	The square root finds what number multiplied by itself equals a given value. The symbol is $\sqrt{\ }$.
Subtraction	Subtraction is taking one number away from another.
Whole number	Whole numbers are the counting numbers (1, 2, 3, etc.) including zero (0).

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3 Operating with numbers

Brainstorming activity: Where's the maths?

Using this photo as a stimulus, brainstorm the type of maths we would need to know so that we could undertake this task or activity. Think especially about any maths skills related to the content of this chapter – calculations and operations. Prompt questions might be:

- What activity might be going on in this photo?
- What mathematical calculations might be needed?
- What different amounts, costs and charges might be involved?
- What different tools, technologies or software might be used?
- What research or investigation questions could be undertaken, based on this photo?

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Chapter contents

Chapter overview and Spotlight

3A Starting activities
3B Tuning in
3C Is it reasonable?
3D Performing operations
3E How do you order that?
3F Rates, ratio and proportions
3G A higher power?
Investigations
Chapter review

From the Study Design

In this chapter, you will learn how to:

- make estimates and carry out relevant calculations using mental and by-hand methods
- use technology effectively for accurate, reliable and efficient calculations
- solve practical problems which require the use and application of a range of numerical computations involving integers, decimals, fractions, proportions, percentages, rates, powers and roots
- check for accuracy and reasonableness of calculations and results.

(Unit 1, Area of Study 1).

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Chapter overview

Introduction

Numbers appear everywhere in the world around us. Not only do we need to read and understand the numbers we meet, we need to undertake a wide range of calculations with them.

This chapter focuses on maths calculations and how we do them, and the importance of checking if the answers are correct or not. We will cover common maths operations and tasks applied to a range of numbers, including fractions, decimals and percentages, and numbers expressed as rates, ratios and more. This will include performing calculations manually and using different software tools and devices.

Learning intentions

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

- check the reasonableness of calculations by considering whether the solution 'feels right', as well as by estimating using rounding, truncation, or leading-digit approximation
- perform mathematical operations using a pen and paper, your head, or a calculator, selecting the most appropriate method for the problem at hand
- solve mathematical expressions in the correct order using the order of operations
- perform calculations involving rates, ratios and proportions
- raise numbers to powers, use powers of 10 to represent numbers, and understand percentage growth
- apply the problem-solving cycle to complete investigations related to the topics contained within this chapter.

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Spotlight: Jaqui Gilmour

An interview with a finance analyst

Tell us about the work you've done and what you do now.

I've worked as a finance analyst throughout my career. I've been quite lucky to work for some well-known, reputable companies. I've managed multi-million dollar budgets and supported developments on some big projects, all under the same umbrella of a finance analyst.

What maths do you use regularly in your job? Could you give some examples?

The biggest part of my role is using numbers, absolutely. The basic addition, subtraction, multiplication, division, and percentages. Basic algebra as well.

The nature of the work is that you're presented with a problem and they need your maths skills to do the number crunching to try to work out the best way forward. If it's something to do with producing a new product, they'll give you all the inputs that you need, like all of the different costs and how much you're going to sell. They need you to put it all together to work out whether it's something that's worth pursuing or if you need to charge more for it to make it profitable. It's up to you to work all that out for the companies.

What is the most useful tool or piece of technology that you use regularly in your job?

Microsoft Excel is generally the most common tool that I've used across every company that I've worked for. It's definitely my favourite. I can appreciate its power in what I can do from a maths perspective and translate that into solving real world problems.

Excel is not just for work. How often can someone say that the main tool they use at work is also the one they use at home in their personal life?

What is your attitude towards the maths you learnt in school?

To be honest, I think the maths that you learn at school is definitely the most abstract maths. School gave me the skills that I need to be able to have that way of thinking, of problem-solving and being analytical. So you take those skills and then you build on them in the workplace.

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3A Starting activities

Activity 1: Calculations in our lives

Calculations are part of our daily lives – at home, in the media, in the community and at work.

Use the following examples to analyse and discuss the different types of calculations we need to understand and apply.

Read the information contained in the three contexts below and answer the questions at the end of this section.

Nutritional information

All food products we buy come with a list of nutritional ingredients. Here are two examples for biscuits.

Brand A:
Cost: $3.20
Size: 190 grams
NUTRITION INFORMATION

Nutritional information

SERVINGS PER PACKAGE: 7.6 SERVING SIZE: 25 g

	QUANTITY PER SERVING	%DAILY INTAKE* (PER SERVING)	QUANTITY PER 100 g
ENERGY	518 kJ	5.9%	2,070 kJ
PROTEIN	2.0 g	3.9%	7.8 g
FAT, TOTAL	5.8 g	8.2%	23.1 g
–SATURATED	1.4 g	5.6%	5.4 g
CARBOHYDRATE	15.6 g	5.0%	62.3 g
– SUGARS	0.4 g	0.4 %	1.5 g
DIETARY FIBRE	0.8 g	2.7%	3.3 g
SODIUM	155 mg	6.7%	620 mg

*BASED ON AN AVERAGE ADULT DIET OF 8700 KJ.
ALL VALUES CONSIDERED AVERAGES UNLESS OTHERWISE INDICATED.

Brand B:
Cost: $1.95
Size: 125 grams
NUTRITION INFORMATION

Nutritional information

SERVINGS PER PACKAGE: 6.9 SERVING SIZE: 18 g (6 Biscuits)

	AVG. QUANTITY PER SERVING	%DAILY INTAKE* (PER SERVING)	AVG. QUANTITY PER 100 g
ENERGY	322 kJ	3.7%	1,790 kJ
PROTEIN	1.9 g	3.8%	10.5 g
FAT, TOTAL	1.3 g	1.9%	7.2 g
– SATURATED	0.6 g	2.5%	3.3 g
CARBOHYDRATE	13.5 g	4.4%	75.0 g
– SUGARS	0.0 g	0.0%	0.1 g
DIETARY FIBRE	0.7 g	2.3%	4.0 g
SODIUM	115 mg	5.0%	641 mg

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Fertiliser



Football

The world of sport is full of numerical information. The ladder positions and each team's points for one of the seasons in the AFLW competition is shown below.

Position	Club	Played	Points	%	Won	Lost	Drawn	Points scored for	Points scored against
1	**Adelaide Crows**	5	**20**	272	5	0	0	204	75
2	**Fremantle**	6	**20**	187.3	5	1	0	251	134
3	**Melbourne**	5	**16**	154.9	4	1	0	223	144
4	**Kangaroos**	5	**16**	152.1	4	1	0	181	119
5	**Brisbane Lions**	4	**12**	130.1	3	1	0	134	103
6	**Collingwood**	5	**12**	101.5	3	2	0	138	136

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Use the three contexts above to answer the following questions.

1 For each context, give examples of different mathematical operations and calculations you *could* undertake using the information. Use the list below to help you. You don't have to do the actual calculations because we will cover them later in the chapter.

Share your answers in a class discussion.

- Addition
- Subtraction
- Multiplication
- Division
- Fractions
- Percentages
- Rates or ratios
- Estimations or approximations



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Activity 2: Estimation

The following list shows the prices and quantity of items purchased from a supermarket.

1 Without using a calculator or pen and paper make an estimate of the total price of all the items. (Try to do this in less than 30 seconds.)

Item	Quantity	Price per item
Full cream milk 2L	1	$5.49
White bread loaf	1	$3.40
Fettuccine pasta 500g	2	$2.95
Passata pasta sauce 700g	2	$4.25
Kiwi fruit	4	$1.50
Punnet strawberries	3	$2.20
Continental cucumber	1	$1.85
Bag of carrots	1	$1.25
Olive oil 500ml	1	$9.59
Corn flakes cereal 725g	1	$5.80
Beef mince 500g	1	$9.20

2 Now use a calculator and add the prices to determine the exact total.

3 How close was your estimate to the exact total? Compare your estimate with your classmates. Discuss what method you used to estimate the total. Which method/s worked best to estimate the total as quickly as possible? Which method was the most accurate?



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3B Tuning in

Understanding operations and calculations and how to apply them is important. We always need to check that our answers are correct and logical. A common mistake is getting the decimal point in the wrong place – like we saw with the concrete mixer story in Chapter 1!

Here is another Epic Fail, where getting the decimal point wrong had critical consequences.

Epic Fail: Caffeine overdose



In 2017, a university in Scotland was fined £400 000 after two students suffered life-threatening effects when they were given 100 times too much caffeine in an experiment.

Two students were each given the equivalent of **300 cups of coffee**.

They were admitted to intensive care for dialysis after the calculation error led to violent side effects. The overdose could easily have been fatal.

The students had volunteered to take part in an experiment, aimed at measuring the effect of caffeine on exercise. While administering the powdered caffeine for the study, a staff researcher calculated the dosages on a mobile phone and missed a decimal point in the calculations. As a result, the volunteers ended up getting **30 grams** of the stimulant mixed into orange juice and water, rather than the intended **0.3 grams**. One cup of coffee typically has 0.1grams of caffeine.

Discussion questions

- What do you think about the consequences of making an error in the calculations?
- If you were running the experiment, what could you do to make sure your answer and the dosage were correct?
- Should the two volunteers have checked the calculations themselves or made sure the experimenter had a second person check them?

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Check and reflect on your answers to maths problems – don't just accept the answers to your calculations. Check that they make sense in the real world! Use your knowledge and experience.

You need to develop a 'feeling' for numbers and quantities: that 30 grams of a powder is way too much compared with just 0.3 grams!

Getting the decimal point in the right place



It is critical when calculating numbers to make sure the decimal point is in the right place in your answer. Check if the size of the answer is about right for the context.

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Practice questions

1 If you and a mate order two pizzas for $15.90 each, two bottles of soft drink for $3.35 each, and have the food delivered by Uber Eats for $3.70, your share of the cost would be approximately:

A $20

B $30

C $35

2 The recommended dose of paracetamol for a baby aged 6–12 months and weighing 8–10 kg is 1.2–1.5 mL. If your baby is in this age range and weighs 9 kg, what is the dose you should give?

3 Imagine you are using a map application and you see there are two routes to your destination. The first uses a tollway, which will cost you $16.80. The estimated duration of this journey is 1 hour each way. The second uses suburban streets, and the estimated duration of this journey is 95 minutes each way.

Which of these options you would choose? Why?

4 A Californian redwood tree grows on average 0.8 m per year, while an oak tree grows at an average rate of 2.5 m per year.

a About how many times is an oak faster to grow than a Californian redwood?

b Look both of these trees up on the internet. Which one would you plant, and why?



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3C Is it reasonable?

When doing calculations with a pen and paper or calculator, there are some important things to consider. Calculators (or you and your pen and paper) can give you the **wrong** answer, for example if you wrote the numbers down wrong or if you entered the number into the calculator incorrectly.

So, be sure to always check your answers. There are two things you can do to check them.

- Do a quick and rough calculation of what the answer should be – this is not an accurate answer, but just a check on your calculations. This is called **estimating**. Make the numbers into simpler numbers by **rounding off**.
- Think about whether your answer feels about right – that is, use your **common sense** to feel if the answer is about right or not. Is it **reasonable** or not?

Rounding off

Rounding off is very important, especially when reading answers off your calculator.

For example, sometimes an answer on your calculator gives too many digits. This can happen when using your calculator to do money or measurement calculations.

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 second decimal place (with money, this is to the nearest cent).
- The nearest 5 cents (as we do with money now that we don't have 1-cent or 2-cent coins).
- The nearest 100 or 1000 (this could be for rough calculations, especially with bigger numbers).

Round up or down?

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? So, for the number 26.4375, if we are rounding to the nearest whole number, are we closer to 26 or are we closer to the next whole number up, 27?

- If you are past halfway, you are closer to 27, so you **round up** to that next number (27).

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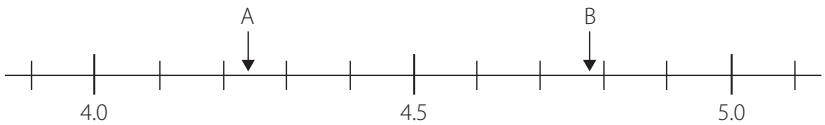
- If you are less than halfway and not closer to the next number, you **round down** to the existing number; here it is 26.
- If you are exactly halfway – for example, if you were at 26.5 – then round up to 27.

This can be shown by looking at a diagram of a ruler.

Here is part of a ruler showing numbers from 4.0 to 5.0, with:

- Marker A at 4.24.
- Marker B at 4.775.

What numbers are A and B when rounded to the nearest whole number?



By looking at the ruler, you can see that A is closer to 4 because it is not past halfway (since 4.5 is halfway).

- So, round 4.24 down to a whole 4.

Marker B is closer to 5 as it is past halfway.

- So, round 4.775 up to a whole 5.

Rounding rules

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

RULE 1: ROUNDING DOWN

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

RULE 2: ROUNDING UP

If the next digit after the rounding off number is a 5, 6, 7, 8 or 9, it means you are past halfway, so you **round up** to the next whole number.

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Example 1 Rounding off

a Round $12.45 to the nearest dollar.
b Round 23 754 km to the nearest 1000 km.

THINKING	WORKING
STEP 1	
Is $12.45 closer to $13 or $12? Is 45 cents closer to the next dollar up or not?	a 45 cents is less than halfway to the next dollar (50 cents would be halfway).
STEP 2	
We are closer to $12 than $13.	$12.45 rounded off to the closest dollar is $12. Note that we no longer show cents, so the answer is not $12.00.
STEP 1	
Is 23 754 closer to 23 000 or 24 000? Is 754 closer to the next 1000 up or not?	b 754 is more than halfway to the next 1000 (500 would be halfway).
STEP 2	
We are closer to 24 000 than 23 000.	23 754 km rounded off to the nearest 1000 km is 24 000 km.

Rounding to the nearest dollar

$125.**2**976 would be $125 to the nearest dollar because the next digit after the 5 dollars is a 2, so it **rounds down** and stays $125.

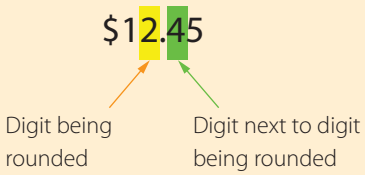
$34.**7**001 would become $35 because the next digit after the 4 dollars is a 7, so it **rounds up** and becomes $35.

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Example 2 Rounding to the nearest dollar

Round $12.45 to the nearest dollar

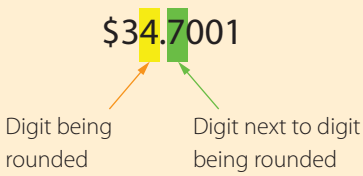
THINKING	WORKING
STEP 1	
Identify the digit being rounded, and note the digit next to it.	$12.45 Digit being rounded: 2. Digit next to digit being rounded: 4.
STEP 2	
If the digit next to the digit being rounded is <5, we round down. If the digit is ≥ 5, we round up.	4 < 5, so we round down.
STEP 3	
If we round down, the digit being rounded stays the same. If we round up, the digit being rounded increases by 1. We replace all digits to the right with zeroes.	$12.45 ≈ $12.00
STEP 4	
Given we are rounding to the nearest dollar, we no longer show cents.	$12



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Example 3 Rounding to the nearest dollar

Round $34.7001 to the nearest dollar

THINKING	WORKING
STEP 1	
Identify the digit being rounded, and note the digit next to it. 	$34.7001 Digit being rounded: 4. Digit next to the digit being rounded: 7
STEP 2	
If the digit next to the digit being rounded is <5, we round down. If the digit is ≥ 5, we round up.	7 ≥ 5, so we round up.
STEP 3	
If we round up, the digit being rounded increases by 1. We replace all digits to the right with zeroes.	$34.7001 ≈ $35.0000
STEP 4	
Given we are rounding to the nearest dollar, we no longer show cents.	$35

Rounding to the nearest cent

When rounding off to the nearest cent, follow the same rules as for dollars or for any number. Look at the original number on the calculator, but try to round it to the nearest cent.

26.4375

The number is $26.43**7**5, and we need to decide whether it rounds down to $26.43 or rounds up to the next cent, $26.44.

We need to look at the next digit after the 3 in the cents place – which is the **7**.

So, using the rules from above, if the next number after the cents figure is a 0,1, 2, 3 or 4, round down and leave the cents the same. But if the next number after the cents figure is a 5, 6, 7, 8 or 9, round up to the next cent because you are past halfway. Therefore, the answer will be **rounded up** to $26.44 because the next digit was a 7.

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There are two other related ways of rounding off that are explained below.

Example 4 Rounding to the nearest cent

Round $26.4375 to the nearest cent

THINKING	WORKING
STEP 1	
Identify the digit being rounded, and note the digit next to it.	Digit being rounded: 3 Digit next to digit being rounded: 7
$26.4375 Digit being rounded Digit next to digit being rounded	
STEP 2	
$7 \geq 5$, so we increase the digit being rounded (3) by 1, and replace all digits to its right with zeroes.	$24.4375 \approx $24.4400
STEP 3	
Given we are rounding to the nearest cent, we no longer show the place values after the cents.	$24.44

Truncation

Truncation is different to rounding off – we simply remove all the digits after the required level of accuracy, and leave the remaining digits alone.

Example 5 Truncation

Truncate 13.98752 to two decimal places.

THINKING	WORKING
STEP 1	
Remove all the digits after the second decimal place.	13.98~~752~~
STEP 2	
Write the truncated number.	The answer is 13.98

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Note how this differs from rounding.
Round 13.98752 to two decimal places.
Look at the digit in the decimal place directly following the desired level of accuracy. In this case, the digit in the thousandths place, the 7 (13.98**7**52) is more than halfway (more than 5), so we round up and get 13.99.

Leading-digit approximation or estimation

Leading-digit approximation is useful with very small decimal numbers less than 1 with leading 0s after the decimal point. The more leading decimal places with 0, the smaller the decimal value is.

The **leading digit** is the first place of the decimal that is represented by a digit other than zero. In the number 0.00074567, the leading digit is a 7.



Example 6 Leading-digit approximation

Use leading-digit approximation to round 0.000036789.

THINKING	WORKING
STEP 1	
The leading digit is the first non-zero digit.	0.000036789 Leading digit: 3
STEP 2	
Round to the place value of the leading digit by checking the digit to the right of the leading digit and following the rounding rules.	Digit next to digit being rounded: 6 $6 > 5$, so we round up. $0.000036789 \approx 0.00004$

Note that the 4 in the answer is in the fifth decimal place, so in words it is 'four hundred-thousandths'.

Not enough digits

Technology often may not give enough digits. For example, a calculator screen might show this answer for the number of dollars:

58.2

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In this case, the problem is easily solved, 58.2 needs to be changed into money by adding an extra 0 on the end. So, 58.2 means $58.20.

No more cents

Another type of rounding occurs when we pay cash for shopping. We need to round off our money to the nearest 5 cents.

Again, we sometimes round **up** to the next highest 5 cents, and sometimes we round **down** to the 5 cents below.

Amount ends in:	Round up or down?	Example
1 or 2 cents	Round **down** to the previous 0 cents.	$7.22 becomes $7.20
3 or 4 cents	Round **up** to the next 5 cents.	$7.23 becomes $7.25
6 or 7 cents	Round **down** to the previous 5 cents.	$7.26 becomes $7.25
8 or 9 cents	Round **up** to the next 10 cents.	$7.28 becomes $7.30

Special cases when rounding

Some sports protect their world records by requiring a challenger to actually break the record rather than the record being broken due to rounding up or down. The 2019 technical rules for track events in athletics, for example, require that *times* be rounded *up*.

Rules

For all races up to and including the 10 000 m, unless the time is an exact 0.01 second, the time shall be converted and recorded to the *next* longer 0.01 second, for example, 26:17.533 shall be recorded as 26:17.54.

For field events such as jumps, the *distance* is rounded *down*.

In all horizontal jumping events, distances shall be recorded to the nearest 0.01 m *below* the distance measured, if the distance measured is not a whole centimetre.

How do these rounding rules protect the world records?

Note how the times notation works, with a colon separating the minutes and seconds (min:sec) but with the seconds part then expressed as decimal parts of a second.

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Estimating

It is also a good idea, when doing calculations as part of a problem, to check your answers by **estimating**.

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 Estimation

Estimate the cost to buy both the Wireless Fast Charging Stand and the USB-C Wall Charger.



THINKING	WORKING
STEP 1	
Round the two prices to the nearest $10.	$47.90 ≈ $50 $74 ≈ $70
STEP 2	
Use these rounded values to estimate the value of $47.90 + $74.	$47.90 + $74 ≈ $50 + $70 $50 + $70 = $120 So an estimate of the cost of the goods is $120

Is it reasonable? Using your common sense

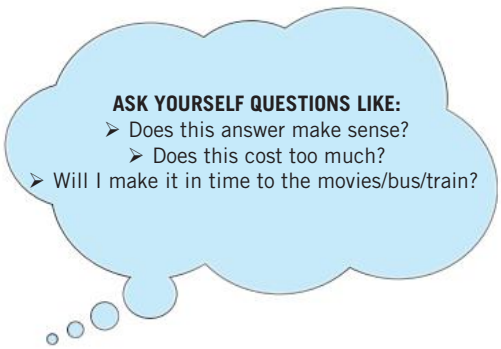
After estimating, think about whether the answer feels correct or not – that is, use common sense to check whether your answer is about right.

It is critical when working with numbers and doing calculations to get the calculations correct and make sure the decimal point is in the right place in your answer. Check if the size of the answer number is about right for the context.

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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 our calculations are probably correct.

But how do you do this?



3C Tasks and questions

Thinking tasks

In these thinking tasks, don't do the calculations but think about the size of the answer number and decide if it is about right or not. Does it feel like it is too big or too small? Use common sense and general knowledge to see if the answer feels correct or not.

1 You and two friends go to a pizza restaurant and buy garlic bread, two large pizzas, one large bottle of drink and a tiramisu each. When you pay, the restaurant charges you $6.45.



Is this about the right amount? Is it too high or too low? Why do you think this? Could the decimal point be in the wrong place? If so, what amount could the bill actually be?

2 A six-pack of drinks is advertised at $9.99.

The unit price is given on the price tag as being $2.67 per can.

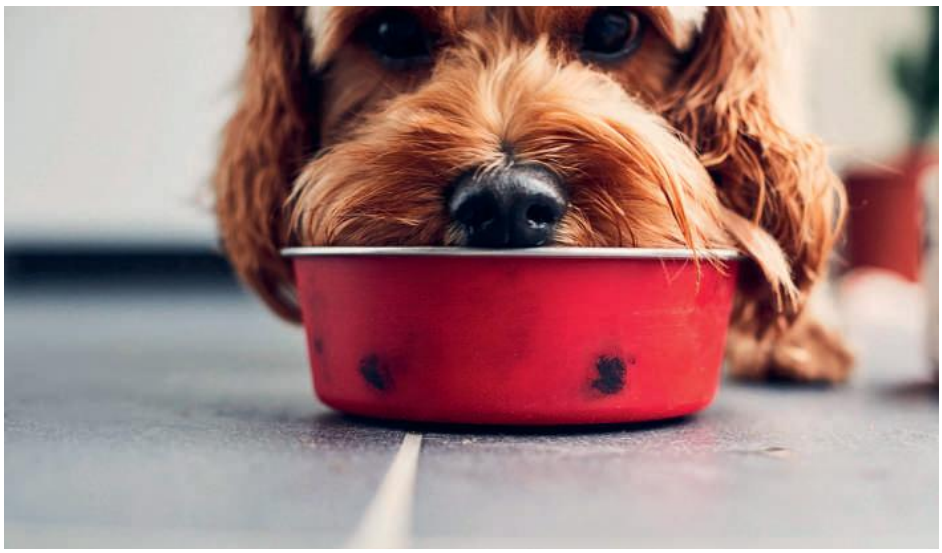
Is this about right? Is it too high or too low? Why do you think this?

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3 A dog should be fed a daily amount of food equal to about 3% of its body weight. Brendan's dog weighs 20 kilograms.

Brendan decides to give his dog 500 grams of food each day.

Is this about right? Is it too high or too low? Why might Brendan do this?



4 Amalia helps with the sausage sizzle that her club runs at a local hardware store on Saturday. The profit margin on each sausage they sell is $1.90. She estimates they will sell about 300–350 sausages, so the overall return should be about $600 for the day.

Is this about right? Is it too high or too low? What estimation did you use?

5 Describe how you estimate your travelling time to and from school each day.

How accurate does your estimate need to be? Would it be better to underestimate or overestimate the travelling time?

Skills questions

6 Round off these amounts of money to the nearest dollar.

a $12.17 **b** $128.86 **c** $223.4587

d $77.21234 **e** $784.76543 **f** $2343.19999

7 Round off these amounts of money to the nearest cent.

a $56.173 **b** $128.862134 **c** $221.458711

d $7.212345 **e** $874.76543 **f** $1333.19999

8 Truncate the following numbers to the number of decimal places shown in the bracket.

a 34.567 (2dp) **b** 123.2467 (1dp) **c** 0.03456 (3dp)

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9 Round the following numbers to the number of decimal places shown in the bracket.

a 0.00003456 (5dp) **b** 0.000284 (4dp) **c** 0.00000543 (7dp)

10 Round off these amounts of money to the nearest 5 cents.

a $4.12 **b** $9.86 **c** $35.48

d $43.21 **e** $234.74 **f** $333.19

11 Using these products, work out the following estimates.



a What is a rough answer for how much it would cost to buy the USB-C Wall Charger and the 3-in-1 Wireless Charging Dock?

b What is a rough answer for the difference in price between the Wireless Fast Charging Stand and the 3-in-1 Wireless Charging Dock?

Mathematical literacy

12 Imagine you are teaching primary school children the following skills. Explain in your own words the process for completing each skill.

a Rounding off to the nearest dollar

b Truncating



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Application tasks

13 When reporting annual personal income (income made in a year), the ATO website requires income to be rounded to the nearest dollar.

Round each of the incomes listed below to the nearest dollar.

Employee	Personal Income	Rounded Income
JD	$23 654.98	
MB	$78 345.23	
FT	$102 456.38	
RC	$99 456.54	

14 The atomic weight of elements to be used in some experiments are given in the table below.

Round each value to 1 decimal place.

Element	Atomic Weight	Rounded Value
Aluminium	26.981538	
Bromine	79.904	
Chlorine	35.453	
Oxygen	15.9994	
Potassium	39.0983	
Silicon	28.0855	
Zinc	65.39	



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3D Performing operations

People do their calculations in different ways, such as the following.

- Using a pen and paper.
- Doing them in our head.
- Using technology such as a calculator or an app.

It depends on where we are, how complicated the calculation is, and what resources we have at hand. For this section, use technology to work out the answers.

Using pen and paper

There are lots of different ways to calculate using a pen and paper. Do your calculations your way – whatever works best for you. If you need help with pen and paper calculations and want to know how to do them, ask your teacher for help. They can explain it or suggest other ways to help you.

In your head

Some people can do calculations quickly and easily in their heads – they have a 'feel' for numbers. There are lots of different short cuts to do this. It is used for adding and taking away rather than for multiplying and dividing, and it all depends on the size of the numbers. If you can do this, good, but if not, don't worry – most people use technology.

Using technology

A calculator is a great tool to use – it helps to do calculations quickly and accurately. The main problem with using a calculator is using it properly and checking your answers. Other software or apps can also be used for calculations. If there are many calculations to undertake with different sets of data, using a spreadsheet application is very useful.

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Using calculators

A typical smartphone in portrait view shows familiar basic keys.

Operation	Button	Meaning
Add	+	Adds the next number you enter.
Subtract or take away	–	Subtracts the next number you enter.
Multiply	×	Multiplies by the next number you enter.
Divide	÷ or /	Divides by the next number you enter.
Equals	=	Shows the answer to the calculation.
Clear last entry	C or CE	Allows you to change the last number you entered.
Clear (all)	AC	Clears all values and allows you to start a new calculation.
Change sign	+/–	Changes the value on the screen from positive to negative and vice versa.
Percent	%	Works out a percentage value.
Decimal point	.	The point that separates the whole number part from the decimal part of a value.

The phone becomes a scientific calculator when it is rotated sideways into landscape view. The extra functionality is not required most of the time.

If brackets () are needed in a calculation, they can be found on the scientific calculator keys, not the basic keys.



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Addition and subtraction

Check that your device gives the same answers as these examples.

Chris worked 4 hours on Monday, 2.5 hours on Tuesday and 5 hours on Thursday. How many hours did she work altogether?
$4 + 2.5 + 5 = 11.5$

Jack worked the same hours as Chris, except he went home 1.5 hours early on Thursday because he was unwell. How many hours did Jack work?
$4 + 2.5 + 5 - 1.5 = 10$ or we could simply calculate $11.5 - 1.5 = 10$.

Multiplication and division

Check that your device gives the same answers as these examples.

Chris worked 9.5 hours in one week. She was paid $26.40 per hour.
What was the total pay for the week?
$9.5 \times 26.4 = \$250.80$
How could estimation be used to know that the answer had to be about $250?

Jack earned $204 for 8.5 hours of work one week.
What was his hourly rate of pay?
$204 \div 8.5 = \$24.00$

Fractions and percentages

Many mathematical situations are best described by fractions or percentages. Whole numbers cannot always tell the whole story.

Fractions

Working out fractions of costs and quantities is often the same as dividing (and sometimes involves multiplying too).

For example, working out one-third of something is the same as dividing it into three equal parts. So $\frac{1}{3}$ of something means divide by 3. And $\frac{1}{4}$ of something means divide by 4.

Working out $\frac{3}{4}$ of something means divide by 4 first to calculate the $\frac{1}{4}$, and then multiply that amount by 3, as you have $\frac{3}{4}$.

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Example 8 Determining fractions of quantities

a Determine $\frac{1}{3}$ of 12.

b Determine $\frac{3}{4}$ of 12.

THINKING	WORKING
STEP 1 Divide 12 by the fraction's denominator (3), and multiply by the numerator (1).	**a** Determine $\frac{1}{3}$ of 12. $\frac{1}{3}$ of $12 = 12 \div 3 \times 1$
STEP 2 Working from left to right, complete the calculations.	$12 \div 3 \times 1 = 4$
STEP 3 State the final results.	$\frac{1}{3}$ of 12 is 4.
STEP 1 Divide 12 by the fraction's denominator (4), and multiply by the numerator (3).	**b** Determine $\frac{3}{4}$ of 12. $\frac{3}{4}$ of $12 = 12 \div 4 \times 3$
STEP 2 Working from left to right, complete the calculations.	$12 \div 4 \times 3 = 3 \times 3$ $= 9$
STEP 3 State the final results.	$\frac{3}{4}$ of 12 is 9.

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Example 9 Determining fractions of quantities in real-world scenarios

Chris worked for an extra $\frac{3}{4}$ of an hour at the hourly rate of $26.40. How much extra did she earn?

THINKING	WORKING
STEP 1	
Rewrite the problem as a mathematical sentence.	Chris earned $\frac{3}{4}$ of $26.40
STEP 2	
Divide $26.40 by the denominator, and multiply by the numerator.	$\frac{3}{4}$ of $26.40 = $26.40 ÷ 4 × 3
STEP 3	
Working from left to right, complete the calculations.	$26.40 ÷ 4 × 3 = $19.80

Percentages

Working out percentages is easy enough with values like 50% or 10% because they are simple fractions of the whole 100%. So, 50% is one-half, and 10% is one-tenth. It is worth learning the following equivalents as they occur regularly in retail and business settings. The decimal equivalent is also provided to make the relationships clearer.

Percentage	Fraction	In words	Decimal
100%	1	the whole	1.00
50%	$\frac{1}{2}$	one-half	0.50
25%	$\frac{1}{4}$	one-quarter	0.25
20%	$\frac{1}{5}$	one-fifth	0.20
10%	$\frac{1}{10}$	one-tenth	0.10

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Percentages on your calculator

The percentage button on a calculator makes percentage calculations easy when using more difficult percent values, such as 24.24%. Check that your device gives the same answers as these examples. (Note: not all calculators work the same way with percentages.)

Chris earns $26.40 per hour. Kai is younger so earns 80% of Chris's rate. What is Kai's hourly rate?
Using the % button: 80% × 26.4 = $21.12 or 26.4 × 80% = $21.12.
Kai's hourly rate is $21.12.



Example 10 Determining percentages of numbers

A kettle is on sale for 25% off. If the original price was $69, determine the discounted price.

THINKING	WORKING
STEP 1	
Rewrite the problem as a mathematical sentence.	Decrease $69 by 25%
STEP 2	
Recall that the equivalent fraction of 25% is $\frac{1}{4}$.	25% of $69 = $\frac{1}{4}$ of $69
STEP 3	
Divide the quantity by the denominator to determine the discount.	$69 ÷ 4 = $17.25
STEP 4	
Subtract the discount from the original price of $69	$69.00 – $17.25 = $51.75

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Working out fractional amounts as percentages

Sometimes we know the original value of something, and we also know its final value. We can calculate the percentage change in the two values.



Example 11 Calculating percentage change

A shirt was originally priced at $30. At a sale, Wendy saves $12 on the shirt and pays only $18. What percentage discount did Wendy receive?

THINKING	WORKING
STEP 1	
Rewrite the problem as a mathematical sentence.	What percentage is $12 of $30?
STEP 2	
Determine what $12 is as a fraction of $30.	$\frac{\$12}{\$30} = \frac{2}{5} = 0.4$ or $\frac{\$12}{\$30} = \$12 \div \$30 = 0.4$
STEP 3	
Convert to the equivalent percentage by multiplying by 100%.	$0.4 \times 100\% = 40\%$ Wendy received a percentage discount of 40%

Using software such as spreadsheets

Here are the common operations and their symbols that are used in spreadsheets.

Mathematical operation	Spreadsheet symbol or term	Excel formula	Excel displays
Addition	+ (plus sign)	= 3 + 3	6
Subtraction	– (minus sign)	= 3 – 1	2
Multiplication	* (asterisk)	= 3*5	15
Division	/ (forward slash)	= 6/3	2
Square	^2	= 5^2	25
Square root	Sqrt	= SQRT(25)	5
Powers or Exponents	^	= 4^3	64
Brackets	()	= (2 + 4)/3	2

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Example 12 Increase and decrease by the same percentage

A footballer weighed 100 kg. After a season in the gym, they put on 10%. At the end of the season, they took off 10%. What was their final weight?

THINKING	WORKING
STEP 1	
Starting weight = 100 kg, then put on 10%.	Press 100 + 100 × 10% = 110 kg.
STEP 2	
The footballer loses 10% of that 110 kg weight.	Press 110 – 110 × 10% = 99 kg final weight.
The overall effect is a loss of 1 kg, which is 1% less than the starting value.	



Effect of repeated percentage change

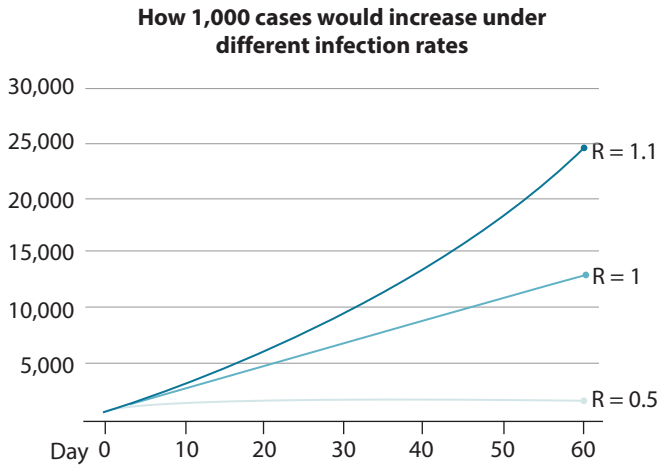
The effect of repeated percentage change is very rapid growth in the value being measured. This is referred to as **exponential** growth.

This branch of mathematics is used wherever a **percentage rate of change** is present, such as the following.

- In banking and finance – to calculate compound interest and mortgage costs.
- In pandemic modelling – where the ***R*-value** simulates the spread of a virus.

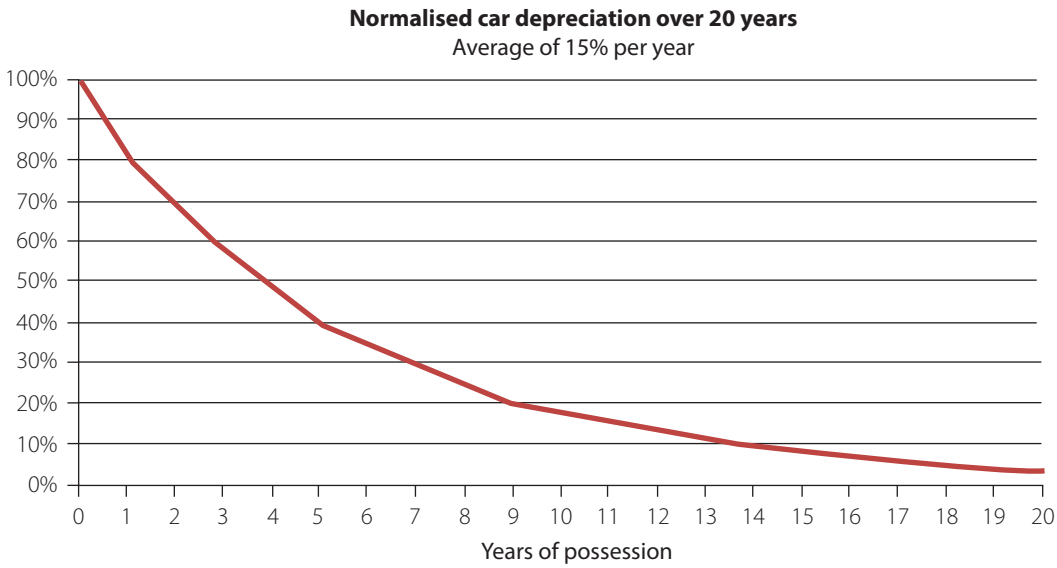
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How 1000 cases would increase under different infection rates.

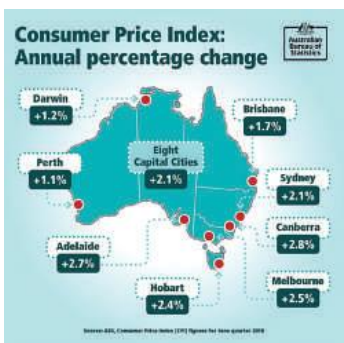


If the R*-value is above 1, then the number of cumulative cases increases rapidly, but if it is below 1, then eventually the outbreak stops. The further* R *is below 1, the faster that happens; it is referred to as* bending the curve.

- In accounting – to calculate the depreciation in value of physical assets. As a car gets older, its value **decreases**.



- In economics – to predict the effect of inflation on the cost of living (CPI is the Consumer Price Index).



Source: ABS

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3D Tasks and questions

Thinking task

1 Calculating 10% of a quantity is the same as finding $\frac{1}{10}$ of that quantity, or simply dividing the quantity by 10. The quickest way is to move the decimal point to the left.

For example, 10% of \$12.50 is \$1.25.

What could be a quick way of calculating 20% or 5% of a quantity?

Skills questions

2 Perform the following calculations using pen and paper, then check the answers using technology.

a Jarvin bought three items at the shop with prices \$4.20, \$2.60, and \$11.50. How much did he pay altogether for the items?

b Jarvin realises that he only has \$10 and needs to leave the \$11.50 item behind. How much did he pay for the other two items?

3 A hardware store performs a stocktake of the lengths of timber they have on the shelves. The results of the stocktake are shown below.

Shelf	Timber Length (m)	Quantity	Total Length (m)
1	12.5	24	
2	15	13	
3	18.5	8	

Use a calculator to calculate the total length of timber on each shelf.

4 In another section of the hardware, a large length of timber which is 16 m long needs to be cut into three equal lengths. Use a calculator to determine the length of each piece.

5 A cross country track is 2.5 km long. The Year 4 students run $\frac{3}{4}$ of the track. How far do they run?

6 Jacqui purchased an apartment for \$637 000 and must pay a 15% deposit. How much money was the deposit?

Mathematical literacy

7 '*Centum*' is Latin for 'hundred'. Explain mathematically what the word **percent** means.

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Application tasks

8 Melbourne scrap metal prices

Javed makes some pocket money by collecting and selling scrap metal. He sets up a spreadsheet to keep track of his earnings.

Here are the average scrap metal prices in Melbourne. Use your calculator to check that the value in cell D7 is correct. Javed's spreadsheet formula for D7 is =B7*C7.

	A	B	C	D
1	**Metal**	**Price paid ($ per kg)**	**Amount (kg)**	**$value**
2	Copper 1 (Clean)	6.45		
3	Copper 2 (Mixed)	5.91		
4	Insulated Wire 2 (PVC)	2.30		
5	Aluminium Extruded	1.35		
6	Aluminium Domestic	0.98		
7	Aluminium Cans	0.85	10.2	$ 8.67
8	Clean Brass	4.45		
9	Stainless Steel	1.12		
10	Lead	1.52		
11	Car Battery	5.51		

Set up an Excel spreadsheet like this, and experiment with different values in column C.

Find out what the current prices are on the day you do this exercise. How would the changes in price affect Javed's income?

9 Investigate other cases of a percentage increase followed by the same percentage decrease, such as: + 20% and – 20%, then + 30% and – 30% etc. What do you notice?

Increase by a fixed amount vs increase by a percentage amount

10 Imagine that 5000 people have an infection. We can examine what happens when the number of cases increases by a **fixed growth of 10% per day**, compared to a **percentage growth of 10% per day**.

a Record in a table the values for the first five days of 10% fixed growth (done in your head or on a calculator as + 500, five times).

b Use your calculator to record values for the first five days of 10% percentage growth (done on a calculator as + 10%, five times).

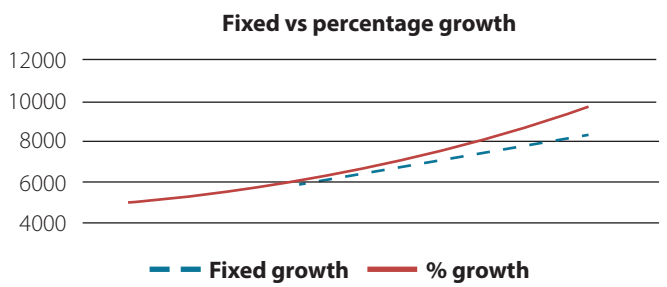
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Time (days)	Fixed growth per day	Percentage growth per day
Start	5000	5000
1	5500	5500
2		
3		
4		
5		

A spreadsheet is more efficient when longer timeframes or larger numbers are involved.

	A	B	C	D
1	Fixed growth vs percentage groeth			
2		Starting number of cases	5000	
3		Fixed growth	500	per day
4		Percentage growth	10%	% per day
5	Time (days)	Fixed growth	% growth	
6	0	5000	5000	
7	1	5500	5500	
8	2	6000	6050	
9	3	6500	6655	
10	4	7000	7321	
11	5	7500	8053	
12	6	8000	8858	
13	7	8500	9744	

From Day 2 onwards, the percentage growth values increase faster than the fixed growth values. When graphed, the difference is clear – the fixed amount graph is a linear shape, but the percentage growth graph is an increasing non-linear curve.



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3E How do you order that?

When we add, subtract, multiply and divide, it is important to follow a particular **order** when we work out the answer, particularly when the addition, subtraction, multiplication and division are all mixed up together in a line of calculations or in a formula.

This section explains why the order is necessary and provides examples to practice on.

This order of operations may be known from school as the BODMAS rule. We will explore this rule in a later section. By using familiar situations, however, rules can be developed easily and the reasons understood so that these rules aren't required when doing calculations in real-world contexts.

ACTIVITY: HOW COME CALCULATORS CAN GET CALCULATIONS WRONG?

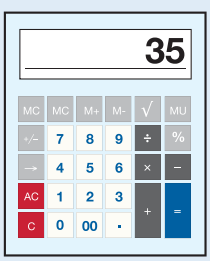
Each student in the class needs to access a calculator. There needs to be different calculators used across the group, including:

- Hand-held calculators of different brands and types (basic and scientific).
- Calculators on laptops, tablets and iPads.
- Calculators on mobile phones – both Android and iPhone.

Everyone should independently enter the following calculation into their calculator:

$$3 + 4 \times 5$$

There will be a range of different answers. Some examples are shown below.

An answer of 35	An answer of 23
	

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Discussion questions

- Discuss the situation – how has this happened and why?
- Can anyone in the class explain why some calculators 'know' there is an order of operations and some do not?
- Discuss BODMAS and everyone's understanding and memory of it.

Everyday calculations and the order of operations

In everyday situations, we can explore the order of operations and why they are important.

Here is part of a menu from a local take-away food shop.

Hot food		**Drinks**	
Hamburger with the lot:	$9	Can of Coke, Fanta, etc:	$3
Steak sandwich:	$10	Milkshakes:	$5
Fish and chips:	$10	Coffee:	$4
Bucket of chips	$5	Tea:	$3
Toasted sandwich:	$7	**Cakes**	
Fresh sandwich:	$6	Muffins:	$4
Wraps:	$7	Carrot cake:	$4
		Donuts:	$2

ACTIVITY: INTRODUCTION TO BODMAS

Work out the answers to each of the following. **Do not use your calculators**. Work in small groups to agree on your answers – do the sums in your head or using pen and paper. Think about the following issues as you work through each question.

- What maths operations did you need to use (+ or – or × or ÷)?
- Can you write down the operations and your answers?
- Are there different ways to work it out? Share your different ways.
- In what order did you need to do the operations? Did you need to use brackets like () or not? Are the brackets necessary? Why?

Part A – In your head and using pen and paper

1 Five of you visit the take-away food shop for some drinks and food. You buy one soft drink and four milkshakes. How much did this cost altogether?

... continued

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2 You have lunch with two friends at the fast food shop. You order three hamburgers with the lot, two buckets of chips to share and three cans of drink. How much did this cost altogether?
3 Three of you go out for lunch and each order a toasted sandwich and a can of drink. How much did it cost altogether?
4 What is the difference in price between ordering two hamburgers and a bucket of chips and ordering two serves of fish & chips?

Part B – Group discussion and introduction to BODMAS – Order of operations

As an introduction to the order of operations – BODMAS – work through the above problems and discuss how the order of operations is simply the rules we apply for operations. Discuss the fact that the order follows the logic of how we solve these problems in the real world.
Here are the key points from the set of questions above.

Key Points

1 The calculation is **$3 + 4 × $5 = 3 + 20 = 23** which is $23.
- This calculation is similar to the problem above, where different calculators got two different answers to a simple sum (23 and 35).
- The rule here is that you need to **multiply before you add.**
- If you are using a calculator that does **not** know the order of operations, you need to use brackets (if it has brackets) or use the memory button. Make sure you know how to use your favourite calculator correctly for such situations.

2 The calculation is **3 × 9 + 2 × 5 + 3 × 3 = 27 + 10 + 9 = 46** which is $46.
- The rule is to **multiply before you add.**

3 The calculation is **3 × (7 + 3) = 3 × 10 = 30** which is $30.
- The rule is to use **brackets** to do the addition first before you multiply. So **brackets** become the priority.
- If not, you would do the multiplication first and get **3 × 7 + 3 = 21 + 3 = 24**.

4 The calculation is **2 × 9 + 5 – 2 × 10 = 18 + 5 – 20 = 3** which is $3.
- The rule is to do the multiplications before the addition and the subtraction in this case.
- It does not matter if you do the addition or the subtraction first – you get the same answer either way, but it is usually simpler to work from left to right. **18 + 5 – 20 = 23 – 20 = 3.**
- So, we do multiplication before we do any addition or subtraction.

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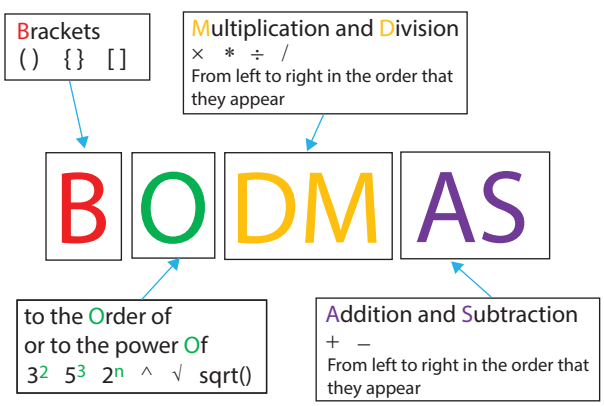
Part C: Using your calculator

Work through the above calculations on your calculator. Think about the following:

- Did the calculator get the correct answer?
- If your calculator did not get the correct answer, discuss why not?
- Can you work out how you could do it on the calculator?
- Does your calculator have brackets that you can use or not? How else can you do it on your calculator without using brackets?

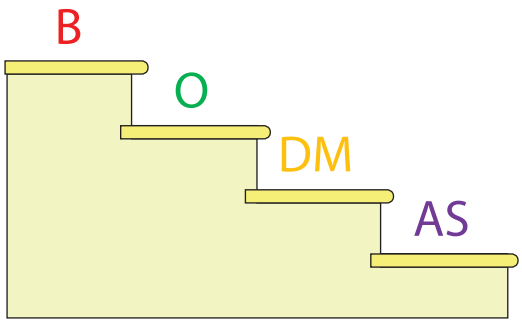
BODMAS

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. 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.



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Another way to think about the letters of BODMAS is to imagine them coming down a staircase, with Brackets on the top stair. This image can help us remember the rule better and remind us that multiplication and division are on the same level, as are addition and subtraction.



Example 13 Applying BODMAS to expressions

Evaluate the following: $3\times5-4\div2+2\times5\times3-7$

THINKING	WORKING
STEP 1	
There are no brackets or indices, so multiplication and division are evaluated first. Working from left to right, evaluate all the multiplications and divisions.	$3\times5-4\div2+2\times5\times3-7$ $3\times5=15$ $4\div2=2$ $2\times5\times3=30$ $3\times5-4\div2+2\times5\times3-7$ So $15-2+30-7$
STEP 2	
Addition and subtraction are evaluated next.	$15-2+30-7=36$

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Example 14 Applying BODMAS to expressions containing brackets and orders

Evaluate the following: $7^3 - 6 \div 2 \times 4 + \sqrt{25} - 8 \times (7 + 3)$

THINKING	WORKING
STEP 1	
First evaluate the brackets.	$7^3 - 6 \div 2 \times 4 + \sqrt{25} - 8 \times (7 + 3)$ $7 + 3 = 10$ So: $7^3 - 6 \div 2 \times 4 + \sqrt{25} - 8 \times (7 + 3)$ $= 7^3 - 6 \div 2 \times 4 + \sqrt{25} - 8 \times 10$
STEP 2	
Next evaluate orders.	$7^3 - 6 \div 2 \times 4 + \sqrt{25} - 8 \times 10$ $7^3 = 7 \times 7 \times 7 = 343$ $\sqrt{25} = 5$ So: $7^3 - 6 \div 2 \times 4 + \sqrt{25} - 8 \times 10$ $= 343 - 6 \div 2 \times 4 + 5 - 8 \times 10$
STEP 3	
Next evaluate division and multiplication, working from left to right.	$343 - 6 \div 2 \times 4 + 5 - 8 \times 10$ $6 \div 2 = 3$ $3 \times 4 = 12$ $8 \times 10 = 80$ So: $343 - 6 \div 2 \times 4 + 5 - 8 \times 10$ $= 343 - 12 + 5 - 80$
STEP 4	
Finally, evaluate addition and subtraction, working from left to right.	$343 - 12 + 5 - 80$ $343 - 12 = 331$ $331 + 5 = 336$ $336 - 80 = 256$ The answer is 256.

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Other ways of remembering

Other parts of Australia and the world use different acronyms. Americans uses PEMDAS (Please excuse my dear Aunt Sally). The P stands for *parentheses* (another word for brackets) and the E stands for *exponents* (another word for 'to the order of' or 'to the power of'). Western Australia refers to BIMDAS, where the I stands for *indices* (another word for 'to the order of'). Notice that, as with Americans, the West Australians have mulitplication and division 'flipped' (so that it is easier to say). This just reinforces that the M and D are on the same level because there is only one correct answer, and that answer is the same in both Western Australia and Victoria.

3E Tasks and questions

Thinking task

1 You are not sure whether your calculator follows the rules for the order of operations. Explain how you could ensure that the following calculation is performed correctly on the calculator?

$$\mathbf{20 + 34 \times 16}$$

Skills questions

2 Solve each of these calculations by hand using BODMAS.

a $24 \div 6 \times 2$

b $12 - 3 \times 4 + 5$

c $(12 - 3) \times 4 + 4$

d $72 - 8 \times 3 \div (11 - 5)$

e $40 - 6^2 \div (2 + 2)$

3 Calculate each pair of calculations, and state whether using the brackets makes a difference to the answer.

a $10 \times 5 + 3$ and $10 \times (5 + 3)$

b $7 - 3 \times 2$ and $(7 - 3) \times 2$

c $15 \div (3 + 2)$ and $15 \div 3 + 2$

d $26 - 15 \div 3 + 2$ and $26 - 15 \div (3 + 2)$

e $(5^2 - 2) + 4$ and $5^2 - 2 + 4$

f $5^2 - (2 + 4)$ and $5^2 - 2 + 4$

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Mathematical literacy

4 How can including brackets affect the result of a calculation? Provide an example.

Application task

5 Look back at the menu from the fast food shop. It has three sub-menus for Hot food, Drinks and Cakes, with several options listed for each sub-menu. Using this as a model, choose a shopping activity from real life that has several cost points and options. Then write up the activity and pose a few questions that involve multiple calculations. Share the activity with your classmates and discuss your answers.

Possible activities:

- Shopping for clothing (tops, jeans, footwear …) and compare prices at different stores.
- Planning a night out to watch a band (travel options, admission, food and drinks …).
- Planning a holiday (travel, accommodation, meals, activities …).



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3F Rates, ratio and proportions

Rates, **ratios** and **proportions** are related concepts that are used in everyday life and in industry.

When you fill a car with petrol, which is measured in litres (L), the tank fills up over a few minutes – the **rate** is in litres per minute (L/min). A car travels a distance which is measured in kilometres over time, which is measured in hours – the rate or speed is in km/h.

For example,

For concrete for paths and driveways, the ratio is 1 part cement with 2 parts sand and 3 parts aggregate. This is written as a ratio of 1:2:3. The consequences of mixing concrete or hair dye in the wrong proportions can be disastrous.



Proportions are important in cases such as cooking when you need to adapt a recipe for more (or fewer) people than the recipe says.

Ratios involve sharing parts in specified proportions which add together to make a whole.

For example, cordial may be measured in a ratio of 1 part cordial to 4 parts water.

Ratios are written with a **colon** in between to show the two parts.

A ratio of 1 part to 2 is written as 1 : 2.

To find the total of the parts, add both sides of the ratio expression together.

1 : 2 has 3 parts in total (1 + 2 = 3).

4 : 5 would have 9 parts in total (4 + 5 = 9).

Ratios indicate the proportions of what is being mixed but do not tell you the amounts. The amounts need to be calculated mathematically.

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Example 15 Ratio and proportion

A batch of cordial is to be made in a one-litre jug in the ratio 1 : 4 for cordial : water.
How much cordial and how much water are needed?



THINKING	WORKING
STEP 1	
The ratio is 1 : 4.	So there are 1 + 4 = 5 parts in total.
STEP 2	
The jug holds one litre, which is 1000 mL.	1000 mL ÷ 5 parts. This means each part is 200 mL.
STEP 3	
Calculate the amounts or proportions of cordial and water.	cordial : water 1 : 4 1 × 200 mL : 4 × 200 mL 200mL : 800mL

To make the cordial in a one-litre jug, mix 200 mL of cordial with 800 mL of water.

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Ratios may also be written as fractions.

For a ratio of 1 : 3, we can look at each part and express it as a fraction of the whole.

1 : 3 has 4 parts in total.

$\frac{1}{4} : \frac{3}{4}$ can be written as fractions.

$\frac{1}{4}$ is said as *one part in four.*

$\frac{3}{4}$ is said as *three parts in four.*

Example 16 Writing ratios as fractions

Write the ratio of 1 : 3 using fractions.

THINKING	WORKING
STEP 1	
Determine the number of parts by adding each side of the ratio together.	$1 + 3 = 4$
STEP 2	
Look at each side of the ratio and express it as a fraction of the total number of parts.	$1:3 = \frac{1}{4} : \frac{3}{4}$
$\frac{1}{4}$ is said as *one part in four*.	
$\frac{3}{4}$ is said as *three part in four*	

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Example 17 Scaling up a recipe in proportion

THAI GREEN CHICKEN CURRY

Ingredients

225 g potatoes, cut into chunks
100 g green beans
1 tbsp vegetable oil
1 clove of garlic, chopped
1 tbsp Thai green curry paste
400 mL coconut milk
2 tsp Thai fish sauce
1 tsp sugar
450 g boneless chicken
Cooked rice, to serve
Chilli (optional)



This recipe serves 6 people. There are 18 people coming to a party. How much of the following will be needed to serve 18 people?

a Coconut milk
b Chicken

... continued

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THINKING	WORKING
STEP 1	
Determine how much the recipe will need to be scaled up by.	18 people = 6 people × 3 So all recipe amounts need to be 3 times greater.
STEP 2	
Multiply each amount by 3.	**a** The recipe requires one 400 mL can of coconut milk. One can × 3 = 3 cans (or 1200 mL of coconut milk) **b** The recipe requires 450 g of chicken. 450 g × 3 = 1350 g
The main idea is that the proportional relationship involves **multiplication**, × 3 (not the addition of + 12 people).	

Rates

A rate is a relationship between two different, but often related, quantities. Rates use the term 'per', such as in dollars per kilogram or in kilometres per hour. Some examples in real life are the following.

Vegetables in the supermarket are measured in *cost per kilogram* – the two variables are **cost**, measured in $, and **weight**, measured in kilograms.

Travel in a car is measured in *kilometres per hour* – the two variables are **distance**, measured in kilometres, and **time**, measured in hours.

A heart rate or pulse is measured in *beats per minute* – the two variables are the number of **heartbeats** and the **time**, measured in minutes.







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Example 18 Comparing heart rates in beats per minute (bpm)

Two people compare their heart rates after an exercise session at the gym.

a Ailsa counts her heart rate as 27 beats in 15 seconds.

b Brendan counts his heart rate as 32 beats in 20 seconds.

Who has the higher heart rate in bpm?

THINKING	WORKING
STEP 1	
There are 60 seconds in one minute, so the conversions are 15 seconds × **4** = 60 seconds or one minute for Ailsa, and 20 seconds × **3** = 60 seconds or one minute for Brendan.	**a** Ailsa has 27 beats × **4** = 108 bpm. **b** Brendan has 32 beats × **3** = 96 bpm.
STEP 2	
Now that the beats are converted to the same time unit (minutes) we can compare the values.	Ailsa has the higher heart rate, by 108 – 96 = 12 bpm.

3F Tasks and questions

Thinking task

1 Shower heads have different flow rates and are given different ratings. Find out what units are used when measuring the flow rate of shower heads. Compare the required flow rates for 3-star, 4-star and 5-star rated shower heads?



Skills questions

2 How many parts in total are there in the following ratios?

a 1 : 3

b 2 : 5

c 10 : 1

d 1 : 2

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3 Use the ratios to work out the amounts needed for each part.

a 10 mL medicine cup. Ratio of 1 : 9

b 2 L jug. Ratio of 1 : 4

c 80 balls. Ratio of 3 : 5

d 20 kg of rice. Ratio of 2 : 3

e 15 L container. Ratio of 1 : 2

f 2 tonnes. Ratio of 1 : 1

4 Write the following ratios as fractions of the whole amount.

For example, if the ratio is 1 : 4, then the fractions of the whole amount are $\frac{1}{5}$ and $\frac{4}{5}$.

a 1 : 3 **b** 2 : 5 **c** 7 : 1

d 2 : 3 **e** 5 : 2 **f** 1 : 5

5 Find the rates of the following and give the units for each where possible.

a A gardener mows 6 lawns each day.

b The drive takes one hour, and the destination is 100 kilometres away.

c The train takes 4 hours, and the trip covers 200 kilometres.

d The chef makes 600 sushi rolls in one 5 hour shift.



e 20 potatoes weigh 2 kilograms.

f The employee earns $16 for an hour of work.

g A 2 L bottle of milk costs $2.40.

h 250 sausages are cooked at a sausage sizzle in 2 hours.

i The number of hours worked per day in your job.

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Mathematical literacy

6 Make a list of about six different rates that are used in your community. Write these as words and then give the units of measurement. Consider finding examples where the word **per** is used.

For example, driving uses a rate of kilometres per hour, which has the units km/h.

Application tasks

7 Find the rates in the following.

a



b



8 Which of the following pairs offers better value for money?

a



b



c



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9 A concreter mixes 4 parts crushed rocks with 2 parts sand and 1 part cement.



Calculate the total amount of concrete that will be produced from the following.

a 4 kg crushed rocks + 2 kg sand + 1 kg cement

b 2 kg crushed rocks + 1 kg sand + $\frac{1}{2}$ kg cement

Calculate the volume of rocks, sand and cement they will need to make the following amounts of concrete.

c 14 kg of concrete

d 21 kg concrete

e 3.2 kg of concrete

10 Look at the following ingredients list needed to make 4 cups of hummus.

500 g dried chickpeas

2 tbsp bicarbonate of soda

$\frac{1}{2}$ cup tahini

1 large lemon, juiced

2 garlic cloves

2 tsp salt

1 tsp ground cumin

1 tbsp extra virgin olive oil

1 tsp paprika

$\frac{1}{2}$ cup finely chopped flat-leaf parsley



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Write the ingredients list needed to make the following.

a 8 cups of hummus

b 2 cups of hummus

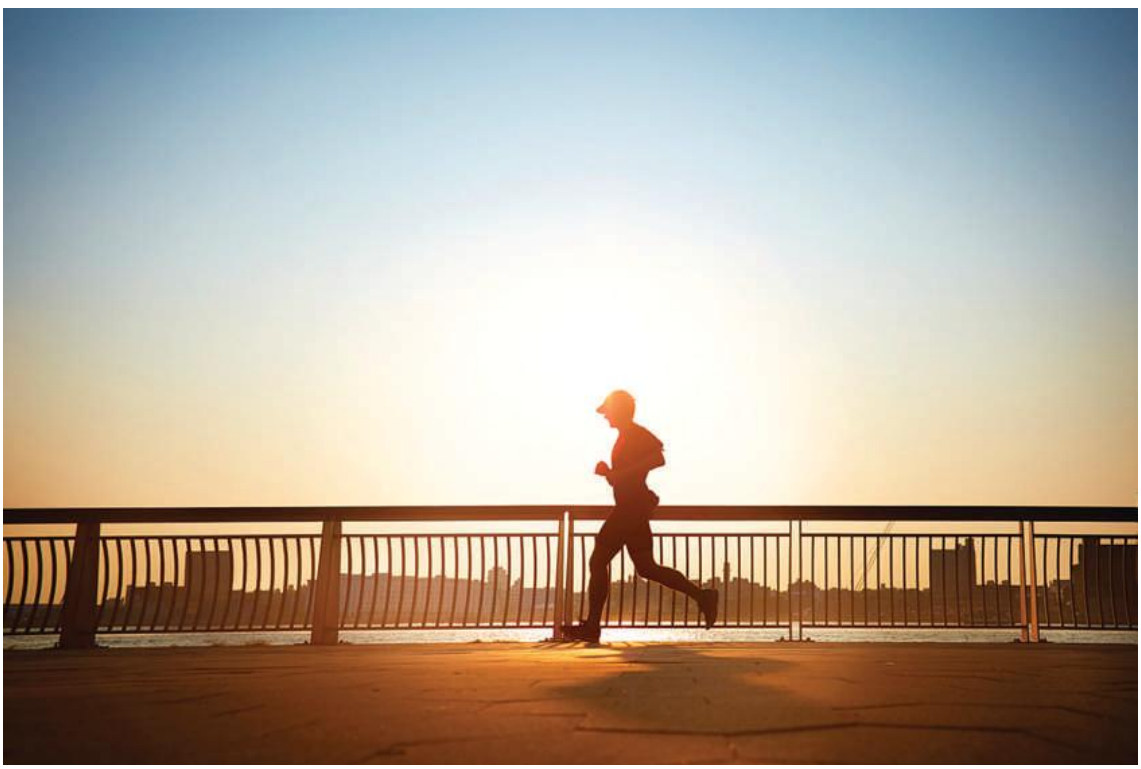
c 10 cups of hummus

11 A bottle of antiseptic needs to be diluted and requires a 1 : 20 dilution with water. You have a 250 mL cup but don't want to fill it to the very top.

What proportion of antiseptic might you put in the cup?

12 A runner takes 15 minutes to run 3 km.

How long might it take them to run 9 km?



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3G A higher power?

For everyday use, we write and say numbers in the familiar decimal system way. For example, the road distance from Ballarat to Bairnsdale is 397 km, which in words is three hundred and ninety-seven kilometres.

For very large numbers, however, it is better to use *power* notation and language (also known as *index* or *exponential* notation).

For example:

The distance from the earth to the moon is about 384,000 kilometres. This can be written using powers of ten as: 3.84×10^5 (write as a superscript)

Simple power calculations

A scientific calculator performs power calculations very efficiently. Look for the button labelled x^y or n^m. With a smartphone calculator, just rotate the device to landscape view to access the scientific calculator.

Example 19 Evaluate powers using a calculator

What is the value of 3^4 (in words: three to the power of four)?

THINKING	WORKING
STEP 1	
Use the power function key x^y .	Press 3 then x^y then 4 then =.
STEP 2	
It means $3 \times 3 \times 3 \times 3$.	The answer is 81.

When the base and power are swapped, the answer is different: $4^3 = 4 \times 4 \times 4 = 64$ (in words: four to the power of three)

Powers of 10

Using **powers of 10** is a special and useful way of writing down large or small numbers. Notice how the increasing powers (1, 2, 3 …) correspond with the increasing place value (tens, hundreds, thousands …).

Here are some common powers of ten.

$10 = 10^1$

$100 = 10 \times 10 = 10^2$

$1000 = 10 \times 10 \times 10 = 10^3$

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$10\,000 = 10 \times 10 \times 10 \times 10 = 10^4$

$100\,000 = 10 \times 10 \times 10 \times 10 \times 10 = 10^5$

1 million = $1\,000\,000 = 10 \times 10 \times 10 \times 10 \times 10 \times 10 = 10^6$

Looking at the pattern, what would 10^{10} equal? Check using your calculator.

Really large numbers have lots of zeros. Instead of writing them all out, we can use **powers of 10** to shorten the way we write them.

For example: $5000 = 5 \times 1000 = 5 \times 10^3$.

So, 10^3 is a shorthand way of writing or replacing the 3 zeros.

Scientists and engineers (who often use very large or very small numbers) prefer to write numbers this way.

Example 20 Writing large numbers as a power of 10

The mass of the Sun is 1 988 000 000 000 000 000 000 000 000 000 kg. Write this number as a power of 10.

THINKING	WORKING
STEP 1	
The leading digit is 1, so a decimal point goes after the 1.	1.988
STEP 2	
Counting across, there are the *three* digits, 988, followed by *twenty-seven zeros*.	This means the power of 10 is $3 + 27 = 30$. Answer is 1.988×10^{30} kg. In words, we say: One point nine eight eight **times** ten to the power of thirty (or we could replace 'times' with 'by' and say: **by** ten to the power of …)

It's hard to accurately write 1 988 000 000 000 000 000 000 000 000 000 kg, and meaningless to try to say it in words (and too easy to make a mistake counting the zeros!).

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Example 21 Converting power of 10 notations to everyday language

A light year (the distance light travels in one year) is 9.461×10^{15} metres. Write this number in everyday notation.

THINKING	WORKING
STEP 1	
The power is 15.	We need to count across *fifteen* places from the decimal point.
STEP 2	
Counting across from the decimal point, the first *three* digits are the 461, followed by *twelve zeros* to give the total of *fifteen* places.	The answer is 9 461 000 000 000 000 metres. That is nine thousand, four hundred and sixty-one trillion.

The value 'trillion' is a 'million million'. It is easy enough to say in words, but the human brain struggles to have a sense of just how big that is.

This way of writing big numbers is called **scientific notation**, or **standard form**. The advantage is that you can easily compare very large numbers just by looking for the largest power value.



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3G Tasks and questions

Thinking task

1 There are some important powers that we use often. Most of these are powers of ten and have specific names, such as million, billion, etc. Research the different names we use for large powers of ten, and write them as powers of ten. One such large power of ten was the inspiration for Google – what is this number and how old was the person who is claimed to have named it?

Skills questions

2 Complete the table using power of 10 notation. Remember that we can use a comma or a space to indicate thousands.

Full number	Power of 10 notation
4300	4.3×10^3
430 000	
	5.146×10^6
26 600 000	
8 031 800 000	
	6.022×10^{23}

3 Calculate the following.

a 2^5

b 0.2^5

c What do you notice about the answers to **a** and **b**?

d 10^6

e 1.07^{10}

Mathematical literacy

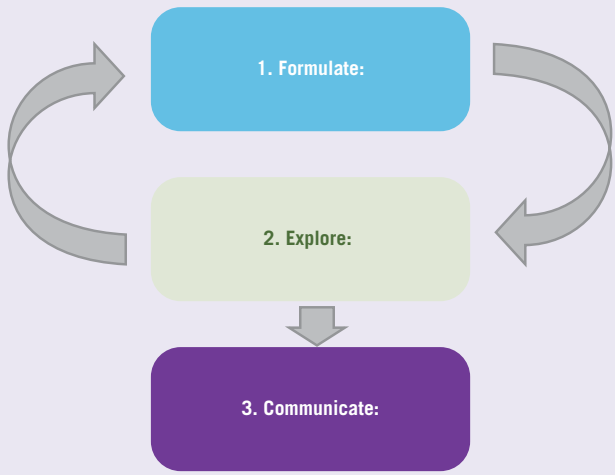
4 When a number is raised to the power of 2, we say that the number is **squared**, or that it is the square of the number. For example, 3^2 is three squared or the square of three. How do we name a number raised to the power of 3? What about a number raised to the power of 4?

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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. Consumer Price Index (CPI) and inflation

The CPI value tells us how fast prices are rising from one year to the next. The percentage rate of increase varies over time, but for this investigation we will assume the percentage rate stays the same.

Set up a spreadsheet to compare the annual CPI changes in the spreadsheet below for Melbourne (+2.5%) and Perth (+1.1%). Run the calculations for 10 years. For ease of comparison, make $1000 the starting value in each category.

	A	B	C
1	**Comparing CPI inflation**		
2	**City**	**Melbourne**	**Perth**
3	Annual % rate	2.5%	1.1%
4	Year		
5	0	$ 1000.00	$ 1000.00
6	1	$ 1025.00	$ 1011.00
7	2	$ 1050.63	$ 1022.12
8	3		
9	4		
10	5		
11	6		
12	7		
13	8		
14	9	$ 1248.86	
15	10	$ 1280.08	

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	A	B	C
1	**Comparing CPI inflation**		
2	**City**	**Melbourne**	**Perth**
3	Annual % rate	0.025	0.011
4	Year		
5	0	1000	1000
6	1	=$B$5* (1+$B$3)^A6	=$C$5* (1+$C$3)^A6
7	2	=$B$5* (1+$B$3)^A7	=$C$5* (1+$C$3)^A7
8	3		
9	4		
10	5		
11	6		
12	7		
13	8		
14	9	=$B$5* (1+$B$3)^A14	
15	10	=$B$5* (1+$B$3)^A15	

Hint Use the $ sign when coding in Excel to fix the cells that you want to use, e.g. 1000 and 0.025. The $ sign is an absolute cell reference.

a Set up your spreadsheet using the coding given in the table above. Use the enter and drag functions to run your code on the spreadsheet.

b Explain using your spreadsheet how different CPI percentages impact prices.

2. Fuel economy



A challenge of climate change when driving petrol cars is fuel economy – that is, how much petrol a car uses. The age, size, weight, type of engine and running condition of a car can affect how much fuel it uses. Smaller cars are more economical than bigger cars, and manual cars are more economical than automatic cars. This is a prominent issue as petrol prices increase.

Fuel economy is measured by working out how many litres of fuel a car uses for each 100 kilometres it travels. This is written as **litres per 100 kilometres** and is abbreviated to **L/100km**.

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This means the following.

- The lower the figure, the more economical or fuel-efficient the car is. A good figure for fuel economy is less than 6 or 7 litres per 100 kilometres.
- The higher the figure, the more fuel a car uses – poor fuel economy figures start at 10 or 11 litres per 100 kilometres and go up from there.

A new car's fuel economy figures are listed in its specifications. Remember that this is *not* the real figure you will get when driving the car. The real fuel economy depends on where and how you drive the car; for example, in the city or on open roads and freeways, whether you drive fast or slow and so on. It is an indication of the fuel economy you can expect, so that car comparisons can be made when deciding which one to buy.

Your task is to create a report about the fuel economy of a 'normal' car (i.e. a type of car you will likely see on the roads and streets around you). The format of your report is up to you.

a What car are you investigating? Include a photo.

b What is this fuel tank capacity of this car?

c Research this car's fuel economy in city and country driving scenarios. Include hyperlinks to the sources of this information.

d Research current petrol prices in your area. Use this to calculate the cost of filling the tank from empty.

e Explain how you would use this car throughout the year.

f Use this to calculate your fuel costs for the year.

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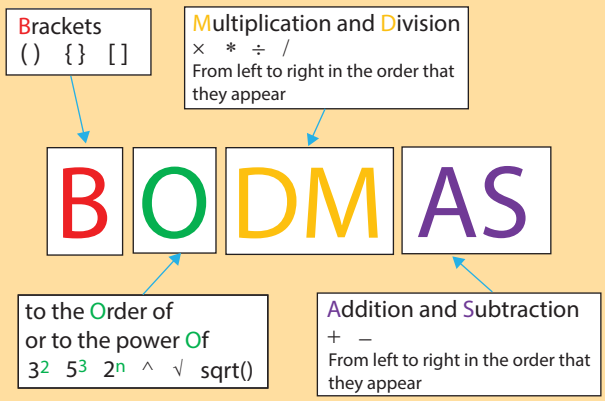
Key concepts

- We can check the **reasonableness** of calculations by considering whether the solution 'feels right', as well as by **estimating** using **rounding**, **truncation**, or **leading-digit approximation**.
  - To **round** a number (e.g. 34.56), first decide what place value we are rounding to (e.g. nearest unit). Then examine the digit in the place value to the right of this digit.
    - If this digit is less than 5, we **round down** by leaving the place value we are rounding to as is.
    - If this digit is greater than or equal to 5, we **round up** by increasing the digit in the place value we are considering by one.
    - After this, we replace all place values to the right with zeroes.
  - **Truncation** involves simply removing all digits after the required level of accuracy (e.g. truncating 1.29 to one decimal place is 1.2).
  - **Leading-digit approximation** involves rounding a number to the place value containing the first non-zero digit.
- **Calculators** and **spreadsheets** can be very useful tools for calculations.

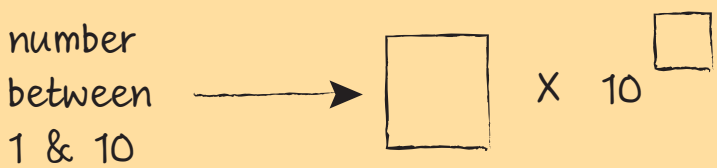
Operation	Button	Meaning
Add	+	Adds the next number you enter.
Subtract or take away	–	Subtracts the next number you enter.
Multiply	×	Multiplies by the next number you enter.
Divide	÷ or /	Divides by the next number you enter.
Equals	=	Shows the answer to the calculation.
Clear last entry	C or CE	Allows you to change the last number you entered.
Clear (all)	AC	Clears all values and allows you to start a new calculation.
Change sign	+/–	Changes the value on the screen from positive to negative and vice versa.
Percent	%	Works out a percentage value.
Decimal point	.	The point that separates the whole number part from the decimal part of a value.

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- Working out **fractions of** numbers involves division and (sometimes) multiplication.
  - For instance, finding $\frac{3}{4}$ of something involves dividing by 4 and multiplying by 3.
- To find a **percentage of** a number, multiply the number by the percentage's fraction or decimal equivalent.
- The **percentage change** of a value = $\frac{\text{new value} - \text{original value}}{\text{original value}} \times 100\%$
- We use **BODMAS** to order operations.



- **Ratios** involve sharing parts in proportion.
  - Ratio problems can be solved by determining the number of parts and the quantity each part represents.
  - **Rates** are ratios that compare two quantities with different units of measure.
- **Power notation** is useful for expressing repeated multiplication concisely. For example, 3^5 means 3 to the power of 5 or $3 \times 3 \times 3 \times 3 \times 3$.
- **Scientific notation** is often used to represent very large or very small numbers.



- Repeated percentage change can lead to very rapid growth called **exponential** growth.

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Success criteria and review questions

☐ I can round and truncate numbers.

1 Round off these amounts of money.
- **a** $23 567.35 to the nearest dollar
- **b** $654.89 to the nearest dollar
- **c** $356.7846 to the nearest cent
- **d** $20.54673 to the nearest cent
- **e** $15.68 to the nearest 5c
- **f** $235.23 to the nearest 5c

2 Truncate 32.4567 to 2 decimal places.

3 Use leading-digit approximation to round 0.000004567.

☐ I can check answers using estimation.

4 Estimate the total cost of these 3 items.
Shirt $42.55
Shoes $97.50
Watch $148.80

5 A second-hand bookshop sells books for 30c, 50c or 70c. They offer a discount for purchasing multiple books. You find 8 books that you like and take them to the register. The cashier charges you $6. Does this seem about the right amount? Is it too high or too low?

☐ I can perform calculations involving the four main operations (+,–,×,÷).

6 Calculate the total cost of the following.
- **a** 3 pizzas that are $6.50, $8.00, and $9.00.
- **b** 4 ice-creams that are $4.50 each.

7 A lottery win of $45 000 was shared between 6 people. How much money did each person receive?

☐ I can perform calculations involving fractions and percentages.

8 A block of land with an area of 1500 m^2 is being subdivided into smaller blocks. A developer purchases $\frac{2}{5}$ of the land. How large is their block?

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9 Jocelyn pays her children $6 a week pocket money when they complete their chores and 20% of their pocket money when they do not. How much pocket money do they receive when they do not do their chores?

☐ I can perform calculations using the correct order of operations.

10 Evaluate the following.

a $10 + 5 \times 6$

b $20 \div 4 + 6$

c $4^2 - 2 \times 6$

11 Insert brackets into this statement to make it true.

$$14 - 12 \div 2 = 1$$

☐ I can perform calculations involving ratios, proportions and rates.

12 The recipe for scones has the following ingredients: self-raising flour, lemonade and cream. The ingredients are in the ratio of 3 : 1 : 1.

a To make a one kilogram batch of scone mix, how much of each ingredient should be added.

b Write the ratio 3 : 1 : 1 as fractions of the whole amount.

13 Every morning, the bakery bakes 1250 bread rolls in 4 hours. What rate is this?

☐ I can perform calculations involving powers.

14 Evaluate 5^3.

15 The distance between Earth and Mars is 334 730 000 km. Write this number in scientific notation.

16 The number of atoms in 12 g of carbon is 6.02252×10^{23}. Write this amount in numbers.

17 **a** A house was valued at $1 250 000. After two years, the price of the house had increased by 20%. What was the value of the house after two years?

b Unfortunately, the house suffered damage in a storm, and the house price decreased by 20%. What was the new value of the house?

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I can put these skills together.

18 Vushna is the owner of a sports shoe store. She is getting prepared for an upcoming sale and needs to calculate the following.

a The total staffing cost to employ two people – a manager and a junior – for 7.5 hours each. The manager earns $35.50/hr and the junior earns $23.00/hr.

b The value of the stock to be sold. The table below shows the stock prices. Complete the final column of the table.

Item	Recommended retail price (RRP)	Number of items	Total value
Asics Gel 7 Running Shoe	$79.99	22	
Mizuno Wave Netball Shoe	$189.99	5	
Adidas Men's Grand Court	$120.00	18	
Nike Zoom Waffle Shoes	$99.99	2	

c The new price of each item after they have been discounted by 10%.

Item	RRP	10% of RRP	Sale Price
Asics Gel 7 Running Shoe	$79.99		
Mizuno Wave Netball Shoe	$189.99		
Adidas Men's Grand Court	$120.00		
Nike Zoom Waffle Shoes	$99.99		

d The quantity of cleaning concentrate to order for cleaning the store if five litres of cleaning fluid are required at a ratio of 1 part cleaning concentrate to 10 parts water.

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Key vocabulary

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

Term	Meaning
Approximation	The result when a value is rounded off, e.g. a lap time of 87.956 seconds is approximately 88 seconds.
Base	The numeral in an index expression that is repeatedly multiplied, e.g. the **3** in $\mathbf{3}^5 = 3 \times 3 \times 3 \times 3 \times 3$.
BODMAS	An acronym to help remember the order of operations in a calculation: **B**rackets, then powers **O**f, then **D**ivision or **M**ultiplication (from left to right), then **A**ddition or **S**ubtraction (from left to right).
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 full stop (**.**) or a comma (,) in different countries.
Estimation	A value arrived at by an 'educated guess' rather than by the use of an accurate calculation.
Exponent	See *Power*.
Fixed growth	Where values increase by a **constant amount** in a straight-line pattern, e.g. 5000, 5500, 6000, 6500 … shows a constant increase by +500.
Index	See *Power*.
Integer	Integers are whole numbers and include positive and negative whole numbers and zero.
Leading digit	The first non-zero digit in a small decimal number, e.g. the 4 in 0.00004672
Linear	Where values increase or decrease by a **constant amount** and form a straight-line pattern when graphed, e.g. *fixed growth*.
Non-linear	Where values increase by a **changing amount** and form a curve pattern when graphed, e.g. *percentage growth*.

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Term	Meaning
Order of operations	See *BODMAS*.
Percentage growth	Where values increase by a **percentage amount** and form a curve pattern when graphed, e.g. 5000, 5500, 6050, 6655 … shows a percentage increase by +10%.
Power	The superscript numeral in an index expression that indicates how many times the base is repeatedly multiplied, e.g. the **5** in $3^5 = 3 \times 3 \times 3 \times 3 \times 3$.
Proportion	A mathematical comparison between two values in a ratio.
Rate	A comparison between two variables, using the word **per** or the symbol **/**, and meaning the number of the first variable *for each one of* the second variable, e.g. a rate of pay of $26 per hour or a speed of 80 km/h.
Rounding off	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 rounds down to $23.85.
To the order of	A step in the BODMAS rules. See *To the power of*.
To the power of	The phrase used to describe power expressions in words, e.g. for 3^5 we say, 'three to the power of five'.
Truncation	A way of rounding by simply removing the digits beyond a specified place value, e.g. when $23.867145 is truncated to cents, the answer is $23.86 whereas $23.87 would be the rounded value.

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4 Describing relationships with algebra

Brainstorming activity: Where's the maths?

Using this photo as a stimulus, brainstorm the type of maths we would need to know so that we could undertake this task or activity. Think especially about any maths skills related to the content of this chapter – algebraic relationships and using formulae. Prompt questions might be:

- What might this person in the photo be doing?
- 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 formulae 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?

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Chapter contents

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4B Tuning in
4C Connecting with algebra
4D Describing relationships
4E Conventions and terminology
4F Applying your skills
4G Formulae use in spreadsheets
4H Manipulations
Investigations
Chapter review

From the Study Design

In this chapter, you will learn how to:

- form estimates and carry out relevant calculations using mental and by-hand methods (Unit 3, Area of Study 1)
- develop simple formulas describing generalisations, patterns and relationships between real-life variables (Unit 3, Area of Study 1)
- solve practical problems using constants, symbols, variables, common formulas, expressions and equations (Unit 3, Area of Study 1)
- check for accuracy and reasonableness of calculations and results (Unit 3, Area of Study 1).

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Chapter overview

Introduction

The aim of this chapter is to explore the world of algebra and look at some of the ways that formal maths is used and applied in the real world, not just in the maths classroom. Understanding algebraic reasoning, rules, conventions and formulas can help us describe, model and interpret relationships, patterns and change where they occur in the real world. There is a need for formulas and algebra in real life, and many occupations and trades use a wide range of formulas every day – builders, electricians, plumbers, dressmakers, chefs, carpenters, mechanics, gardeners and landscapers, sportspeople, drivers, bookkeepers, asphalters and pavers, and so on.

This chapter will take a short journey of discovery about why we need to know some algebra, and that maybe it's not so painful after all.

Learning intentions

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

- appreciate why algebra and formulas are highly relevant to your life and work
- apply formulas to everyday scenarios
- understand the words and conventions associated with algebra
- substitute numerical values for pronumerals
- use spreadsheets to write formulas to perform calculations
- transpose formulas
- apply the problem-solving cycle to complete investigations related to the topics contained within the chapter.

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Spotlight: James Courtot

An interview with a landscape gardener

Tell us about the work you've done and what you do now.

I got a Bachelor of Business in Sports Management. I thought that was my calling and enjoyed it but then I went into financial planning with a small company in the city. It was enjoyable, but I didn't want to be stuck in an office so much as I was, so I went into landscaping.

I did my apprenticeship, which takes four years. I worked another year as a fully qualified landscaper and now I've just started my own landscaping business. So far, it's a bit more demanding than just working away in an office, but it's more rewarding.

What maths do you use regularly in your job? Could you give some examples?

For quoting, you're going out and measuring up jobs. Using the standard equations and measuring to try to figure out the amount of materials and items that you'll need for a job. For landscaping there are many different shapes, so you need to work out all the perimeters for them. You also need areas for the in-fill or you might find volume to see how much material you need to bring in or take out.

What is the most useful tool or piece of technology that you use regularly in your job?

Out on site, for the quoting side and measuring up, I will use the standard calculator that you'd find in your phone. To find the whole area or volume, I've got the calculator there that I can type those equations into.

At home I put it into my Excel spreadsheets to simplify my quoting. What I found is I can put mathematics equations into my Excel spreadsheets that will work out the costs for me when I put in my measurements: my length, height, area, volume. It just speeds it up so much compared to having to just simply work out every single length and add them all up at the bottom.

What was your attitude towards maths when you were in school?

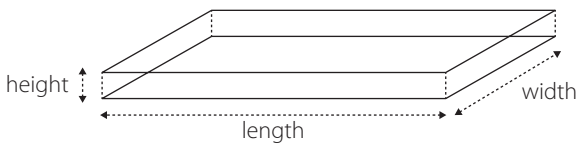
I did have that natural ability for maths but you know, it sort of stopped in spots. There were a few times early on when it was difficult, I needed to work on it, so I studied hard and got back on track. And you really have to work on your maths in those final years of school. I don't think it matters who you are unless you actually are categorised as a genius. You need to knuckle down and study. It's not something you can get to the final exam and just go 'Oh, we'll be right.' You need to have it ready to go.

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4A Starting activities

Activity 1: Gardening and landscaping

A landscaper is creating some garden beds and needs to work out how much mulch they need. They know that they need to use this formula to calculate the volume of mulch required to cover a garden bed.



$$\text{Volume of mulch (in litres)} = \frac{\text{length} \times \text{width} \times \text{height (in cm)}}{1000}$$

1 m = 100 cm

1000 L = 1 cubic metre

To work out the volume of mulch, in litres or cubic metres, required to cover a garden bed, take the following steps.



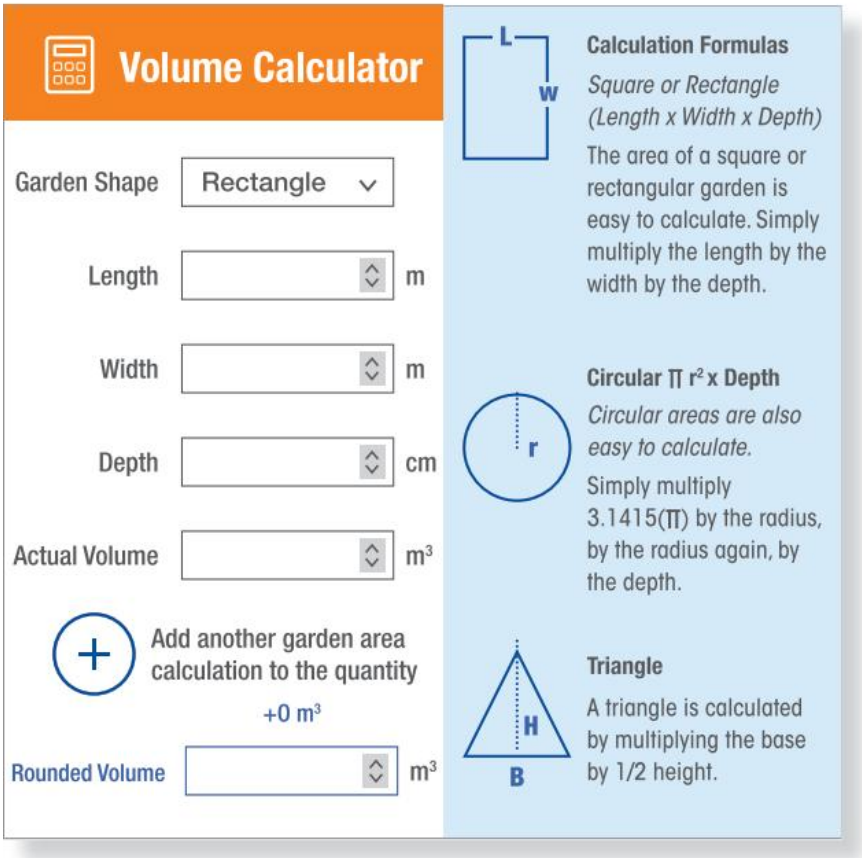
Step 1 First convert all dimensions to centimetres. There are 100 cm in 1 m, so multiply any measurements in metres by 100 to convert them to centimetres.

Step 2 Multiply length × width × height, then divide by 1000 to convert the result from cubic cm to litres.

Step 3 If we need to convert the result from litres to cubic metres, then divide by 1000.

Another method is to use an app or a website on the internet. Many garden and landscaping suppliers will provide online calculators. Search for 'volume calculator' or 'soil calculator'. Below is an example of the sort of information and calculator you might find.

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1 Why does the app state both 'Actual Volume' and 'Rounded Volume'?

2 For circular shapes, you can just use 3.14 for π. Do you really need accuracy to four decimal places in these calculations?

3 Calculate the volume of mulch you would need to order for the following garden beds. Give your answers in either litres or cubic metres (m^3) or both.

a Square shapes

i length = 2.2 metres, depth = 30 centimetres

ii length = 180 cm, depth = 25 cm

b Rectangular shapes

i length = 2 metres, width = 140 cm, depth = 30 centimetres

ii length = 180 cm, width = 150 cm, depth = 20 cm

c Circular shapes

i radius = 1.1 metres, depth = 25 cm

ii diameter = 1.8 metres, depth = 30 cm

(In a garden, which is easier to measure – the radius or the diameter?)

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iii a semicircular shape next to a path, with diameter = 1.6 m, depth = 0.3 m



iv a quarter-circle shape in a corner, with radius = 1.2 metres, depth = 20 cm



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d Triangular shapes

i base = 1.4 m, height = 80 cm, depth = 30 cm

ii base = 140 cm, height = 70 cm, depth = 25 cm

iii a raised garden bed in the shape of a right-angled triangle, with base *and* height = 110 cm, depth = 40 cm



Activity 2: Uber and taxi fares

Uber fares in Australia

Uber fares are calculated using four main criteria.

- **Base fare –** A flat fee charged at the beginning of every ride.
- **Cost per minute –** An amount charged for each minute you are inside the Uber.
- **Cost per kilometre (km) –** An amount charged for each kilometre of the ride.
- **Booking Fee** – A flat fee to cover Uber's 'operating costs'.



Here's how Uber uses the four main criteria to calculate a fare.

Fare = Base Fare + (Cost per minute × time in ride) + (Cost per km × distance) + Booking Fee

1 What is the formal mathematical formula for calculating an Uber fare?

Use the following letters to represent the criteria given above.

F = Fare

B = Base fare, in dollars

C = Cost per minute, in dollars

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t = Time of the ride, in minutes

K = Cost per km, in dollars

d = Distance of trip, in km

b = Booking fee, in dollars

Convert the word formula above to a maths formula, using the symbols.

Here is the information (at the time of writing) for working out an UberX fare in Melbourne. Use this information and your formula above to answer the next two questions. You may want to look up the latest rates.

UberX is the cheapest of all Uber cars. The rates for UberX are different in different cities. Here are the UberX fares for Melbourne.

- Base fare: $2
- Per minute: $0.35
- Per kilometre: $1.15
- Booking fee: $0.55

2 How much would it cost for an UberX fare of 30 minutes, travelling a distance of 20 km. Show your calculations.



3 How much would it cost for an UberX fare of 20 minutes, travelling a distance of 6 km. Show your calculations.

4 Below is an example of the details of a daily taxi rate in Melbourne.

Daily Rate (09:00 – 16:59)			
Flag Fall	**Distance Rate**	**Booking Fee**	**Waiting Time**
$4.20	$1.622/km	$2.00	$0.57/minute

Notice how taxi rates are set differently from UberX rates. For example, taxi 'waiting time' is not the same as Uber 'time in ride'. You may want to look up the latest rates.

Develop and write an algebraic formula that calculates the cost of a taxi fare in Melbourne, using the rates given above.

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4B Tuning in

In this chapter, we will learn some of the basics of algebra and understand how it can be particularly useful in our working life. We have already calculated areas and volumes to determine the amount of mulch needed for gardening jobs, and have calculated taxi and Uber fares. In this section, we will consider other examples that show us how algebra can be useful.

Epic Fail – Space accident



Here is an Epic Fail, where issues with conversions had significant and expensive consequences.

In September 1999, after almost ten months of travel to Mars, the Mars Climate Orbiter burned and broke into pieces. On a day when NASA engineers were expecting to celebrate, the reality turned out to be completely different, all because someone failed to convert a measurement into the correct metric units.

The Mars Climate Orbiter, built at a cost of $125 million, was a 338-kilogram space probe, launched by NASA on 11 December 1998 to study Mars. The team at the Jet Propulsion Laboratory (JPL) used the metric system of millimetres and metres in its calculations, while Lockheed Martin in Denver, Colorado, the designers and builders of the spacecraft, provided crucial data in the English imperial system of inches, feet and pounds.

The software calculated the force that the thrusters needed to exert in a type of measurement called 'pounds of force'. A piece of code that read this data was incorrectly coded to read it as the metric unit of 'Newtons'.

HOW TO CONVERT NEWTONS TO POUNDS OF FORCE

$$Pound\ force = \frac{Newton}{4.4482216}$$

$$Newton = 4.4482216 \times Pound\ force$$

This accident pushed the spacecraft dangerously close to the planet's atmosphere, where it presumably burned and broke into pieces, killing the mission on a day when engineers had expected to celebrate the craft's entry into Mars' orbit.

Source: Adapted from Simscale website

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Discussion questions

- Do you think this is an easy error to make? Why?
- Are you surprised that such a mistake was made in this project? Why?
- Units of measurement must be right – recall that even in the mulch-volume calculator there was a mix of metre and centimetre inputs required.

Double Check

Remember that it is important to always reflect and check each calculation and result – this is a critical part of the problem-solving cycle! It helps overcome the possibility of Epic Fails like this one.

Agriculture

Boom sprayer calibration

Many farmers use boom sprayers to apply herbicides across a large area. Liquid herbicide feeds into a long arm (the 'boom') which has multiple spray nozzles – this provides a wide spread of the herbicide as the apparatus is driven around the field.



It's important for the boom sprayer to apply the right amount of herbicide. Too much can damage the crop and harm the environment – and will also waste money! But if there isn't enough herbicide, then pests can invade the crop.

The chemicals used in a boom sprayer are measured in amounts per hectare. So, to work out how much herbicide to put in the tank, we need to know how much will be discharged over a given area – this is called the sprayer output. To calculate the sprayer output (in litres per hectare) the farmer needs to consider the boom output (how many litres per minute the boom will spray), the width of the area the boom covers and the speed being travelled.

The following information on these calculations comes from the West Australian Department of Primary Industries and Regional Development.

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Calculate the spray output

Given the desired speed, in km/h, spraying width (also called swath width), in metres, and boom output rate, in L/min, apply this formula.

$$Sprayer\ output = \frac{600 \times boom\ output\ (L/\min)}{swath\ [spraying]\ width\ (m) \times speed\ (km/h)}$$

This formula is based on the fact that a one-metre wide sprayer, travelling at 1 km/h, will cover 1 hectare in 600 minutes.

Example:

A boom sprayer has 30 nozzles, each spraying an average of 425 millilitres per minute (mL/min). Total boom discharge is 0.425 × 30 = 12.75 L/min.

Swath width is 15 m and speed selected is 10 km/h.

$$Sprayer\ output = \frac{600 \times 12.75}{15 \times 10}$$

$$= 51\ L/ha$$

Calculate the amount of chemical to add

$$\text{Amount} = \frac{tank\ capacity \times chemical\ rate/ha}{sprayer\ output\ (L/ha)}$$

Example:

Tank capacity = 1000 L

Recommended rate = 750 mL/ha = 0.75 L/ha (750 mL divided by 1000 = 0.75 L)

Output calculated (from above) = 51 L/ha

$$Amount\ of\ chemical\ to\ be\ added\ to\ the\ tank = \frac{1000 \times 0.75}{51}$$

$$= 14.7\ \text{L}$$

Note: The formulas in this example have not used the technical mathematical way of writing formulas, they have used words like 'spray output', 'boom output', 'swath width' and 'speed'. In maths, we would normally use letters like $\boldsymbol{O_S}$, $\boldsymbol{O_B}$, $\boldsymbol{w}$ and $\boldsymbol{s}$ to stand for each of these values. This makes the expression shorter and simpler. In full, the expression looks like this:

$$Spray\ output = \frac{600 \times boom\ output}{swath\ width \times speed}$$

In maths shorthand, it could read like this.

$$O_S = \frac{600 \times O_B}{w \times s}$$

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This is one of the advantages of using a mathematical formula, and throughout this chapter we will explore other advantages.

Conversions

There are formulas that convert one unit to a different unit. Here is one for temperature.

Temperature conversion – Fahrenheit to degrees Celsius

$$C = \frac{5}{9}(F - 32)$$

and here is an online tool for converting inches to centimetres.

Metric conversion tool



Source: Australian Government Department of Industry, Science and Resources website

Sports scores – What have they got to do with algebra?

Did you know that working out sports scores relates to algebra and formulas?



When we work out the number of points a team scores in Australian Rules football, we can represent this mathematically. In Australian Rules football, 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 using a maths formula.

$P = 6g + b$

We will talk some more about how this works later!

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Getting the message

From these examples, we can see that we use a range of formulas in different real-world contexts, from gardening and agriculture through to catching an Uber and playing sport.

This chapter explores how we use formal maths in everyday situations, and explains the fundamental knowledge and skills needed in order to understand the maths we are using. We will keep coming back to formulas in other chapters in this book.

Practice questions:

1 A recipe for Balsamic vinegar salad dressing is 1 part vinegar to 3 parts olive oil.

- **a** If you use two cups of vinegar, what is the quantity of olive oil that you will need?
- **b** What is the total amount of dressing this will make?

2 You are thinking about selling your cupcakes for $3 each at a market where a stall costs $55 to hire.

- **a** How many cakes would you need to sell to make a profit?
- **b** In summer you could hire a canopy for an extra cost of $15. How many cakes would you now need to sell to make a profit?

3 Ace Electricals charges a $185 call-out fee, and $95 per hour.

Betta Electricals charges a $160 call-out fee, and $105 per hour.

- **a** Calculate the cost of hiring each company for a job that will take 3 hours.
- **b** Which company is cheaper for a job that takes 2 hours?
- **c** Which company is cheaper for a job that takes 4 hours?



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4C Connecting with algebra

We might feel that understanding and using algebra is not interesting, relevant or useful, despite spending quite a lot of time studying it in our maths classes at school.

Is that how you feel?

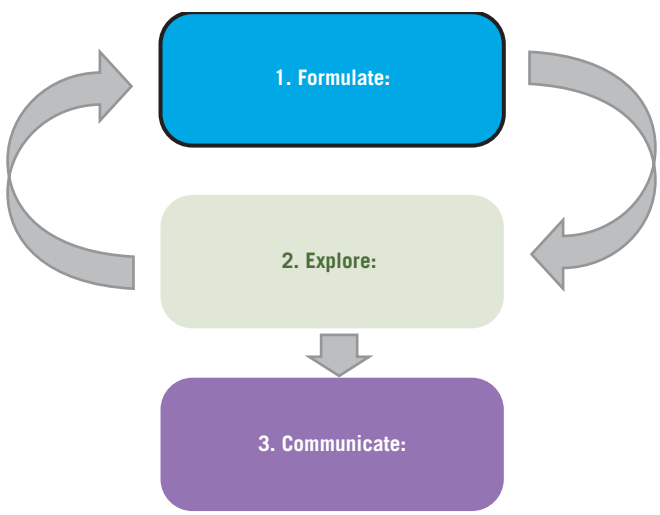
In this chapter, we will see the way that algebra can be developed and illustrated through generalisations of relevant, real-life situations, and how there is a need for formulas and algebra in workplace situations. Hopefully, this will provide a purpose for learning and using algebra and give you a reason to engage more fully with it.

Many occupations and trades use a wide range of mathematical skills every day – shop keepers, builders, electricians, plumbers, dressmakers, chefs, carpenters, mechanics, gardeners and landscapers, sportspeople, drivers, bookkeepers, bricklayers and pavers, and so on. In many of these occupations, it's important that they understand and apply algebra and formulae.

Making connections – generalisations

Algebra can be used to make generalisations about situations in which patterns or repeated calculations occur, such as:

- Working out how long it might take you to travel somewhere.
- Calculating how much you might be paid if you get travel allowances.
- Making conversions, for example, between temperatures in Fahrenheit and degrees Celsius.
- Calculating interest.
- Generalising when calculating or estimating anything that has a regular pattern like when calculating football scores.



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4C Tasks and questions

Thinking task

1 Personal reflection

a What are your most common experiences of learning algebra at school?
b How was it introduced?
c How was it explained?
d How did you practise it?

Skills question

2 Make a poster or online presentation about the history of algebra through the ages. Consider the perspectives of different cultures and countries that have long-used algebra.

Mathematical literacy

3 How would you describe algebra to a primary school kid?

Application task

4 Work in a small group with a couple of other students. Reflect on how algebra has been taught to you – what are your feelings and thoughts about algebra?

Think about questions such as the following.

- Was the algebra that you studied ever meaningful or relevant?
- Was algebra related to real situations?
- What methods were used to teach it to you?
- Were there any hands-on materials used, or was it predominantly taught by the teacher out of textbooks or online?
- Did your teachers explain the value and importance of learning algebra?
- Did learning algebra make you feel worried about maths or turn you off maths?

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4D Describing relationships

Most children and adults from Victoria who know about Australian Rules football (AFL) can work out the score in their heads, without realising they are using and applying a form of algebra.



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.

How does the scoring work?

Here are some scores for a football game between two teams – Essendon and Brisbane.

Team	Goals	Behinds	Points
Essendon	11	16	82
Brisbane	12	10	82

Each goal is worth 6 points and each behind is worth 1 point.

To work out the total number of points, multiply each goal by 6, and then add on the number of behinds.

For example, for Essendon you have 11 goals which scores 11 times 6 points, which is 66 points. Then we add the number of behinds (16). So altogether, Essendon's score of 11 goals and 16 behinds is worth 66 plus 16 points, which gives 82 points.

With Brisbane it will be 12 times 6 points for the 12 goals, plus 10 for the number of behinds. So, the number of points will equal 12 times 6, which equals 72, plus 10 more, which gives us a total of 82 points.

In this case, the game would be a draw because the two teams have each scored the same total number of points (82).

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So, what has this got to do with algebra?

No matter the number of goals and behinds each team kicks in football, we have a scoring scheme that enables us to work out the total score each time. There is, therefore, a general method that applies in **any** situation where we need to calculate an Aussie rules football score.

This calculation is a *generalisation*, which is what an algebraic formula in mathematics can do for us – a formula is a way of representing and writing down what we need to do.

Moving towards a maths formula

Let's have a look at these football examples. In the last calculation above for Brisbane, we have written a mathematical sentence.

The number of points will equal 12 times 6, which equals 72, plus 10 more, which gives us a total of 82 points.

If we write the maths words using their symbols (**times** is **×**, and **plus** is **+,** and **equals** is **=**) then we have something looking like this:

$$\text{Number of points} = 12 \times 6 + 10 = 72 + 10 = 82 \text{ points.}$$

However, this is just for one particular score – we can generalise this for any number of goals and behinds like this:

$$\text{Number of points} = \text{number of goals} \times 6 + \text{number of behinds.}$$

This is what we call an **algebraic sentence**.

In mathematics, we like to use quick ways of writing things down. We usually use a single letter (called a **pronumeral**) to represent what we are talking about.

In this case, we can use a letter to stand for the number of points (let's use $\boldsymbol{p}$), a letter for the number of goals (let's use $\boldsymbol{g}$), and finally a letter for the number of behinds (let's use $\boldsymbol{b}$). Then, if we use these letters instead of words in the sentence, this will give us:

$$\text{Number of points} = \text{number of goals} \times 6 + \text{number of behinds.}$$
$$p = g \times 6 + b$$

In the world of mathematics, we often make shortcuts in how we write down algebra and formulas. When we multiply a number by a letter, for example, $g \times 6$, we shorten this further to be simply $6g$. So, the convention we use for multiplication is that we put the number in front of the letter.

$$p = 6g + b$$

Now it looks more like the algebra that we have seen previously. It is the **formula** for working out the number of points that a team scores in Aussie Rules football.

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Example 1 Representing real-life scenarios algebraically

A plumber charges a $60 attendance fee for coming out to your house (call-out fee), and then $120 per hour for the time spent working on the job. Write a formula you could use to work out the total charge.

THINKING	WORKING
STEP 1	
The total cost will be the call-out fee plus the fee for working on the job.	Total fee = call-out fee + fee for working on job
STEP 2	
The fee for working on the job is $120 multiplied by the number of hours worked. The number of hours worked is not a fixed amount, so we assign a variable h.	The call-out fee is $60. Fee for working on job = $120 \times h = 120h$
STEP 3	
Let the total fee be represented by the variable C.	$C = 60 + 120h$

4D Tasks and questions

Thinking task

1 What about sports other than AFL?

If you follow other sports, like rugby or basketball, there are similar scoring schemes where we can write out a generalisation, and hence a formula, for how the score is worked out.

Try and create a formula for scoring in these sports.

- **a** Rugby
- **b** Basketball
- **c** How does scoring work for netball or soccer, compared with other sports?

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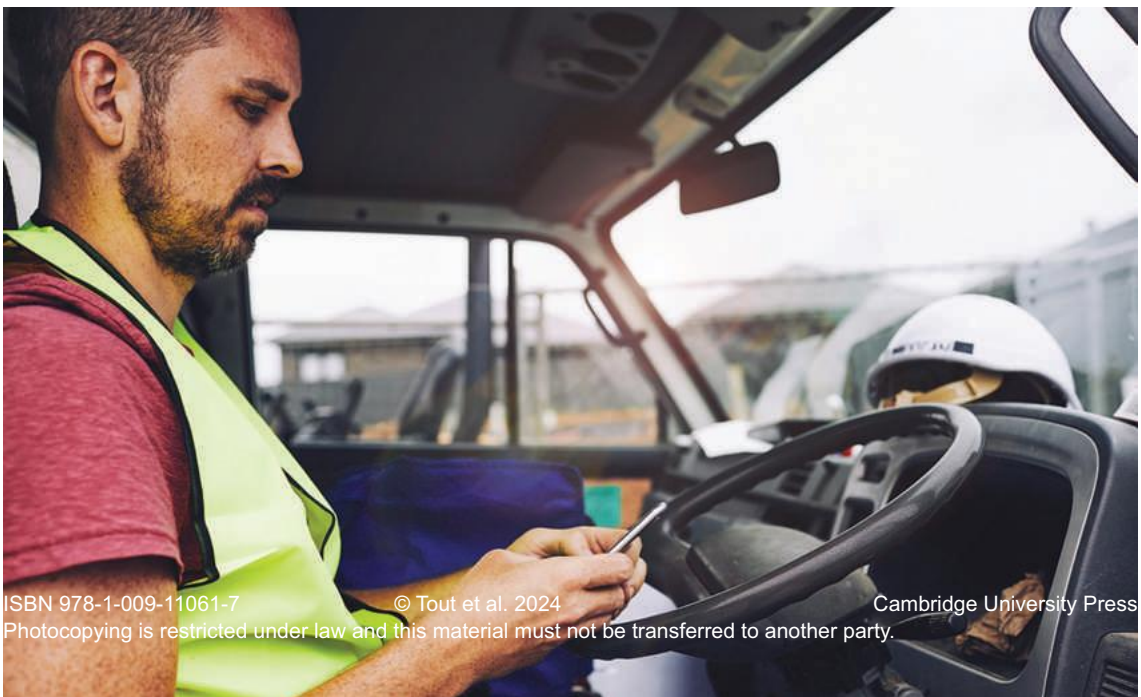
Skills questions

2 Turn the following into mathematical sentences.

- **a** Five times eight plus sixty-four.
- **b** Forty-two divided by seven plus five times fifteen.
- **c** Two bags of apples at $4.99 and 5 bags of potatoes at $3.75.
- **d** Twelve plus thirty-two take away eighteen lots of three.
- **e** Five lots of $15 with six lots of $45.
- **f** $75 plus thirty items at a cost of $24 each.

3 Complete the tasks below for the following situations.

- **i** Write word sentences to describe the relationship.
- **ii** Turn your word sentence into a mathematical sentence.
  - **a** Four pies at $6.50 and two apple turnovers at $5.25.
  - **b** You buy two icypoles at the canteen for each of your mates at $1.75 each icypole.
  - **c** Four friends go to the movies. Movie tickets cost $19.95 each and one friend buys two large popcorns to share at $11.35 each.
  - **d** You get a Public Transport Victoria fine of $224 for putting your feet on the seat on the train. Your V-Line fare is $16 each way and you make 8 trips during the week. What is the total cost for the week?
  - **e** Your aunty gives you two rabbits for your birthday. A hutch costs $130, hay costs $12 for a one-month supply and food costs $20 for a two-week supply. What are the total costs over one year.
  - **f** Your employer pays you a daily food and meal allowance of $50 when you travel out of town for a day's work. You also get paid a distance allowance of 55 cents per kilometre that you travel.



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Mathematical literacy

4 Explain **algebra** to someone using between 10 and 20 words.

Application tasks

5 Eli sells cakes at the local Sunday market. What is the correct formula for working out his profit? Here are some details about his costs and charges.

- Eli's profit depends on how many cakes he sells.
- To calculate Eli's profit, subtract the costs that he has, which are described below.
- One of his two costs is the hire of the market stall, which is $70.
- The other of the costs is the cost of making the cakes. Each cake costs Eli $2 to make.
- Eli sells each cake for $5 at the market.

Use P for the profit Eli makes in dollars, and use n for the number of cakes he sells.

Which formula matches this situation?

A $P = 3n$

B $P = 3n + 70$

C $P = 5n - 70$

D $P = 5n - (2n + 70)$

E $P = 5n - 70n$



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6 Bella is an electrician. What is the correct formula for calculating Bella's charges when she works? Here are some details about her costs and charges.

- Bella's charges depend on how long she spends working.
- Bella's charges include two parts: a fixed charge and an hourly rate.
- Bella's fixed charge for each visit is $75, no matter how long she stays and works.
- Bella charges $120 for each hour she works.

The formula uses the pronumeral h for the number of hours Bella works, and C is used for Bella's total charge, in dollars.

Which formula matches this situation?

A $C = 120h$

B $C = 120h - 75$

C $C = 120h + 75$

D $C = 75h$

E $C = 75h + 120$



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4E Conventions and terminology

There is a formal world of algebra which uses abstract values (like the h and n and other pronumerals we saw earlier). In this section, we will explore some of the conventions and terminology we often use when talking about algebraic expressions and formulas.

Pulling it together – Writing equations and formulas

In the examples above, we looked at some rules and short-cuts that we use in more formal mathematics. We will learn more about these here.

A **formula** is a mathematical rule, written using symbols for variables, which describes relationship between quantities. It can be used to evaluate a real-world value, such as the score in an AFL game.

An **equation** is a mathematical statement containing an equals sign, which shows that two algebraic expressions are equal.

An **expression** is a string of mathematical symbols which are part of a formula or equation, such as $6g + b$ in the AFL formula.

Words, terms and conventions used in algebra

One of the benefits of putting algebra into an everyday context is that it allows us to talk about the simplifications, symbols, conventions, terminology and types of relationships that are used and how they are represented.

Here are some more examples of the words and symbols we use in the world of formal mathematics, based on the example of Aussie Rules football: $p = 6g + b$.

Word or term used in mathematics	Meaning
Pronumeral	When we use a letter like g, b and p to stand for something like goals, behinds and points, the letter is called a **pronumeral**. We do not have to use the first letter of a word, but it can help to keep track of the symbols.
Subject	In the formula $p = 6g + b$, the p is called the **subject** of the formula. Just as in English, the subject tells us what the mathematical sentence is about.
Variable	In $p = 6g + b$, the p, g, and b are also called **variables** – because their values **vary** from one situation (football game) to another.

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Word or term used in mathematics	Meaning
Dependent and independent variables	In $p = 6g + b$, the number of points, p, is called the **dependent** variable in the formula because its value **depends** on the value of the other two variables (which are the number of goals kicked, g, and the number of behinds, b). The variables g and b are called **independent** variables.
Constant	A **constant** is a term in the formula or equation that has a fixed value which does not change or vary – it is **constant**! In $p = 6g + b$, the **6** is a constant – it is the number of points you get for each goal that is kicked – so it is always a 6. The 6 is constant.

More about symbols and conventions

As we saw in Chapter 2, there are different words and symbols used for the different operations. Here is how we usually use them in algebra.

Operation	Symbol
Equals	=
Multiplication	We do not normally use the × sign between numbers and pronumerals in algebraic expressions. When we multiply a number by a letter (pronumeral), like in $p = 6g + b$ above, the $6g$ means 6 times g.
Addition	+
Subtraction	–
Division	In algebra, we usually use a line, — like in a fraction. For example: $s = \frac{d}{t}$ This means that to work out s, you need to divide d by t.

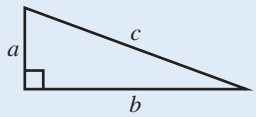
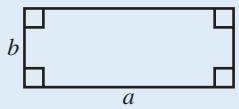
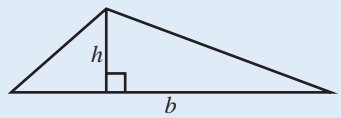
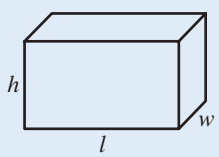
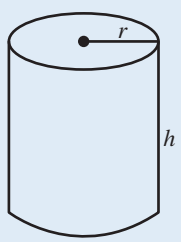
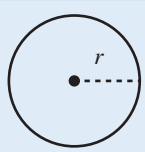
Some other common formulas related to measurement

Here are some examples of formulas related to measurement that are used in everyday situations, jobs and workplaces. It's surprising how many occupations require the use and application of formulae, and not just the mathematically-based jobs like engineering, surveying and architecture.

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Lengths, areas and volumes

Many occupations, such as building and construction, painting, landscaping, asphalting and paving, need to use formulas to calculate lengths, areas and volumes for different shapes. Here are some, many of which you will have seen before.

Diagram	Description	Formula
	The **Pythagorean rule** for a right-angled triangle with sides a, b and c, where c is the hypotenuse.	$a^2 + b^2 = c^2$
	**Area** of a rectangle with length a and width b.	Area $= a \times b$ A $= ab$
	**Area** of a triangle with perpendicular height h and base b.	$Area = \frac{1}{2} b \times h$ $A = \frac{1}{2bh}$
	The **circumference** of a circle with radius r.	Circumference $= 2 \times \pi \times r$ $C = 2\pi r$
	The **area** of a circle with radius r.	Area $= \pi \times r^2$ $A = \pi r^2$
	**Volume** of a cuboid (rectangular prism) with length l, width w and height h.	Volume $= l \times w \times h$ $V = lwh$
	**Surface area** of a closed cylinder with radius r and height h.	Area $= 2 \times \pi \times r^2 + 2 \times \pi \times r \times h$ $= 2 \times \pi \times r \times (r + h)$ $A = 2\pi r\,(r + h)$
	Volume of a cylinder with radius r and height h.	Volume $= \pi \times r^2 \times h$ $V = \pi r^2 h$
	**Surface area** of a sphere with radius r.	Area $= 4 \times \pi \times r^2$ $A = 4\pi r^2$
	Volume of a sphere with radius r.	Volume $= \frac{4}{3} \times \pi \times r^3$ $V = \frac{4}{3}\pi r^3$

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Temperature

Fahrenheit to degrees Celsius	$C = \frac{5}{9}(F - 32)$
Degrees Celsius to Fahrenheit	$F = C \times \frac{9}{5} + 32$

Travel and speed

Speed, distance and time	Speed s is a measure of how quickly something moves, and it is calculated by dividing the distance travelled d by the time taken t. The speed formula can be rearranged to have d or t as the subject.	$s = \frac{d}{t}$ $d = s \times t$ $t = \frac{d}{s}$



Example 2 Identifying the parts of an algebraic formula

The formula for converting temperature in degrees Celsius to Fahrenheit is

$F = C \times \frac{9}{5} + 32$

Identify the following:

a The pronumerals used
b The subject of the formula
c The variables used
d The dependent variable
e The independent variable
f Any constants

THINKING	WORKING
STEP 1	
a Pronumerals are letters used to stand for something.	The pronumerals are F and C.
b The subject of the formula is a letter on its own on one side of the equals sign.	The subject of the formula is F.
c Variables and pronumerals are the same thing.	See part **a**.
d The dependent variable changes based on the value of the independent variables. In this case, F changes as C varies.	F is the dependent variable.

... continued

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e The independent variable changes value, impacting the dependent variable. In this case, C varies and impacts F.

C is the independent variable.

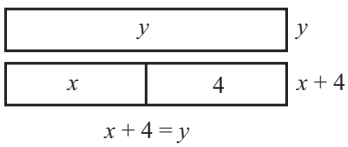
f A constant is a term in the formula or equation that has a fixed value which does not change or vary.

32 and $\frac{9}{5}$ are constants.

4E Tasks and questions

Thinking task

1 The Singapore bar method is one way of picturing algebraic expressions.



Use the Singapore bar method to draw out the following.

a $x + 2 = 6$ **b** $x + 5 = 24$ **c** $x + 3 = y$

d $x + 7 = y$ **e** $18 + x = y$ **f** $x = y + 9$

Skills questions

2 Identify the variables in the following formulae.

a $C = \pi D$

b time (mins) × drops per minute = volume

c dose ordered / solution concentration = volume per hour

d floor area percentage = total floor area / total site area × 100

3 Identify the dependent variable or variables in the following formulas.

a $A = \pi r^2$

b $A = l \times w$

c A (desired amount) / H (dose on hand) × V (volume) = D (dose)

d Interest = $P \times r \times t$, where P = principal, r = interest rate as a decimal and t = time

4 Identify the independent variable or variables in the following formulas.

a $\text{Discount percentage} = \dfrac{\text{discount}}{\text{marked price}} \times 100$

b $\text{Average stock} = \dfrac{(\text{opening stock} + \text{closing stock})}{2}$

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c $\dfrac{\text{The sum of the data points}}{\text{the number of data points}} = \text{the mean}$

d $V = \dfrac{(l \times w \times h)}{3}$

5 The time (in minutes) to cook a chicken depends on its weight. One way to work this out is to multiply its weight in kilograms by 45 minutes and add on an extra 15 minutes.

Which formula matches this situation?

A $t = 15w + 45$ **B** $t = 45w + 15$ **C** $zt = 60w$ **D** $t = 45 + 15$

6 If you make tea using tea leaves and a tea pot, a rule of thumb to work out how much tea to put in is the following. *One teaspoon per person and one extra for the pot.*

Which formula matches this situation?

A $t = p + 1$ **B** $t = p + t$ **C** $t = 2p$ **D** $t = p\,(p + 1)$

7 The body mass index (BMI) is sometimes used to help determine whether an adult is underweight or overweight. It is calculated by dividing your weight, in kilograms, by your height, in metres, squared.

Which formula matches this situation?

A $BMI = \dfrac{w}{2h}$ **B** $BMI = \dfrac{w}{h^2}$ **C** $BMI = \left[\dfrac{w}{h}\right]^2$ **D** $BMI = wh^2$



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Mixed practice

8 Answer these questions about some common formulas.

a What are the three **variables** in the formula: $V = \pi r^2 h$?

b What is the **dependent** variable in the formula: Area = $\pi \times r^2$?

c What is the **independent** variable in the formula: $C = \frac{5}{9}(F - 32)$?

d What is the **constant** in the formula: Area = $\pi \times r^2$?

Mathematical literacy

9 Remember back in Chapter 1 we 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 we met above. Write down the ways these words are used in everyday life – and explain how they might be related to the way we use them in the maths world. Some of the words might only be maths words and might not be used outside the maths classroom. One is done for you as an example.

Word	Meaning of the word in everyday life – or are they not used outside maths?
Pronumeral	
Subject	
Variable	
Dependent	In everyday life, this can mean you rely on someone or something else for assistance or support.
Independent	
Constant	

Application task

10 For the following formulae, identify and explain the meaning of each variable.

a Profit = Selling price – Cost price

b $A = \pi r^2$

c $C = 2\pi r$

d $V = \frac{1}{3}Ah$

e $V = \frac{4}{3}\pi r^3$

f $l = \frac{\theta}{360} \times 2\pi r$

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4F Applying your skills

We have seen how algebra works as a generalisation for different calculations. This section helps us practise using algebraic formulas with different values. When we use an algebraic formula, we substitute numerical values in place of the variables or pronumerals in the formula.

It is important to check whether your answer is reasonable. If not, you could end up with too much of something – remember the apprentice in Chapter 1 whose calculation meant that 15 cement mixer trucks could have turned up for one very small concreting job! Or, you could end up not having enough of something and waste time collecting it or waiting while it is delivered. Either way, it means added cost to the job that the boss will not be happy about. So, when using **substitution** (any time you use a formula!), it's important to **estimate** the answer before you do the calculation, and check the reasonableness of the answer you do get (which is just using your **common sense**).

Back to AFL

Here are some other AFL scores.

Team	Goals	Behinds	Points
Carlton	9	15	
Adelaide	15	8	
Fremantle	10	12	
Sydney	15	8	

To work out the score for Carlton, who kicked 9 goals (so $g = 9$) and 15 behinds (so $b = 15$), we need to put 9 and 15 into the formula (this process of calculating the answer by putting specific values into a formula is called **substitution**).

$p = 6g + b$

$p = 6 \times 9 + 15$

$p = 54 + 15 = 69$ points

Number of points scored by Carlton was 69.

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Example 3 Substitution

Team	Goals	Behinds	Points
Carlton	9	15	69
Adelaide	15	8	
Fremantle	10	12	
Sydney	15	8	

Given $p = 6g + b$, calculate the points scored by the following three teams:

a Adelaide
b Fremantle
c Sydney

THINKING	WORKING
STEP 1	
Replace g and b with the known values for each team.	
a Replace g with 15 and b with 8	$p = 6(15) + 8$
b Replace g with 10 and b with 12	$p = 6(10) + 12$
c Replace g with 15 and b with 8	$p = 6(15) + 8$
STEP 2	
Evaluate the resulting expressions to find the value of p	a $p = 6(15) + 8 = 90 + 8 = 98$ b $p = 6(10) + 12 = 60 + 12 = 72$ c $p = 6(15) + 8 = 90 + 8 = 98$

Example 4 Substitution

To calculate the cost of an UberX fare in Melbourne, we use the following formula

$$Fare = Base\ Fare + (Cost\ per\ minute \times time\ in\ ride) + (Cost\ per\ km \times distance) + booking\ fee$$

We also know that

- base fare: \$2
- per minute: \$0.35
- per kilometre: \$1.15
- booking fee: \$0.55

Write the above formula algebraically, then use it to determine the cost of a journey of 10 km that takes 12 minutes.

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THINKING	WORKING
STEP 1	
Rewrite the formula using pronumerals.	Let: F = Fare B = Base fare, in dollars C = Cost per minute, in dollars t = Time of ride, in minutes K = Cost per km, in dollars d = Distance of trip, in km b = Booking fee, in dollars So $F = B + Ct + Kd + b$
STEP 2	
Substitute the fixed costs and rates in.	$B = 2$ $C = 0.35$ $K = 1.15$ $b = 0.55$ So $F = 2 + 0.35t + 1.15d + 05.5$
STEP 3	
Substitute in the values associated with this particular journey.	$d = 10$ $t = 12$ $F = 2 + 0.35 \times 12 + 1.15 \times 10 + 0.55$ $= 2 + 4.2 + 11.5 + 0.55$ So $= 18.25$
STEP 4	
State the final results.	$F = 2 + 0.35t + 1.15d + 0.55$ using UberX for a journey of 10 km that takes 12 minutes will cost $18.25.

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4F Tasks and questions

Thinking task

1 It is important to pay attention to the units you are using when you carry out substitution.

- **a** Why do you think this is important?
- **b** What units are involved in the UberX example?
- **c** What would happen if you substituted time in *hours* instead of time in *minutes* for the UberX example?

Skills questions

2 **a** The Women's Big Bash League (WBBL) is the Australian women's domestic Twenty20 cricket competition. They keep a record of the number of runs they make – the number of sixes, fours and singles. Calculate the number of runs for the following WBBL players in the 2020 final. As an example, Heather Knight scored $1 \times 6 + 2 \times 4 + 12 = 26$ runs.

Name	Sixes	Fours	Singles	Balls faced
Heather Knight	1	2	12	19
Rachel Trenaman	0	5	3	26
Rachel Haynes	1	2	7	17
Katherine Brunt	0	0	22	27
Annabel Sutherland	1	1	10	20

b The strike rate is calculated by dividing the number of runs scored by the number of balls faced. The algebraic formula for this is shown here.

$k = \frac{r}{b}$ where k is the strike rate

r is the number of runs scored

b is the number of balls faced

Calculate the strike rate for each of the players. Round your answers to 2 decimal places where necessary.

3 We looked earlier at a formula for a plumber's charges. A different plumber charges a \$50 call-out fee for coming to your house, and then charges \$150 per hour for the time they spend working on the job.

In this case, the formula for their charges would be the following.

$C = 150h + 50$

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Use this formula to work out the charges for different job times.

a How much would the plumber charge if they worked for 5 hours?

b How much for two and a half hours?

c How much for 45 minutes?

4 An employer pays their worker a $100 daily food and meal allowance for travel out of town for a day's work. They also pay a distance allowance of 75 cents per kilometre.

a How much allowance would the worker be paid for one day's work if they travelled a total of 200 km in that day?

b How much allowance would the worker receive if they travelled 340 km over two days?

c Can you write a formula that will calculate the worker's allowance for any number of days and any number of kilometres?

Mathematical literacy

5 Choose one of the formulas shown in section 4E. Place a large copy of this formula in the centre of a landscape A4 page.

- Add the following labels to the formula: *pronumeral*, *subject*, *variables*, *dependent variable*, *independent variable* and *constant*.
- Show a worked example of a substitution using this formula.

Share and discuss your diagram with other students or display it on a wall.

Application tasks

6 Practice substitution by calculating the following. The formula is given in each part.

Write down an **estimate** of the answer first.

Perform the substitution and calculation.

Check how reasonable the answer is, considering your estimate.

a Area of a rectangle: $A = l \times w$

i Length (l) = 18 cm
Width (w) = 24 cm

ii Length (l) = 7.8 cm
Width (w) = 2.5 cm

iii What units will the answers be in?

iv Was your estimate realistic? How could you improve it for your next calculation?

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b Volume of a rectangular prism: $V = l \times w \times h$

i Length (l) = 235 mm
Width (w) = 147 mm
Height (h) = 150 mm

ii Length (l) = 23.5 cm
Width (w) = 14.7 cm
Height (h) = 15 cm

iii What units will the answers be in?

iv Was your estimate realistic? How could you improve it for your next calculation?

c Area of a circle: $A = \pi r^2$ (Round answers to 2 decimal places.)

i Radius (r) = 4 cm

ii Radius (r) = 1.35 m

iii What units will the answers be in?

iv Was your estimate realistic? How could you improve it for your next calculation?

Hint If you do not have a π key on your calculator, use 3.14 as the value for π)

7 Calculate the UberX fares using the following algebraic formula.

$F = 2 + 0.35t + 1.15d + 0.55$

a A journey of 15 km that takes 10 minutes.

b A journey of 57 km that takes 1 hour and 5 minutes.

c A journey of 32.3 km that takes $\frac{3}{4}$ of an hour.

d A journey of 42.3 km that takes $\frac{3}{4}$ of an hour.

8 Use Google Maps to find the distance of the following car journeys and the estimated time to complete them. Use the UberX formula from question 7 to calculate the cost of taking an UberX for that journey.

a Between your home and the centre of Melbourne (or the centre of your nearest major town if you are regional).

b Between your home and a friend's home.

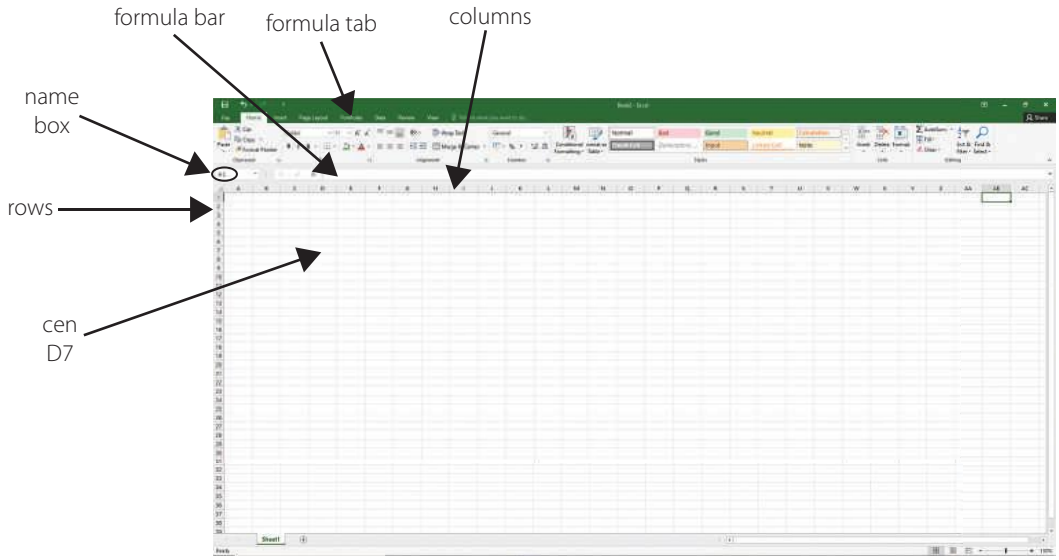
c Between your school and the closest TAFE or university.



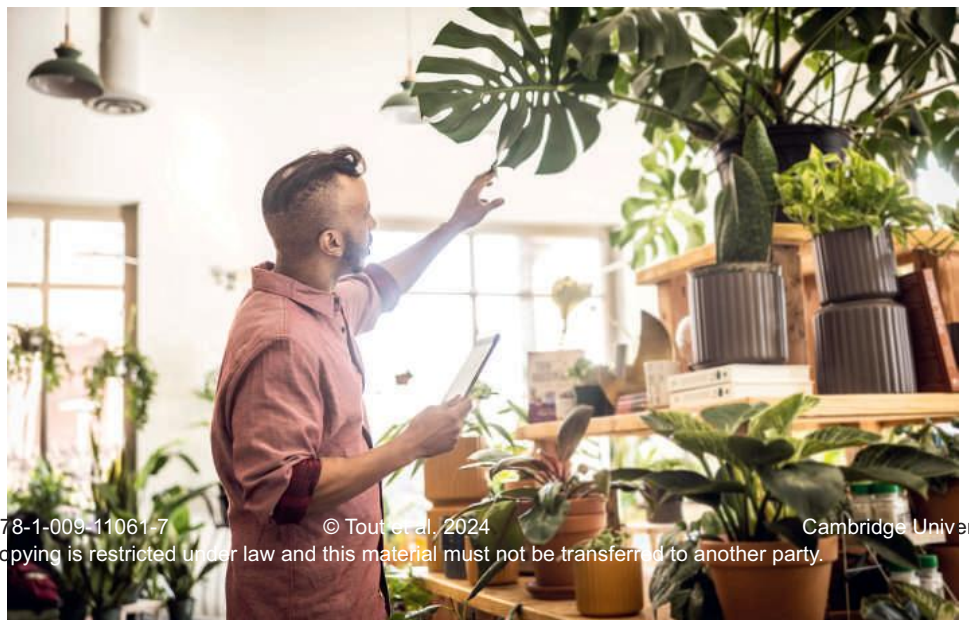
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4G Formula use in spreadsheets

Spreadsheets are a great way to keep track of the information and data required in a business, whatever its size! Small businesses such as sole trader landscapers, plumbers and cafe owners might use spreadsheets to keep track of income (money in) and expenditure (money out), and undertake calculations based on that data. Larger stores and businesses use spreadsheets to manage stock – listing the number of items in the store along with their barcode and alerting managers when stock needs re-ordering.



Spreadsheets do more than just display the data. Many spreadsheets allow for calculations to be performed, and data can be graphed easily into many different representations. Spreadsheets incorporate a range of mathematical operations and formulae. The trick is knowing the language of spreadsheets and how they work.



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Example 5 Using formulas in spreadsheets

The number of points scored in AFL = 6 × the number of goals + the number of behinds.
Calculate the number of points scored for each of the following teams.

TEAM	GOALS	BEHINDS
Gold Coast	10	5
Carlton	7	8
Sydney	21	13
Melbourne	18	11
Fremantle	7	15
Essendon	25	9
Geelong	19	10

THINKING **WORKING**

STEP 1

In Excel, enter the data or download it from the Interactive Textbook

	A	B	C	D
1	**TEAM**	**GOALS**	**BEHINDS**	**POINTS**
2	Gold Coast	10	5	
3	Carlton	7	8	
4	Sydney	21	13	
5	Melbourne	18	11	
6	Fremantle	7	15	
7	Essendon	25	9	
8	Geelong	19	10	

STEP 2

Click the cell D2. Type the general command of = to start the formula.

	A	B	C	D
1	**TEAM**	**GOALS**	**BEHINDS**	**POINTS**
2	Gold Coast	10	5	=

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STEP 3

In AFL, each goal is worth 6 points. We enter this as a formula in the Formula bar, or straight into a cell.
Click the cell B2, and notice the cell B2 automatically is entered. This represents the number of goals for the Gold Coast.
Then type *6 to multiply this number by 6.

	A	B	C	D
1	**TEAM**	**GOALS**	**BEHINDS**	**POINTS**
2	Gold Coast	10	5	=B2

	A	B	C	D
1	**TEAM**	**GOALS**	**BEHINDS**	**POINTS**
2	Gold Coast	10	5	=B2*6

STEP 4

Add the behinds for the Gold Coast by typing +, then clicking the cell C2.

	A	B	C	D
1	**TEAM**	**GOALS**	**BEHINDS**	**POINTS**
2	Gold Coast	10	5	=B2*6+C2

STEP 5

Evaluate the formula by pressing the ENTER key.

	A	B	C	D
1	**TEAM**	**GOALS**	**BEHINDS**	**POINTS**
2	Gold Coast	10	5	65

STEP 6

To quickly apply the formula to all cells, place the cursor over the cell until it changes. Grab the box at the bottom right corner and drag it down to the bottom right corner of cell D8.

	A	B	C	D
1	**TEAM**	**GOALS**	**BEHINDS**	**POINTS**
2	Gold Coast	10	5	65
3	Carlton	7	8	50
4	Sydney	21	13	139
5	Melbourne	18	11	119
6	Fremantle	7	15	57
7	Essendon	25	9	159
8	Geelong	19	10	124

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4G Tasks and questions

Thinking task

1 Open a spreadsheet application such as Excel or Google Sheets.

What do you notice about the layout?

Look at the Formula bar.

Look at what is available on the Formula tab.

What did you find in relation to maths-related formulae?

Skills questions

2 Use the spreadsheet to enter the following calculations. Remember to always start an equation with = and use the following commands.

+ for addition

– for subtraction

* for multiplication

/ for division

a 5×3 **b** $6 \div 2$ **c** $5 \times 4 \times 7$

d $397 \div 4$ **e** $2000 \div 2 + 56 - 3257$

3 Set up your spreadsheet so that in cell A1 you have the number 54, and in cell B1 you have the number 3.

Place the curser in cell C1. Enter the following relationships.

a cell A1 ÷ B1 (Hint: Use your mouse to select each cell.)
b cell A1 + B1
c cell A1 × B1
d cell B1 ÷ A1
e cell B1 ÷ B1

4 **Adding a column of numbers**

a Enter the following numbers into cell D1 to D12.
25 17 83 23 94 56 37 82 91 77 5 11
b Add the numbers using =sum(D1,D12)
c Add the numbers using the 'autosum' function.
d Find the average of the numbers, correct to 2 decimal places
e Find the largest number. (Hint: Maximum)
f Find the lowest number.

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Mathematical literacy

5 Using the internet, find and list six or more types of workplaces that use spreadsheets, and describe what they use them for.

Application tasks

6 Using the first tab named 'Standard', we are going to insert another sheet. Rename your sheets as shown.



Copy the data from Standard by selecting columns A and B and pasting it into cell B1 in the Supergoal sheet.

Make a new heading for column A – Supergoal.

Add the following data to column A.

	A	B	C	D
1	Supergoals	Goals	Behinds	
2	1	10	5	
3	1	7	8	
4	0	21	13	
5	3	18	11	
6	2	7	15	
7	1	25	9	
8	1	19	10	
9				
10				

a Each supergoal is worth 9 points. In column D, enter the formula to calculate the points value for supergoals.

b Each goal is worth 6 points. In column E, enter the formula to calculate the points value for goals.

c Each behind is worth 1 point. In column F, create values for each behind. (Hint: Do not enter each data value individually).T

d In cell G1, write the heading **Total points**. In column G, enter a formula to calculate the total number of points. (Hint: Use the sum function.)

e In column H, find the total using just the first 3 columns. In words, the formula is 9 × supergoal + 6 × goal + behinds. (Hint: Don't forget to start with =.)

f Find the sum of all the points.

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4H Manipulations

Sometimes, when using a formula we need to work in reverse. We call this 'working backwards'. This happens when we know the end result from the calculation in a formula, and we want to work out what values we need to get that answer.

Transposition

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 – leads us to what we call **transposing** a formula in mathematics.

Transposing mathematically

To be able to **transpose** formulas to solve equations, we need to understand the relationships between the operators (+, –, ×, ÷).

Remember the picture of the BODMAS staircase in Chapter 3? It showed Division and Multiplication together on the same step, and Addition and Subtraction together on the step below. This is important to know because the operations on the same step of the staircase are the opposite of each other. So, Division is the opposite of Multiplication, and Addition is the opposite of Subtraction. This is handy to know when we are transposing.

Let's look at some examples.

Example 6 Making a variable the subject

Make y the subject of the equation $y + 2 = 5$

THINKING	WORKING
STEP 1	
Determine the operation that has been applied to y.	2 has been added to y.
STEP 2	
Apply the opposite operation to both sides to isolate y	The opposite operation of adding 2 (+ 2) is subtracting 2 (– 2). $y + 2 - 2 = 5 - 2$ $y = 3$

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Example 7 Transposing formulas to determine a value

In AFL, $p = 6g + b$, where p = the number of points, g = the number of goals, and b = the number of behinds.

a If a team scored 100 points and kicked 14 goals, how many behinds did they kick?

b If a team scored 100 points and kicked 10 behinds, how many goals did they kick?

THINKING	WORKING
STEP 1	
Substitute the known values into each of the formulas.	**a** $100 = 6 \times 14 + b$ So $100 = 84 + b$ **b** $100 = 6g + 10$
STEP 2	
Determine the operations that have been applied to the variable, in order. Note that, in part **b**, we know that g was multiplied by 6 first because, if 10 had been added first, we would see $6(g + 10)$.	**a** 84 has been added to b. **b** g has been multiplied by 6, then 10 has been added.
STEP 3	
Identify the opposite operations for each of these.	**a** The opposite operation of adding 84 (+ 84) is subtracting 84 (– 84). **b** The opposite operation of multiplying by 6 (× 6) is dividing by 6 (÷ 6). The opposite operation of adding 10 (+ 10) is subtracting 10 (– 10)
STEP 4	
To isolate the pronumeral, apply the opposite operations to each side of the equation in **reverse** order.	**a** $100 - 84 = 84 + b - 84$ $16 = b$ **b** $100 - 10 = 6g + 10 - 10$ $90 \div 6 = 6g \div 6$ $15 = g$
STEP 5	
State the final results.	**a** They scored 16 behinds. **b** They scored 15 goals.

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Here are some more examples to help with the questions.



Example 8 Transposing equations in two variables involving addition and subtraction

Make c the subject of $c - d + 5 = 7$.

THINKING	WORKING
STEP 1	
Determine the operations that have been applied to c.	d has been subtracted, and 5 has been added.
STEP 2	
Identify the opposite operations for each of these.	The opposite of adding d $(+ d)$ is subtracting d $(- d)$. The opposite of adding 5 $(+ 5)$ is subtracting 5 $(- 5)$.
STEP 3	
To isolate c, apply the opposite operations to each side.	$c - d + 5 + d - 5 = 7 + d - 5$ $c = 2 + d$

Note: Remember to work out the sequence of what was done to the variable we are making the subject, and work backwards.
Addition and subtraction are opposites, and multiplication and division are opposites.



Example 9 Transposing equations in two variables involving multiplication and division

Make f the subject of $2f = \frac{h}{3}$.

THINKING	WORKING
STEP 1	
Determine the operations that have been applied to f.	f has been multiplied by 2.
STEP 2	
Identify the opposite operations of this.	The opposite of multiplying 2 $(\times 2)$ is dividing by 2 $(\div 2)$.

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STEP 3

To isolate f, apply the opposite operation to each side.

$$2f \div 2 = \frac{h}{3} \div 2$$

$$f = \frac{h}{6}$$

Note: Remember to work out the sequence of what was done to the variable we are making the subject, and work backwards.
Addition and subtraction are opposites, and multiplication and division are opposites.

4H Tasks and questions

Thinking task

1 Sometimes it helps to see transpositions visually. Use sticky notes for this activity.

- **a** On the first sticky note, write **speed**.
- **b** On the second, write **equals**.
- **c** Then, on the next ones write **distance**, **divided**, **multiplied, by** and lastly **time**.
- **d** Place the notes down in the following order.
  Speed equals distance divided by time
- **e** Rearrange the formula to make the subject **distance**, and then rearrange again to make the subject **time**.

Try this activity with other formulas, such as $V = l \times w \times h$ and $I = \frac{PRT}{100}$.

Skills questions

2 Transpose the following formuale to make y the subject.

a $y + 2 = 7$ **b** $y + 2 = x$ **c** $2 + y = x$ **d** $x - 2 = y$
e $y + 5 = 7 + z$ **f** $y - x = 6 - q$ **g** $2 + a = 8 - y$ **h** $g + 7 - y = x + 4$

3 Transpose the following formuale to make A the subject.

a $2A = 8$ **b** $2A = x$ **c** $\frac{A}{2} = 24$ **d** $\frac{A}{2} = x$

e $2A = \frac{y}{8}$ **f** $w = \frac{A}{l}$ **g** $2A = b \times h$ **h** $\frac{2A}{h} = a + b$

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4 Transpose the following formulae.

a Make F the subject. $m = \frac{F}{a}$

b Make r the subject. $c = 2\pi r$

c Make l the subject. $A = l \times w$

d Make h the subject. $V = l\,w\,h$

e Make b the subject. $A = \frac{b+h}{2}$

f Make u the subject. $a = \frac{v-u}{t}$

Mathematical literacy

5 Find formulae on the internet for calculating a taxi share.

a Write the formula out in words.

b Write the formula out formally using mathematics symbols and conventions.

Applications

6 Steph loves photography and decides to try to sell some of her photos by hiring a stall at the next community market in her town.

The charge to hire the stall is $100 for the day. She decides to sell her photos for $25 each.

Answer the following questions.

a Write a formula to show how much money Steph makes from the market, showing a connection between the amount of money she takes home and the number of photos she sells.

b How much money does Steph make if she sells 10 photos? Show how to calculate this using your formula.

c How much money does Steph make if she sells 24 photos?

d How many photos does Steph need to sell to **break even** on the day? (To **break even** is when the money you earn equals the money you had to spend, so for Steph this means covering her hire of the stall.)

e How many photos does Steph need to sell to make $200?

7 Manuel is an electrician who charges a $40 call-out fee for coming to your house and then charges $90 per hour for the time they spend working on the job.

a What is a formula to work out what Manuel charges for different job times?

Use the formula to answer the following questions.

b How much would Manuel charge if he worked on a job for 4 hours?

c How much for two and a half hours?

d How much for 45 minutes?

e How many hours would Manuel need to work to earn $400?

f How many hours would Manuel need to work to make $1000?

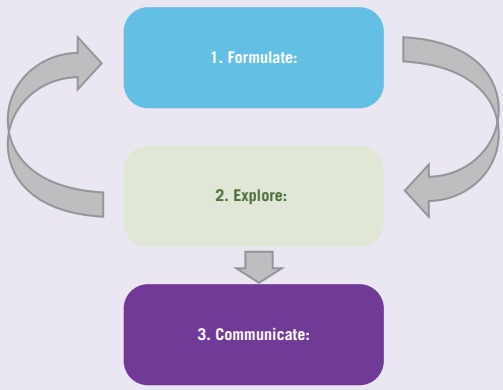
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Investigations

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

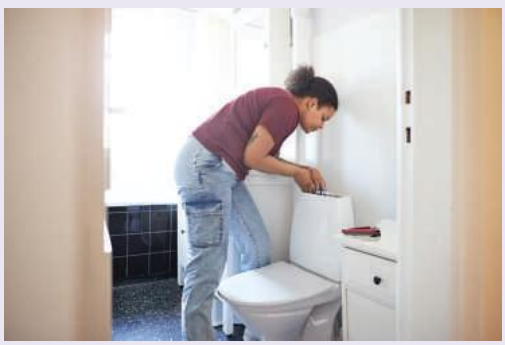
- **Formulate** – Sort out and plan what you need to know and need to do to solve the problem.
- **Explore** – Use and apply the maths required to solve the problem.
- **Communicate** – Record and write-up your results.

1 Fix my drain



Have you ever had an emergency plumbing issue on the weekend or on a public holiday? How much does it cost to get a tradesperson to attend on a weekday, and how much more expensive is it on the weekend or public holiday?

The scenario



Five friends are staying with you over the holiday period and the toilet is 'stuffed'. You have tried the DIY options and admit that you need professional assistance!

You call a couple of numbers for quotes and realise it will take 2 hours to fix the toilet.

Things you need to know:

Call-out fee = the amount you pay, regardless of how long the job takes.

Hourly rate = the amount the plumber will charge for each hour of work.

Quote = an estimate of how much the job will cost. If the quote is in writing, it is the agreed price for doing the work.

Task:

a What is the range of call-out fees for plumbers in Melbourne?

b What is the range of hourly rates for plumbers in Melbourne?

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c Explain how these rates would be affected by where you live in Victoria.

d How do you think these rates would be affected if you had a plumber come to your house on the weekend or a public holiday? Explain whether or not you think that this is fair.

Here is a break-down of three plumbers' charges:

Plumber	Call-out fee	Hourly rate	Surcharge for weekends	Surcharge for public holidays
Jonah	$65	$80	8%	15%
Sam	$55	$100	10%	20%
Assan	$75	$95	5%	10%

e Enter this data into an Excel spreadsheet.

f Calculate the cost of each plumber if the job is done during the week.

Hint Use a spreadsheet to help with your calculations.

g Calculate the cost of each plumber if the job is done on the weekend.

h Calculate the cost of each plumber if the job is done on a public holiday.

i Write word equations to calculate the costs of each plumber in each different situation.

2 Work trip



Imagine you work for a small national company, and they have asked you to go on a work trip for three full days and four nights to the central business district of Brisbane. They will pay airfares and have provided you with a budget. The company has a policy that employees should minimise expenses on work trips. They give you a company credit card to use for your expenses.

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The rules for using the company credit card are as follows.

- Accommodation – $190 per night maximum.
- Meal allowance per day – $28 for breakfast, $35 for lunch and $55 for dinner.

Brisbane taxi rates are as follows.

- Flag fall is $3 plus $2.25 per kilometre with a booking fee of $3.

Your task is to create a spreadsheet of your expenses for this business trip.

a Research your accommodation to calculate this cost. Include a photo and hyperlink.

b Research the distance between the airport and your accommodation to calculate the taxi fares.

c Research the menus of restaurants and cafes near your accommodation to calculate the cost of your meals.

d Are there any other expenses that need to be included before you finalise your report?



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Key concepts

- **Algebra** is a way of writing mathematical sentences to describe relationships.
  - **Formulas** are rules written using pronumerals which describe relationships between real-world quantities.
  - **Equations** are mathematical statements with an equals sign.
  - An **expression** contains pronumerals, numbers or symbols, but does not contain an equals sign.
  - **Pronumerals** or **variables** are letters that we use to represent a quantity.
  - A **constant** is a number with a fixed value.
- We can **substitute** numbers for pronumerals in equations and formulas.
  - For instance, the area of a square is $A = l^2$. Substituting $l = 3$ metres, $A = 3^2 = 9$ square metres.
- **Spreadsheets** can be used to perform algebraic calculations.
- Sometimes we need to **manipulate** a formula to make a particular pronumeral the **subject**.
  - We first must identify the sequence of operations, in order, that have been applied to the pronumeral we want to make the subject.
    - For instance, in the formula $p = 6g + b$, g has been multiplied by 6, and then b has been added.
  - We apply the **opposite operations** to this pronumeral in reverse order.
    - Recall that addition and subtraction are opposite operations, and that multiplication and division are inverse operations.
    - If we were to make g the subject in the above formula, we would first subtract b, then divide by 6.

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Success criteria and review questions

☐ I can recognise where algebra is used.

1 Give three examples where algebra is used in trade or industry.

2 Find five formulas on the internet used in trade or industry.

3 Find three apps or online calculators that do algebraic formulae.

☐ I can write mathematical sentences.

4 Write the following as mathematical sentences.

a Five times sixteen plus twenty-three.

b Twenty-eight divided by four plus nine lots of twelve.

c Five and three together in 8 groups.

d Fourteen minus eight plus two groups of six.

e Three lots of twenty-seven take away nine groups of five.

5 Write the following as mathematical sentences.

a Five days of weekday meal-kits at $12 per day for one month.

b Eighteen jumpers at $43 each plus a mark-up of $12 per jumper, with a delivery cost of $24.

c Eight tickets at $25.99 each plus food of $86, divided evenly between a group of 8.

d Eleven friends sharing evenly in a present that costs $58 plus $199.

e A trip for four friends where the costs are: petrol $80, food $165, drinks $65 and accommodation $210 per night for 3 nights. Costs are shared evenly.

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☐ I can recognise the components of algebra.

6 Identify the variables in the following formulae. For each variable, state whether it is:

i Dependent

ii Independent.

a $C = \pi D$

b $V = \frac{(b \times h \times l)}{2}$

c $\text{Density} = \frac{\text{mass}}{\text{volume}}$

d $\text{Food cost} = \frac{(\text{opening inventory} + \text{purchases} - \text{closing inventory})}{\text{food sales}}$

☐ I can understand the terminlogy used in algebra.

7 Match the following terms with the correct explanation below.

Term Pronumeral Expression Constant Equation Variable

a A letter representing a word in an algebraic sentence.

b A mathematical sentence.

c A mathematical sentence with an equals sign.

d A letter in place of a number.

e A number in a formula that doesn't change.

f Part of an algebraic sentence that has a plus or minus before it.

☐ I can transpose formulas.

8 Transpose the following formulas.

a Make y the subject. $x + 21 = 8 - y$

b Make x the subject. $y = 4x + 2$

c Make r the subject. $A = 2\pi rh$

d Make P the subject. $I = \frac{PRT}{100}$

e Make t the subject. $C = \$120 + 5t$

f Make q the subject. $y = \frac{7 + q}{x}$

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☐ I can apply algebra.

9 An electrician has a call-out fee of $110 on weekends and a charge of $75 per hour.

- **a** Write a formula to represent this.
- **b** How much would it cost for 1 hour of work?
- **c** How much for 3.5 hours of work?
- **d** Transpose the formula so that **time** is the subject of the formula.
- **e** If the cost was $410, how many hours of work does this represent?

10 A cafe is catering for a function. The charges include a room-hire fee of $300. Food is $18 per head and drinks are a flat fee of $150 per hour.

- **a** Write a formula to represent this.
- **b** How much would it cost for 50 guests over 3 hours.
- **c** How much would it cost for 75 guests over 4 hours.
- **d** Transpose your formula so that *time* is the subject of the formula.
- **e** If the cost was $1470, how many hours would this represent?

11 Jenny is cooking roast pork for the family. The recipe says to cook it for 30 minutes per 500g, plus 30 minutes on very high at the start to create the pork crackling.

- **a** Write a formula to represent this. Make *cooking time* the subject of the formula.
- **b** How many hours would you need to cook a 3 kg roast? (3 kg ÷ 500 g = 6; 60 minutes = 1 hour)
- **c** How many hours would you need to cook a 2.3 kg roast?
- **d** Transpose the formula so that *weight* is the subject of the formula.
- **e** If the roast took 3 hours to cook, how much did the roast weigh?

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Key vocabulary

Term	Meaning
Algebra	Algebra is a branch in mathematics that deals with symbols or variables (like x and y or p and b) and all the rules for working with and manipulating those symbols.
Constant	A constant is a term in the formula or equation that has a fixed value and does not change or vary e.g., in $p = 6g + b$, the 6 is the only constant.
Dependent and Independent variables	In the formula $p = 6g + b$, the number of points, p, is called the **dependent** variable in the formula because its value depends on the value of the other two variables (the number of goals kicked, g, and the number of behinds kicked, b). On the other hand, the g and b are called **independent** variables.
Equation	An equation is a mathematical statement containing an equal sign which shows that two algebraic expressions are equal.
Expression	An **expression is** a string of mathematical symbols forming part of a formula or equation, such as the $6g + b$ in the AFL formula.
Formula	A **formula** is a mathematical rule written using symbols for variables and describing a certain relationship between quantities. It can be used to evaluate a real-world value, such as the score in an AFL game.

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Term	Meaning
Independent variable	See above – *dependent variable*.
Pronumeral	When we use a letter like g, b, and p to stand for something like goals, behinds and points it is called a **pronumeral**. We do not have to use the first letter of a word, but it helps to keep track of the symbols.
Subject	In the formula $p = 6g + b$, the p is called the **subject** of the formula. Just as in English, the subject tells us what the mathematical sentence is about.
Substitution	The process of calculating the answer by putting specific numerical values into a formula is called substitution.
Transposition	When we re-arrange a formula to make a different variable the subject, we are **transposing** the formula.
Variable	In the formula $p = 6g + b$, the p, g, and b are called variables—because they vary in value from one situation (game) to another.

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5 Behind the statistics – collecting, organising, describing and presenting 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 – data collection and statistics. Prompt questions might be:

- What activity might be happening in this photo?
- What data and information could be collected and represented?
- What type of data might be collected?
- What different ways might the data be collated and represented?
- What different tools, technologies or software might be used?
- What research or investigation questions could be undertaken, based on this photo?

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From the Study Design

In this chapter, you will learn how to:

- explore categorical and numerical data. (Unit 1, Area of Study 2)
- use methods of data collection and organisation (Unit 1, Area of Study 2)
- collect, organise, collate and represent categorical and numerical data (Unit 1, Area of Study 2).

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Chapter overview

Introduction

Today, more and more data and statistical information is collected than ever before. The use of technology means that collecting and recording data is easier than any time in history. Data is used in many aspects of life, whether personal or at work such as in the media, in sport, and when shopping. It is important that we can understand the data and interpret the meaning of the data. Data can be presented in a wide range of formats, such as tables or graphs, and software allows data to be presented easily in any format.

This chapter explores the process of how data is collected, organised and presented. We will look at how to find the story behind the data, and learn how data may be collected.

Learning intentions

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

- distinguish between categorical and numerical data, and explain why this distinction is important
- understand that everybody collects data, and that data is collected for a particular purpose
- describe different methods of collecting primary and secondary data, including surveys, questionnaires, and reliable sources of secondary data
- select the most appropriate method for organising and displaying data, depending on its nature and purpose
- read data displays such as tables and graphs
- construct different types of graphs, such as column graphs, bar graphs, histograms, pie graphs, line graphs and scatterplots
- interpret the real-world meaning and implications of data
- critically evaluate given data or data displays to see if it has been distorted
- apply the problem-solving cycle to complete investigations related to the topics contained within this chapter.

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Spotlight: Kate Gray

An interview with a netball coach

Tell us about the work you've done and what you do now.

I'm a netball coach. I have coached the 15-and-under Australian and Victorian schoolgirls' teams. I've also been head and championship coach of the Victorian Netball League Club, which is the highest level of competition for athletes before they go to national.

What maths do you use regularly in your job? Could you give some examples?

We've had statisticians and uni students who collect data in real time for us. We look at it at an individual level, then a team level. It's a reflection of performance and then we look at how to improve the next performance using that data.

For the different court areas, there are different things that we measure. Some of them are consistent across all players, but the results that we expect of certain players are different. So for our goalers, we take shots per quarter and goals per quarter and we're expecting them to hit a conversion rate of at least 80%.

Another consistent metric is gradual increase over time in a player's performance. That's more qualitative than quantitative and is about athlete perception. It is harder to measure but you tend to use things like a 10-point scale. So it's trend data rather than a single figure.

What is the most useful tool or piece of technology that you use regularly in your job?

We have what we call the heat map, which pulls all the data together. On one page, I can see all my athletes listed and then across the top we've got the headings for how many quarters they've played, how many possessions, errors, goals, etc. I have red coding for a player whose metric is well below expected level, dark green for those well above expected level and then every shade in-between. If I can look down and see a whole heap of green, that's awesome. But if one person's red and everyone else is green, I think 'What's happened there?' It gives us an overview.

What was your attitude towards maths when you were in school?

I wasn't necessarily great at maths, but I was good enough for my options. I use maths in my coaching capacity more than I would have if I hadn't done them as subjects.

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5A Starting activities

Activity 1: Smarties or M&Ms?

Do boxes of Smarties or packets of M&Ms have more red ones?

For this activity, everyone in the class should have either a box of Smarties or a packet of M&Ms.

1. Organise and record the contents of the box or packet by colour. (What are you going to use to organise and record your data – a table, a dot plot?)
2. Compare the results with others in the class.
3. Collate all the class results into separate Smarties and M&Ms datasets.
4. From what you have found so far, are you able to answer whether boxes of Smarties or packets of M&Ms have more red ones? What is meant by 'more' in these samples?
5. What else could be done to the data that has been collected to answer the question?



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Activity 2: Fastest runner

The following data shows the Olympic Gold Medal times for the 100-metre sprint, from 1896 to 2020.

Olympic Gold Medal times in the 100 metre sprint					
Olympic city / Year	**Men (secs)**	**Women (secs)**	**Olympic city / Year**	**Men (secs)**	**Women (secs)**
Tokyo 2020 (2021)	9.80	10.61	Rome 1960	10.2	11.0
Rio 2016	9.81	10.71	Melbourne 1956	10.5	11.5
London 2012	9.63	10.75	Helsinki 1952	10.4	11.5
Beijing 2008	9.69	10.78	London 1948	10.3	11.9
Athens 2004	9.85	10.93	Berlin 1936	10.3	11.5
Sydney 2000	9.87	–	Los Angeles 1932	10.3	11.9
Atlanta 1996	9.84	10.94	Amsterdam 1928	10.8	12.2
Barcelona 1992	9.96	10.82	Paris 1924	10.6	
Seoul 1988	9.92	10.62	Antwerp 1920	10.8	
Los Angeles 1984	9.99	10.97	Stockholm 1912	10.8	
Moscow 1980	10.25	11.06	London 1908	10.8	
Montreal 1976	10.06	11.08	St Louis 1904	11.0	
Munich 1972	10.14	11.07	Paris 1900	11.0	
Mexico City 1968	9.95	11.00	Athens 1896	12.0	
Tokyo 1964	10.0	11.4			

1 What do you notice about the data? Share your observations with your classmates.

2 How much faster than your school 100 m record holders are the Olympic runners?

3 Is this table layout the best way to present this data? What could be a better way?

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5B Tuning in

Data is big business. In 2016–17 there were 301 000 people employed in data science in Australia. At this time, it was forecast there would be an extra 2.4% of data scientists added each year. While this might not sound like much, the annual growth in the overall workforce was only forecast to be 1.5% per year, so the number of data science jobs was predicted to grow more rapidly than many other jobs in Australia. This shows the key role data has to play in our future.

(Source: Deloitte Access Economics, The Future of Work: Occupational and education trends in data science in Australia*, 2018.)*

Epic Fail – Hottest recorded temperature

Accuracy in data collection is important! Historically, the hottest official temperature recorded anywhere on earth was 58°C! It was recorded at El Azizia in Libya in 1922.

But in 2012, the World Meteorological Organisation (part of the United Nations) debunked this record that had stood for 90 years.

The reason they debunked the record? **A data collection error!**



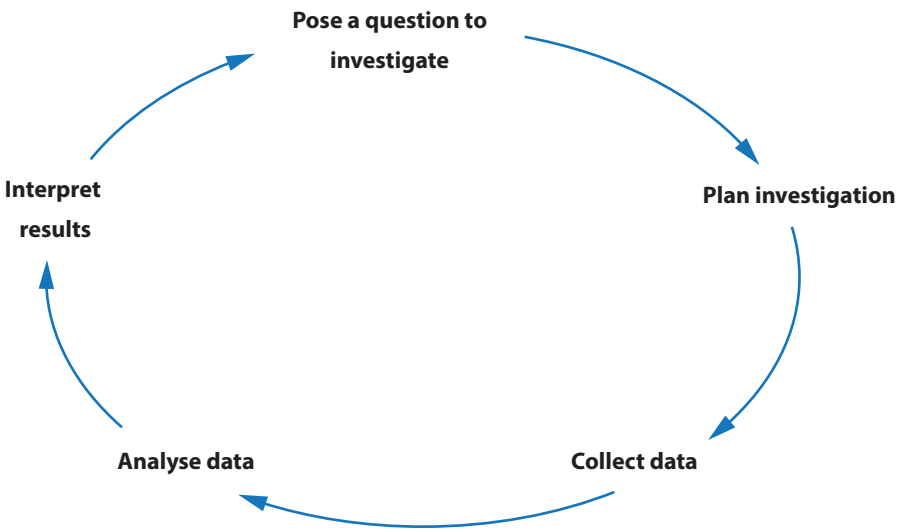
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Discussion questions

- What is data?
- What do we mean by data collection?
- How could a data collection error happen?

Use your real word experience to recognise a strange result. If you have a record result, and it's so far beyond all the other results, question whether it is accurate. Then follow-up by doing your own research. Had these actions been taken in 1922, we would not have this epic fail.

The statistical cycle



The statistical cycle is a highly useful framework for conducting statistical investigations in a clear and organised way, which mirrors real-world practice in a variety of fields. Each of the stages is explained below.

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.

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Planning 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.

For example, the business owner might choose to give a survey to their existing customers using Google Forms. The survey would ask about customer attitudes towards sustainable packaging. They might limit the amount of writing allowed in responses to make it easier to analyse the data.

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.

For example, the business owner might wait a couple of weeks to ensure they have a large sample of responses. Then they might notice that there are reoccurring themes in the responses, such as cost, climate change, impact on oceans, and aesthetics, and arrange the responses accordingly.

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.

For example, after collecting data on customer attitudes, the business owner might use a software program or spreadsheet to analyse the data. For instance, if they asked their customers to rate how much they cared about sustainable packaging on a scale of 0–5, they might calculate the mean of these responses to gain an idea of the average customer's attitudes.

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

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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.

Practice questions

1 Consider the interpretation of data in the above investigation about sustainability by the business owner. Brainstorm some new statistical investigative questions in light of their findings.

2 Select one investigative question. In pairs, brainstorm ways to carry out the investigation by **a** collecting data yourselves and **b** collecting data from online sources.

3 Brainstorm some questions you would include in the survey. How are they relevant to the investigation question? What stage in the cycle does writing these questions fall under?

4 Here's some of the responses to one of the survey questions in the sustainable packaging investigation. How would you analyse these responses?

Do you have any concerns about me moving to more sustainable packaging?
More expensive
n/a
Your packaging is really cute right now. It's one of the reasons I love buying from you. So much "sustainable" packaging is just ugly brown cardboard. It would be a shame if this happened to you.
Sounds expensive. So long as it doesn't impact the cost of your product I'm fine, but I'm looking for the best deal
No
Some "sustainable" packaging isn't all that sustainable and still takes decades to break down... if you move to sustainable packaging, make sure it's *actually* sustainable
Your products make really great gifts for Kris Kringle and for my mates. The packaging right now is fun to open. I don't even need to gift wrap it! I'm all for sustainability but please make whatever you're doing aesthetically pleasing.
My experience of sustainable packaging is it breaks more easily in transit.
I'm sick of the virture signalling. Nobody cares. We're sick of this marketing ploy to mask poor products.
None whatsoever! It's great that you're doing this
More expensive
N/A
This survey is annoying
No. Consumers do care about this. We are happy to pay more for more ethical, more sustainable businesses.

5 From your analysis, write a new investigative question for the business owner to pursue.

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5C What is data?

Types of data

Data can be classified as either **categorical** or **numerical**. The names give you a hint as to what might be classified in each type.

Categorical data refers to items that we can classify into named groups or **categories**.

Examples of categorical data include the following:

- hair colour of students in the class – for example: brown, black, blonde and red
- favourite colours – for example: yellow, purple and red
- types of pizzas sold at a pizza shop – for example: Hawaiian, meat lovers, supreme and vegan
- social media sites visited each day – for example: Snapchat, Instagram and TikTok
- personal data – for example: our name, home address and email address.

Numerical data refers to items that we **count** or **measure**.

Numerical data can be discrete or continuous. The difference between discrete and continuous data is that discrete data has finite values that can be counted, whereas continuous data relates to values that can be measured, and therefore has an infinite number of possible values.



Examples of numerical data include the following:

- number of pizzas sold each day (count) – for example: 38, 17, 65
- length of time spent on social media each day (measure) – for example: 2 hours, 34 minutes, half an hour
- number of pets each student in the class owns (count) – for example: 1, 0, 5.
- length of javelin throws at school sports (measure) – for example: 25.27 m, 33.58 m, 31.56 m
- personal data – for example: age, height and weight.

In each of the examples above, is the numerical data discrete or continuous?

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5C Tasks and questions

Skills questions

1 For the following datasets, indicate whether the data is categorical or numerical:

- **a** 3, 5, 2, 8, 4, 5, 2, 3
- **b** red, green, orange, red, blue, green
- **c** 4.76 kg, 3.54 kg, 2.97 kg, 1.23 kg
- **d** room 1.01, room 3.02, room 2.04, room 1.14.

2 Classify the following as categorical or numerical data and give three examples of values that could be found in the dataset:

- **a** height of the members of the netball team
- **b** hair colour of the members of the netball team
- **c** times recorded for the 100 m backstroke swimming race
- **d** number of white cars in different carparks
- **e** types of fish sold in a pet shop
- **f** genres of movies watched (e.g. drama, comedy, romance)
- **g** temperature at Melbourne Airport
- **h** snowfall at Mt Buller
- **i** whether people like popcorn or not
- **j** eye colour of pets.



Mathematical literacy

3 Research the different types of categorical and numerical data and what the difference is between them. Give two examples for each different type.

Application tasks

4 Research and look up some data about at least two different sports. It could be about particular players, or teams, or about Australian teams competing in international competitions such as the Olympic Games or World championship events. Decide if the data you find is categorical or numerical – or are both used in your chosen sports?



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5D How is data collected?

Data is a collection of items; for example: numbers, words, observations, measurements or descriptions. When we use data that we have collected ourselves, we are using **primary** data. When we use data that someone else has collected, we are using **secondary** data.

Before we start to collect data, we should plan the method of collection. This can be based on the following.

- The purpose of the data collection.
- The availability and suitability of sources of data – if there is secondary data available that meets the purpose, this secondary data should be considered.
- Resources available to collect the data – how much data is needed, and how difficult is it to collect?

One of the most common forms of data collection is the **survey** or questionnaire. This involves participants answering questions contained in the survey. Surveys can be carried out face to face or electronically.

Scientific data is often collected by people making observations or by instruments recording data automatically. This includes such things as weather data, air-quality readings or the UV index.

Other forms of data collection happen automatically without us being aware of it. This data includes visitor numbers to a website, number of clicks on a follow-through link such as an advertisement, Spotify listening habits, and the number of queries tracked by Google on a particular topic that can be displayed in Google trends.

Surveys and questionnaires

Surveys can be carried out in person, face to face or by telephone, or can be done electronically through an app or online. They can be very quick with just one or two questions, or take much longer for participants to complete, requiring in-depth responses, depending on the purpose of the survey.

Surveys contain questions that can be open-ended or closed. Open-ended questions allow participants to use their own words in answer to the question; however, they are much more difficult to collate and analyse. Open-ended questions allow participants more freedom to express their opinion, but the results are therefore harder to collate and analyse. Closed survey questions present the participant with a set of choices or options that have been pre-determined.

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Survey question formats

The examples given here are questions from different surveys. Each refers to the same theme.

Multiple choice and multiple choices

Multiple-choice questions can be single answer, or sometimes they can allow for multiple choices to be selected (more than one answer). If the latter, you should let your participants know that they can select more than one answer by including this in the instructions. Note: Multiple-choice questions are fast to collect and simple to analyse.

Which part of the school uniform do you think needs to be changed?

- ☐ sun-protection hat
- ☐ shirt
- ☐ jumper
- ☐ blazer

Short-answer questions

A short-answer question gives participants the opportunity to express an opinion in their own words (though they are more challenging to collate and analyse). They might include answers that have not been previously considered. For example:

> For each of your selections in the previous question, state what you think the change should be.
>
> _____
>
> _____
>
> _____

Yes/No questions

Yes/No questions can also be qualified with Yes/No/Don't know. These questions quickly build a snapshot of participants. Yes/No questions are fast to collect and simple to analyse.

Do you think the school uniform should be compulsory?

- ☐ Yes
- ☐ No

Continuum or slider questions

A continuum or slider question allows participants to give a **rating** of how they feel about a particular issue.

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How committed are you to changing the school uniform?

Not at all  Fully

Avoiding bias and confusion

It's important to collect answers that are as honest as possible, so that the data collected reflects participants' true thoughts and feelings.

To achieve this, avoid asking the following types of questions:

- **biased** questions that will lead participants to answer in a certain way;
- questions that include **jargon** that participants will not understand;
- double-barrelled questions such as 'Do you like cats **and** dogs?' (what if they only like cats?); or
- questions that are poorly worded so that their meaning is unclear.

To overcome these problems, write questions that:

- are easy to understand
- use plain language
- are short and to the point
- focus on one point.

What could possibly go wrong with data collection?

Remember that data is collected for a purpose – to answer a question, make a decision or make a prediction. Once we have written our questions, we need to check back to make sure the data collected will meet this purpose.

It is important to remember that if you don't plan your data collection carefully, you may end up with data that does not answer your questions. It is easy to know what data to collect if we are trying to find the most popular place to hold the school ball. But if we want to report on people's attitudes to passive smoking, asking them what they do when they encounter a smoking area will not help us discover their opinion.

Using secondary data

When we use data that has been collected by others, we are using secondary data.

When using secondary data, you need to think about the source of the data, how reliable the data collection is likely to have been and the purpose for which it was collected. Data collected by government agencies, such as the Australian Bureau of Statistics, is considered reliable, as is data collected by organisations whose reputations rest on their data collection abilities. Much less reliable are 'pop' surveys on social media.

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5D Tasks and questions

Thinking task

1 List some situations where data collection could go wrong. Share these with the class and compile a class list. Group the items in the list into meaningful categories. For each category, create suggestions as to how these problems could be avoided.

Skills questions

2 Match the following questions with the likely answer datasets.

Question asked	Likely answer given by participants
A What is your favourite animal?	1 Rice, Rice, Beans, Beans, Beans, Rice
B Which do you prefer: rice or beans?	2 Cooked, Rare, Medium-rare, Medium, Burnt, Well done
C How do you like your steak done?	3 19 cm, 20 cm, 20.5 cm, 198 mm, 18.7 cm
D How tall are you?	4 Koala, Dog, Cat, Guinea Pig, Wombat, Platypus
E What is the length of your handspan?	5 156 cm, 174 cm, 1.67 m, 173 cm, 1.59 m

3 Classify the following questions as open-ended or closed.

a What do you think of the new canteen menu?

b Which of these facilities would you like to see the local council provide?

- ☐ Basketball court
- ☐ Childcare centre
- ☐ Playground
- ☐ Private study area in the library
- ☐ Skate park

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c Where would you like to travel overseas?

d How many mobile phones do you own?

e What do you like doing best during the weekend?

4 Rank the following secondary sources of data from most to least reliable in your opinion and give reasons for your thinking:

- ringing household landlines to gather information on political opinions
- the Australian Bureau of Statistics
- a website claiming to present opinions on current topics.
- an organisation that conducts surveys and provides data to its clients
- stopping random shoppers in a shopping centre to ask for their political opinion
- a poll that pops up on social media asking whether there is more violence in society
- an SMS poll collected from viewers of a sports game voting for the 'most valuable player'

5 Identify whether each of the following questions shows bias, includes jargon, is double-barrelled or is unclear.

a Most people think that this new flavoured milk is great. What do you think?

☐ It tastes great.

☐ It's OK.

b Do you play piano and guitar?

c How much time do you spend playing sport?

d The school gym should be used for the senior school ball.

Agree Somewhat — Agree Totally



e Do you think the new policy of staggered school starting times for different year levels is good?

Yes No

6 Identify the format used for the following questions.

a Which flavour icypole do you like best?

☐ Blackberry

☐ Lemon

☐ Lime

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- ☐ Pineapple
- ☐ Raspberry
- ☐ Other _____

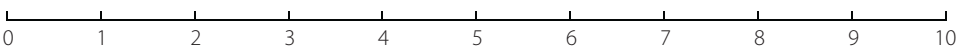
b Please explain your choice for 'homework should be compulsory'.

c Which sports do you participate in outside school? Select all that apply.

- ☐ AFL football
- ☐ Basketball
- ☐ Cricket
- ☐ Gymnastics
- ☐ Hockey
- ☐ Netball
- ☐ Soccer
- ☐ Swimming
- ☐ Other _____



d How likely is it that you would recommend this product to a friend?



Mathematical literacy

7 Explain the possible bias in each of the following surveys.

a People at a football match at the MCG are surveyed to find the favourite football team in Victoria.

b Students for a class survey are selected if their name starts with a letter from A through to K.

c Facebook users are asked to vote on whether they believe Facebook provides all the news they need.

d A survey of students arriving late to school indicated that 94% of the school were in favour of starting school at a later time.

e A survey of people at a train station found that 90% of Victorians were in favour of lower public transport ticket prices.

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Application tasks

8 Identify what makes the following questions biased. Rewrite the question so that it is no longer biased.

a What do you think of that monstrosity of a sculpture?

b Are you in favour of starting school at the ridiculously late time of 10:00 am?

c Why should skateboarding be banned in the mall?

d Why does butter taste better than margarine?



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9 For the following multiple-choice questions, identify the problem with the options. Rewrite each question with a more suitable range of options.

a What pets do you have? (Select all that apply)

☐ Cat

☐ Dog

☐ Bird

b How many hours do you spend playing competitive sport at the weekend?

☐ One	☐ Two	☐ Three	☐ Four	☐ Five
☐ Six	☐ Seven	☐ Eight	☐ Nine	☐ Ten
☐ Eleven	☐ Twelve	☐ Thirteen	☐ Fourteen	☐ Fifteen

c How many hours did you spend checking social media yesterday?

☐ 1 hour

☐ 2–3 hours

☐ More than 5 hours

d Which age group are you?

☐ Less than 15 years old

☐ 15–25 years old

☐ 25–40 years old

☐ 40–65 years old

☐ 65–80 years old

☐ More than 80 years old

10 With regard to the multiple-choice questions above, answer the following questions.

a What are the disadvantages of having too few options in a multiple-choice question?

b What are the disadvantages of having too many options in a multiple-choice question?

c What are the advantages or disadvantages of an 'Other' option with an answer space for the participant to write in their answer?

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5E Organising data

If we have ever used an app to split a bill or managed a local sports team, then we have collected and used data! Data is simply pieces of mathematical information that can be collected and organised for useful purposes.

Entertainment venues may use a 'clicker' to record attendance, and QR check-ins collect more than just numbers but personal information as well. Data collection may be for the purpose of choosing sizes for Year 12 jumpers or which meal you would like at the school formal.

Once data has been collected it needs to be organised, and the way data is organised is dependent on the following.

- The purpose of the data.
- The nature of the data.

If a school collected data on students attending camp, any allergies and dietary requirements would be collected and summarised in a table like the one here.

Student name	Allergies	Dietary requirements
Nadzmi	peanuts	no peanuts
Lara	none	vegan
Alfred	penicillin	Halal
Manvir	none	vegetarian
Chen	none	none
Arnetta	none	vegan
Simmy	none	vegetarian
Aarkansha	peanuts	vegan
Byron	all nuts	no nuts
Hok	shellfish	no seafood
Tupuna	none	none
Tun	none	none
Kobi	none	none
Mithale	none	vegan

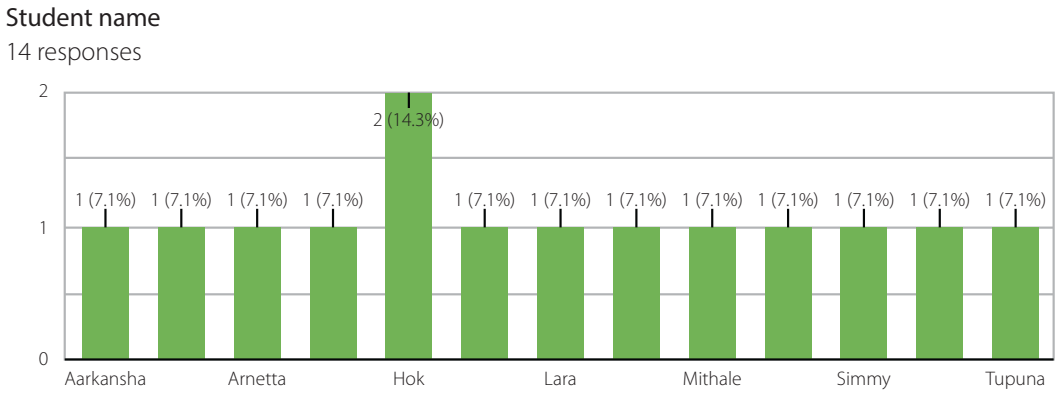
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In this form, you can scan down the list and pull out the information you need, such as the following.

- Who has allergies and what are they allergic to?
- Who has dietary requirements and what are they?

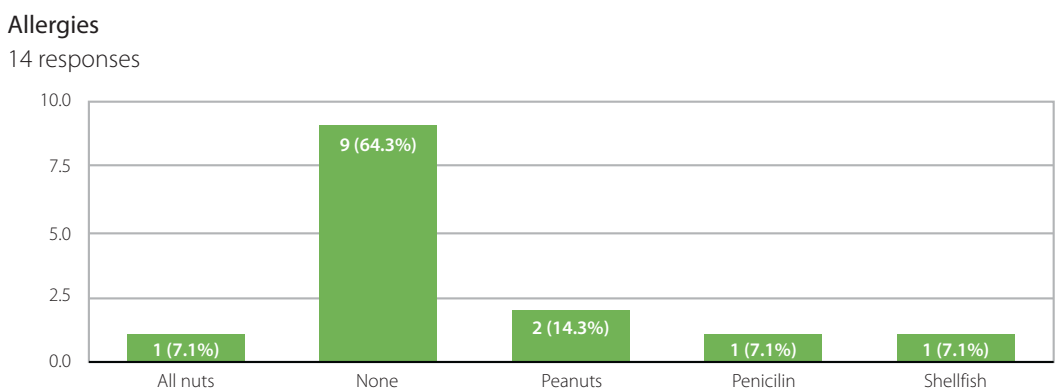
Technology can help us display information as a graph. This software provides two alternative graphs as suggestions. For this data, the two automatically-generated graphs are shown.

Graph 1



Graph 1 does not have information organised in a way that is useful for planning purposes. What are the limitations of this graph?

Graph 2



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This graph is more helpful for planning. We can quickly see how many students have no allergies. It also displays the number of students with each allergy, which is needed for meal planning.

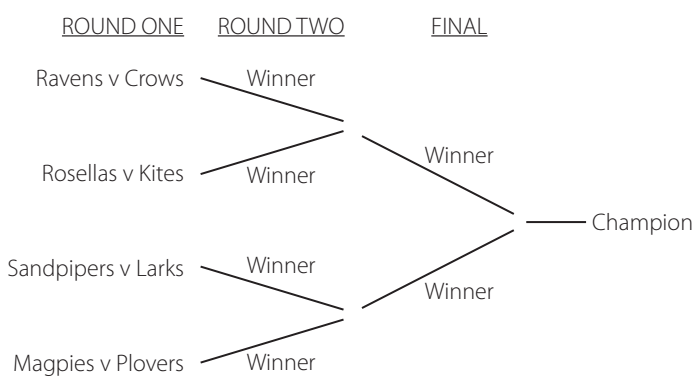
However, the graph does not include student names and includes percentages of students for each category. If you were to create a graph from the data, which information would you include, and which information would you exclude?

Other ways of organising data

Another way data can be organised is a mind map. In workplaces, this might be written on a whiteboard, in a shared document or in a table.

Netball tournament – Elimination round	
Game 1	Ravens v Crows
Game 2	Rosellas v Kites
Game 3	Sandpipers v Larks
Game 4	Magpies v Plovers
Game 5	Winner of game 1 plays Winner of game 2
Game 6	Winner of game 3 plays Winner of game 4
Game 7	Winner of game 5 plays winner of game 6

The information in this netball tournament table could also be shown in a tree diagram. Visual pictures like tree diagrams can help with planning.



These are just a few of the many ways in which data can be organised. Technology means that data can be organised in a myriad of possibilities.

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5E Tasks and questions

Thinking task

1 Choose a favourite song to play. Thinking of the lyrics, divide the words of the song between students for tallying purposes. As you play the song, record the frequency of each word that is sung using a tally method, and graph your results.

e.g. Love 𝍸 IIII II
get 𝍸 III
can't II

Skills questions

2 Give one method to organise each of the following data.

- **a** Public transport times.
- **b** Patrons attending a music venue each night.
- **c** Stock levels in a shop.
- **d** Football draw and game times.
- **e** Employee hours worked each day and week.
- **f** Water levels in a reservoir.
- **g** Shows watched on a streaming service.

3 Consider the following data, and decide which is the best way to organise it. Give a reason for your choice.

- **a** Number of scam emails per month.
- **b** Number of children with up-to-date immunisations per age group.
- **c** Cost of tickets to summer concerts.
- **d** Year 12 jumper preferences.
- **e** What to do in an emergency.
- **f** Percentage of people who wear football colours and which team.
- **g** Preferred prime minister.
- **h** Cost of household electricity over a year.

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Mathematical literacy

4 Go online and find a version of a bus or train timetable that can be used in printed form. Describe how the timetable is organised (for example, days or weeks) and which hours of the day the timetable covers. What features does the timetable have to increase readability (for example, the use of colours or bold lines)? How could the timetable be improved?

Application task

5 Consider eight teams playing each other twice in a soccer league.

a Find and use an online fixture maker to design the draw (a schedule of games).

b What are some of the advantages and disadvantages of using an online tool?



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5F Reading data

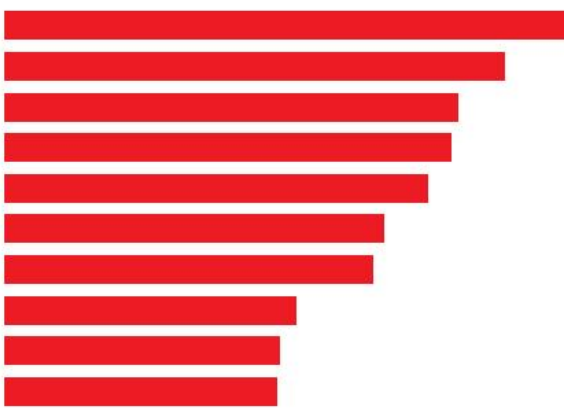
Data comes in many forms, including some of the following:

- graphs
- lists
- maps
- tables.

Below are some examples of how data can be represented.

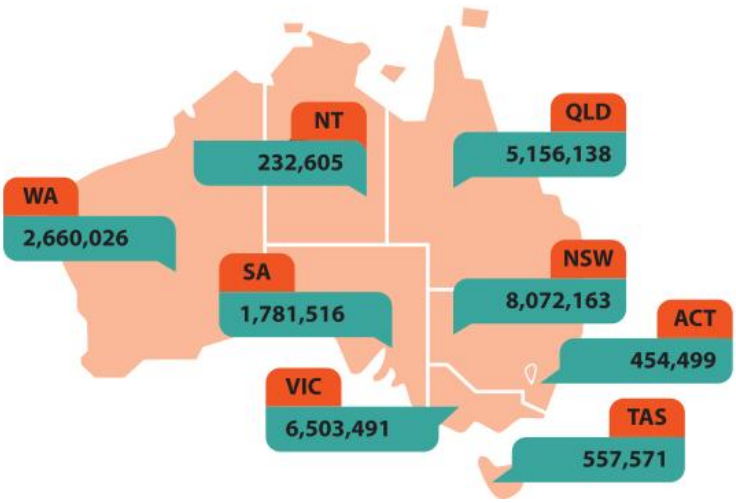
- Data about the money spent on poker machines – in a list and as a bar graph.

Victorian councils	Metro Melbourne
Total	$4,636,733
Brimbank	$351,771
Casey	$314,148
Hume	$286,440
Greater Dandenong	$280,764
Whittlesea	$267,752
Wyndham	$239,782
Monash	$232,689
Mornington Peninsula	$184,693
Darebin	$174,017
Kingston	$171,344



Source: Victorian Gambling and Casino Control Commision (pokies data 2021–2022)

- Census population count by state and territory – as a map.



Source: ABS website

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- Labour force status by non-school qualifications, by sex (a)

	Employed full-time (%)	Employed part-time (%)	Unemployed (%)	Not in the labour force (%)
Males – Bachelor level and above	73.5	11.4	2.1	13.1
Males – Below bachelor level(b)	69.0	11.2	2.5	17.3
Males – No non-school qualification	44.4	18.4	4.1	33.1
Females – Bachelor level and above	53.0	26.1	1.7	19.1
Females – Below bachelor level(b)	39.1	32.3	2.9	25.6
Females – No non-school qualification	23.1	29.2	3.2	44.5

(a) All persons aged 15-74 with a non-school qualification.

(b) Includes certificates I-IV, diplomas, advanced diplomas and associate degrees.

Source: ABS website

Mathematical literacy related to data

When reading and interpreting data from tables, graphs are useful because they show you what is happening with a picture rather than just the numbers.

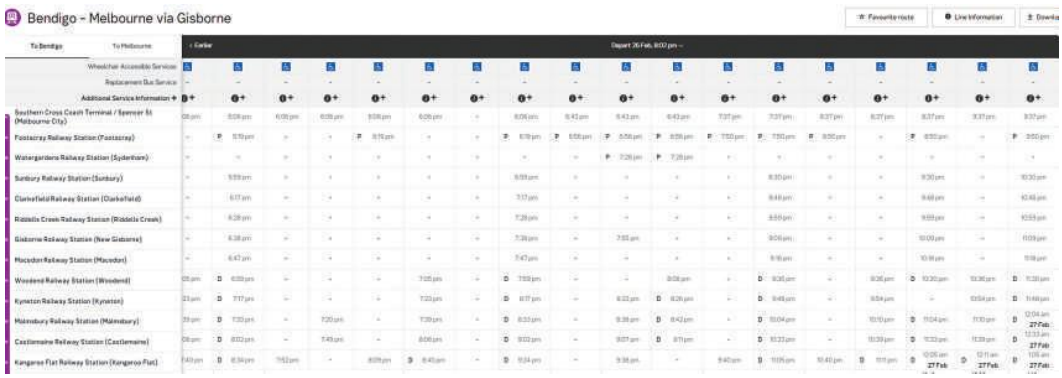
Below is a list of some of the common words that we often use to talk about data in tables, graphs or charts.

Term	Meaning
maximum	highest or greatest value.
minimum	lowest or smallest value.
constant	the data or graph isn't changing, it stays the same. A graph would be horizontal. Also called **stable**, **steady**.
increase	the data or graph is rising or going up.
decrease	the data or graph is going down.
trend	any pattern that is showing up in the data or graph: • **predictable** – shows a pattern (increase, decrease, constant) • **unpredictable** – shows no pattern • **fluctuates** – varies up or down randomly.

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Reading data from tables

The Public Transport of Victoria (PTV) website and app provide data in the form of lists, maps and tables. Consider the following PTV timetable.



Source: Public Transport Victoria website

This timetable shows the following.

- There are 12 stations to Kangaroo Flat after leaving Southern Cross Station.
- The departure times are 7:40 am, 9:06 am, 10:06 am, 11:06 am, 12:06 pm and 1:06 pm.
- If you miss the 7:40 am train, there is a wait of 1 hour and 26 minutes until the next train.
- Some trains do not stop at all stations.
- The 11:06 train does not stop at Sydenham and arrives at Kangaroo Flat at 12:50 pm.

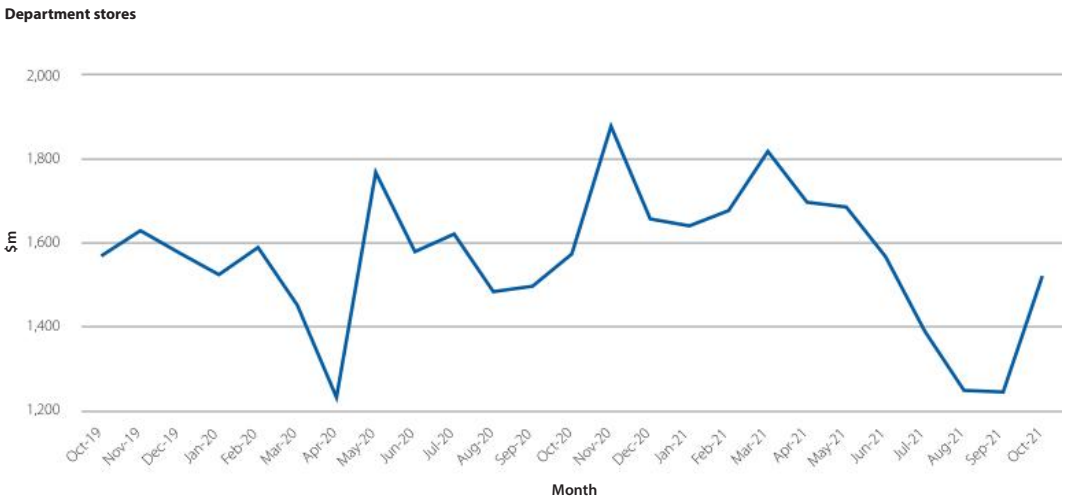
Many questions can be answered from this timetable. Tables of information are a great way to clearly present large amounts of information.

Reading data from graphs

Most graphs have two variables: one on the horizontal axis and the other on the vertical axis. With graphs, convention states that the horizontal or x-axis is the independent variable (categorical or numerical) and the vertical or y-axis is the dependent variable (frequency or amount). We will investigate this further in section 5H.

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The following graph shows total sales in Australian department stores. The independent variable is time, in months, and the dependent variable is the value of sales, in millions of dollars. Looking at the highs and lows in the graph, we can make assumptions about why people may or may not have been spending their money in the different months depicted. Note that the vertical axis does not start at $0.



Source: ABS website

The next graph uses data taken from sensors placed around the city grid in Melbourne. These sensors measure the number of pedestrians at a given time of day.

You may want to explore this data for yourself at www.pedestrian.melbourne.vic.gov.au.

In this graph we can see the following information.

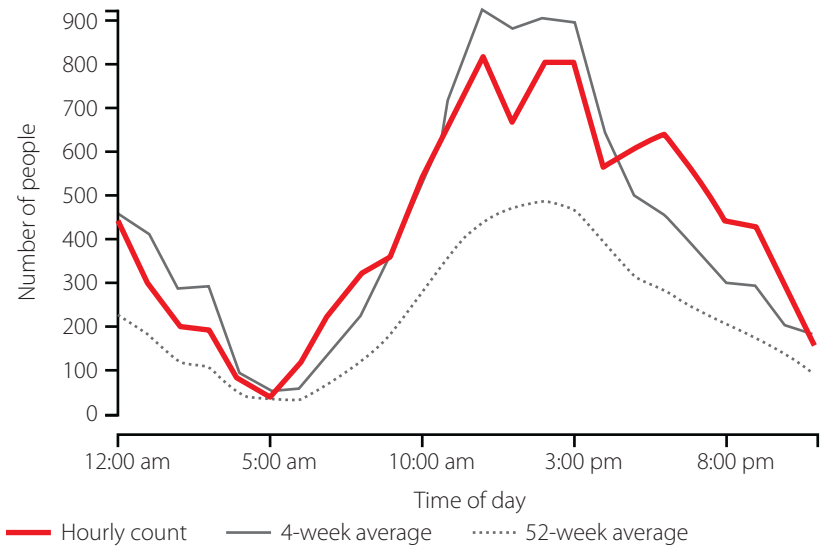
- The x-axis tells us the time of day. This is the independent variable.
- The y-axis tells us the number of pedestrians at that time. This is the dependent variable.



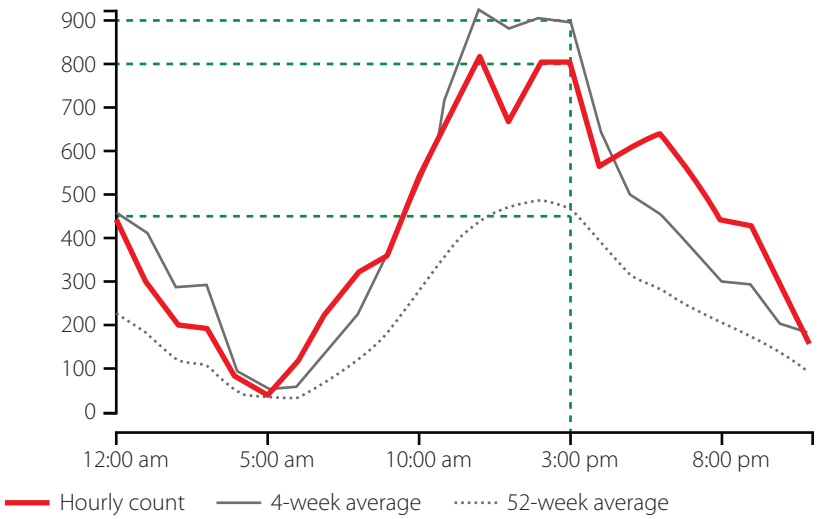
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Hourly pedestrian count at 231 Bourke St

Sunday 19 December 2021



To read the graph, we track from one variable to find another. For example: the number of pedestrians at 3:00 pm.

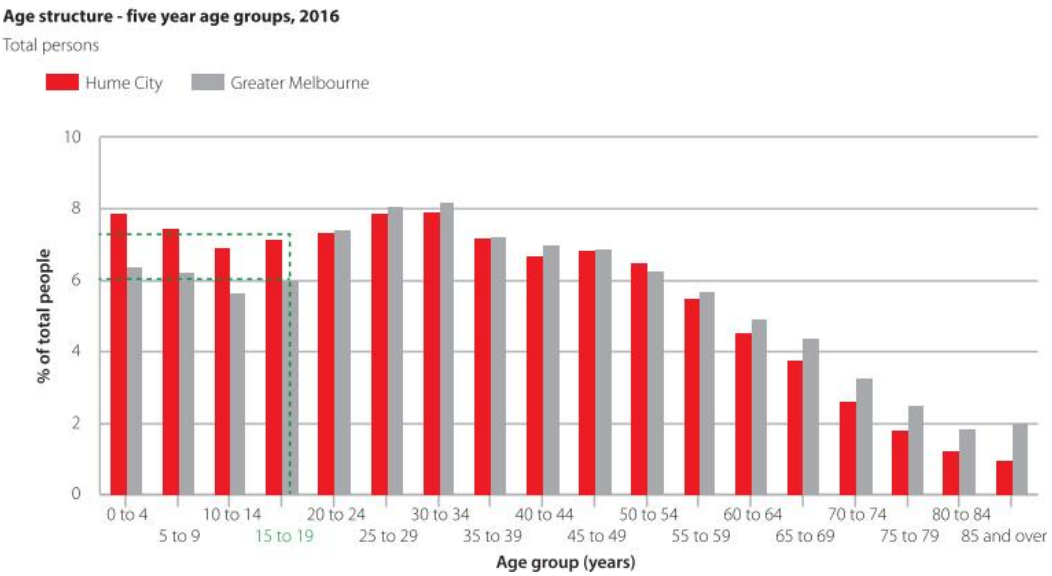


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From the graph we can see the following:

- At 3:00 pm, the hourly count is around 800 people.
- This is less than the 4-week average of around 900 people.
- It is greater than the 52-week average of about 450 people.

The next graph shows the age of people in the City of Hume and compares them to Greater Melbourne.



Source: Hume City Council website

If we consider the age group of 15–19 years old, we can see the following.

- There is a higher percentage of people who are 15–19 years old in the City of Hume than in Greater Melbourne.
  - Greater Melbourne has roughly 6% of its people in this age group.
  - The City of Hume has roughly 7.5% of its people in this age group.
- The overall trend is that Hume has relatively more younger people while Melbourne has relatively more older people.

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5F Tasks and questions

Thinking task

1 Explore the Worldometer site at www.worldometers.info

a Describe one interesting dataset.

b Is this data surprising?

c How might this data have been collected?

Skills questions

2 The Victorian Government provides grants (extra money) to **Volunteer Emergency Services** groups to purchase needed equipment. These grants are called the Volunteer Emergency Services Equipment Program (VESEP). The table below lists the groups beginning with 'A' that were successful in obtaining a grant to purchase equipment in one year.

Agency	Name	Category	VESEP contribution (excluding GST)
CFA	Acheron	Minor Facility Improvements	$2000.00
CFA	Alexandra	Minor Facility Improvements	$66 666.67
CFA	Allansford	Operational Equipment	$1274.69
CFA	Almonds	Minor Facility Improvements	$524.52
CFA	Anakie	Operational Equipment	$3400.00
CFA	Anglesea	Operational Equipment	$2930.00
CFA	Apollo Bay	Operational Equipment	$4607.59
CFA	Avenel	Minor Facility Improvements	$13 334.00

a All these groups are from the CFA. What does the acronym CFA stand for?

b List the grant categories that were applied for.

c Which group received the highest grant?

d Which group received the lowest grant?

e Which group received $3400?

f How much was awarded, in total, on operational equipment?

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g How much was awarded, in total, on minor facility improvements?

h What is the difference between the amounts in the answers to questions **f** and **g**?

3 Worksafe Victoria compile data on the number of claims submitted to Worksafe each financial year (1 July to 30 June).

Industry Division	Number of claims	
	2017/18	2018/19
Agriculture, Forestry and Fishing	652	598
Mining	127	106
Manufacturing	4 103	4 183
Electricity, Gas, Water and Waste Services	354	386
Construction	3 794	3 862
Wholesale Trade	1 649	1 657
Retail Trade	1 420	1 434
Accommodation and Food Services	939	1 005
Transport, Postal and Warehousing	2 113	2 142
Information Media and Telecommunications	128	146
Financial and Insurance Services	184	192
Rental, Hiring and Real Estate Services	347	355
Professional, Scientific and Technical Services	679	663
Administrative and Support Services	1 031	1 139
Public Administration and Safety	2 112	2 179
Education and Training	1 796	1 865
Health Care and Social Assistance	4 017	4 217
Arts and Recreation Services	752	816
Other Services	744	772
Unknown	15	10
Total	**26 956**	**27 727**

a How many claims were there in Construction in 2017/18?

b How many claims were there in Transport, Postal and Warehousing in 2018/19?

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c How many claims were there in Retail Trade in 2017/18 and 2018/19 together?

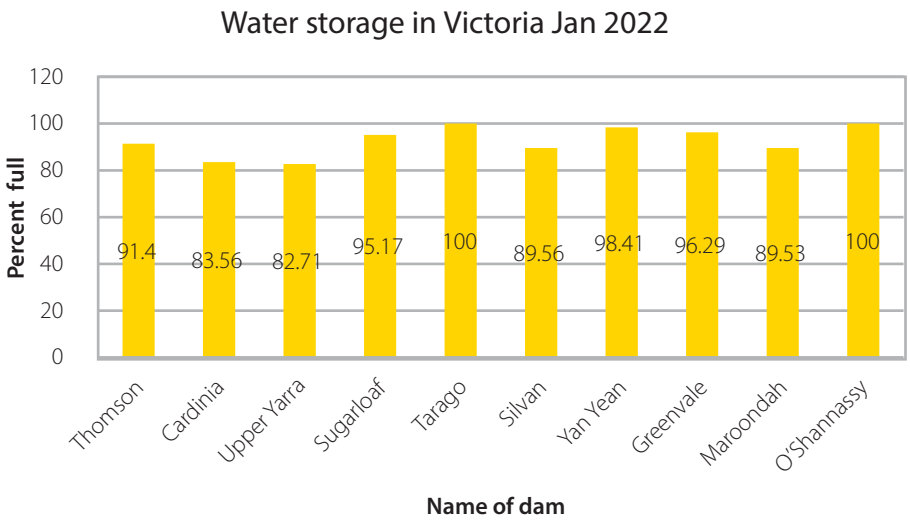
d Which industry had 1139 claims in 2018/19?

e Which industry had the most claims in 2017/18?

f Which industry had the least claims in 2017/18?

g Which industry had the largest difference in the number of claims for the two years?

4 Melbourne Water measures the water storage levels of the dams surrounding Melbourne.



a Which dams were at full capacity?

b Which dams were below 90% full?

c Order the dams in terms of how full they were, from highest to lowest percentage.

d What is the percent full value of the Thomson dam?

e What is the percent full value of the Silvan dam?

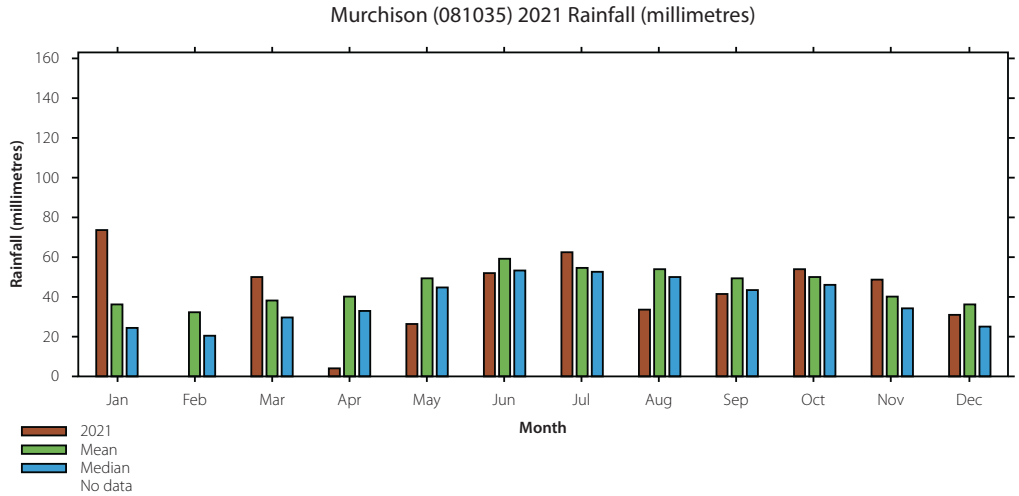
f Use the internet to find the total storage capacity of each dam. Which of these dams would be the most important for water supplies to Melbourne?

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5 The graph below shows rainfall data for Murchison during the year 2021.

The brown column shows the rainfall for each month in 2021.

The other columns show the mean and median rainfall for all years in the dataset.



Source: Adapted from Climate Data Online, Bureau of Meteorology, Copyright Commonwealth of Australia, 2022

a Locate Murchison on a map.

b Which month in 2021 had no rainfall?

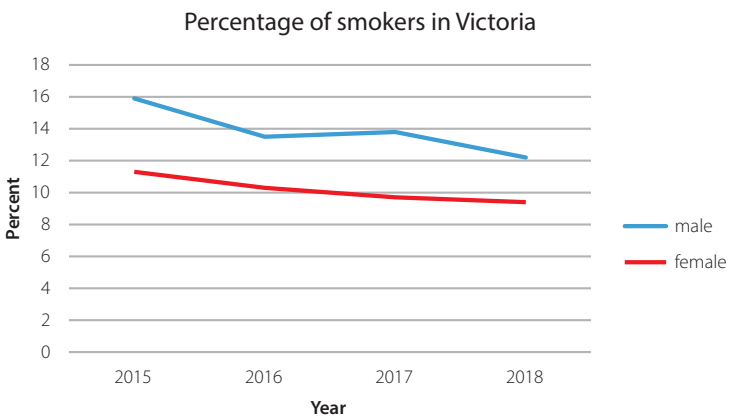
c Which month had the highest rainfall?

d How many months had rainfall above 40 mm?

e How many months had rainfall above the average (mean) value?

f In which months was the rainfall below the median value?

6 Consider the graph below.



Source: VicHealth

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a What is the graph about?

b Describe the general trend in smoking habits for males and females.

c In 2015, what percentage of males in Victoria smoked?

d In 2018, what percentage of males in Victoria smoked?

e What is the decrease in the percentage of males who smoked between 2018 and 2015?

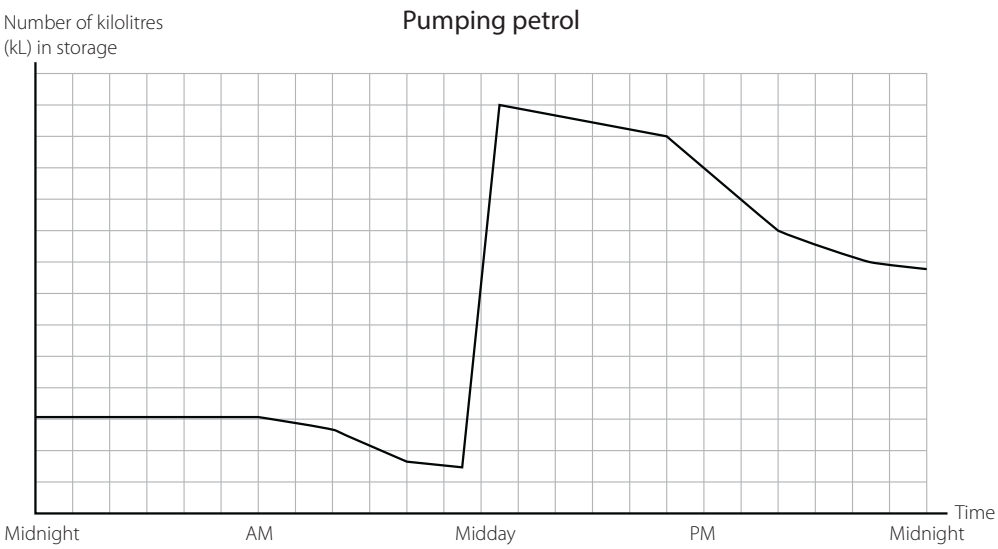
f Estimate when the percentage of females who smoked dropped below 10%.

g What was the difference in percentage between male and female smokers in 2017?

h Give potential reasons for the decline in smoking in Victoria.

Mathematical literacy

7 Look at the following graph which shows the amount of petrol in the tanks at a petrol station. Write the story the graph is telling. Use words such as maximum, minimum, constant, sharp rise and gradual decrease in your story.



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Application tasks

8 The following data on bridges in Victoria is provided to engineering contractors by VicRoads to help the contractors when they perform bridge works. All measurements are given in metres.

NAME	MINIMUM CLEARANCE	OVERALL LENGTH	OVERALL WIDTH
Cox Creek	1.8	5.4	11
Road over Eastlink tollway fwy	N/A	1	N/A
Colac-Forrest Rd	1	6	13
Bengworden Rd	1	6.2	11
Road over Perennial Watercourse	N/A	3.6	13
ST023985	N/A	1	0
Floodway culvert	1	4.8	27
Murray River Rd	2	3.6	33
LaTrobe River	10	84	11
Road over irrigation channel	1	1	N/A
Koo-Wee-Rup – Longwarry	1	9	8
Cumberland River	3	23.1	11
Devilbend Creek	1	8.7	130



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a What does the abbreviation N/A stand for?

b What is the minimum clearance for Cox Creek Bridge?

c What is the length of the floodway culvert?

d What is the width of the Cumberland River?



e Which is the longest bridge?

f Calculate the difference in length between the longest and shortest bridge.

g Think of a reason why a bridge might be 130 m wide.

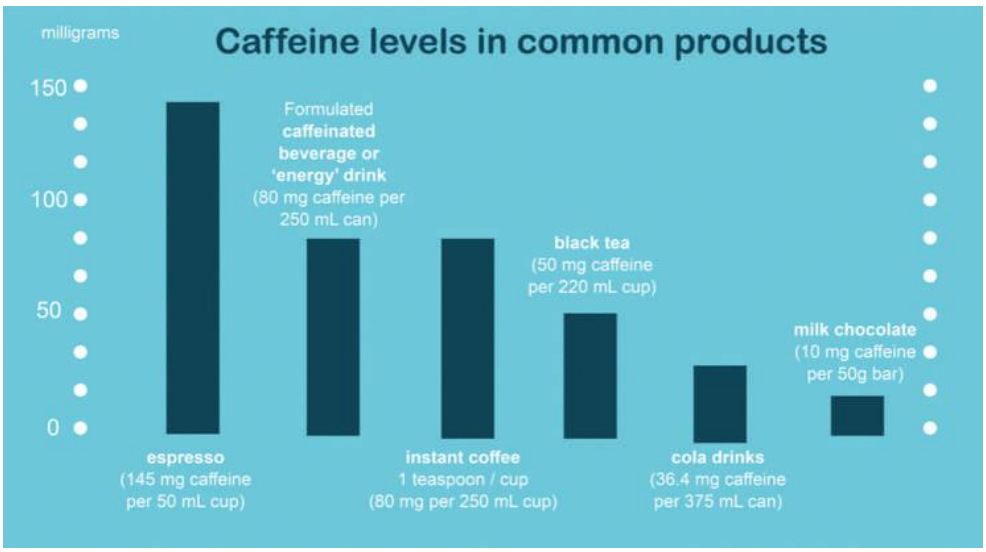
h High-speed roads in Victoria generally have lanes that are 3.5 m wide. Which bridges have four or more lanes?



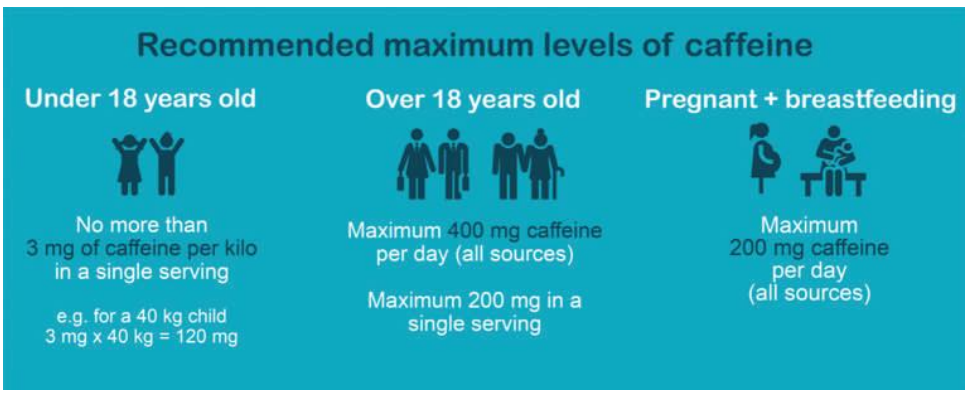
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9 The government organisation Food Standards of Australia and New Zealand (FSANZ) provides guidelines about the amount of caffeine that is considered to be safe to consume each day from a scientific point of view.

Look at the infographic from FSANZ and answer the following questions.



Source: Australian Government Food Standards website



Source: Australian Government Food Standards website

a Which of the foods and drinks listed have the lowest amount of caffeine?

b What is the difference in the amount of caffeine in a can of energy drink compared with a can of cola?

c How many espressos could an adult safely have per day?

d How many cups of tea per day is safe when pregnant?

e How many cans of energy drink could a 50 kg teenager safely drink per day?

f How many 50 g chocolate bars could a 15 kg child safely eat per day?

g How many espressos could a 45 kg teenager safely drink per day?

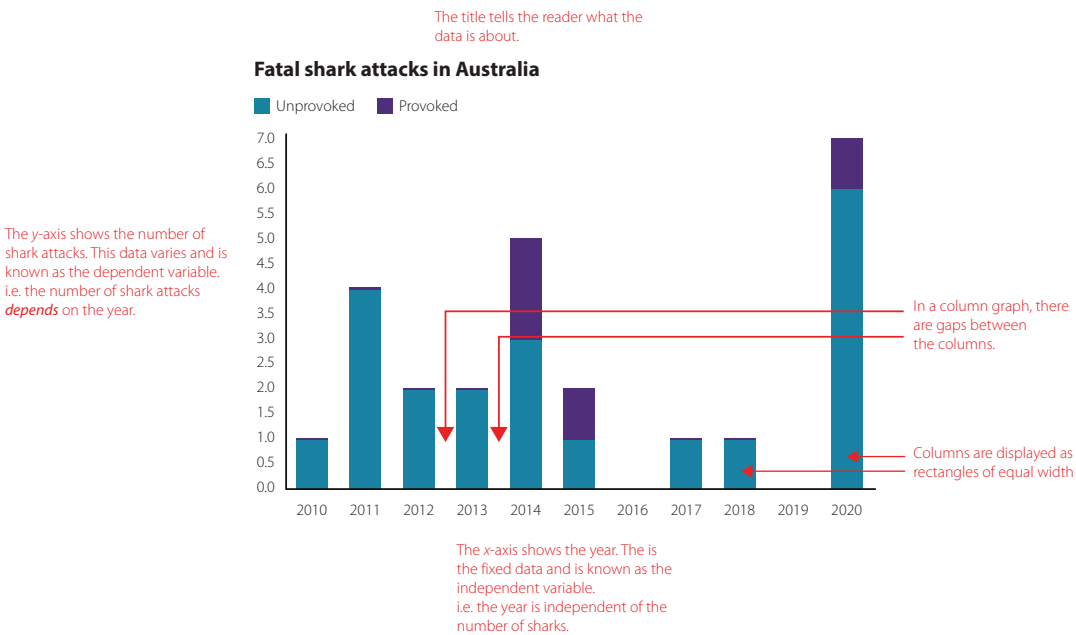
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5G Presenting data

When we write, there are certain 'rules' or 'conventions' that everyone follows so that we understand each other. Because data exists in many forms, we also follow certain mathematical conventions when we want to represent data clearly.

Column graphs, bar graphs and histograms

Column graphs, bar graphs and histograms are used for 'discrete' data that has distinct categories.



When the data in a graph is arranged in rectangular blocks like this they are usually called bar or column graphs. When the bars are shown vertically it is usually called a column graph. When the data is arranged horizontally it is usually called a bar graph, in which case the vertical axis shows the independent variable, and the horizontal bar length shows the values of the dependent variable. Column graphs and bar graphs have spaces between the columns as the data is discrete.

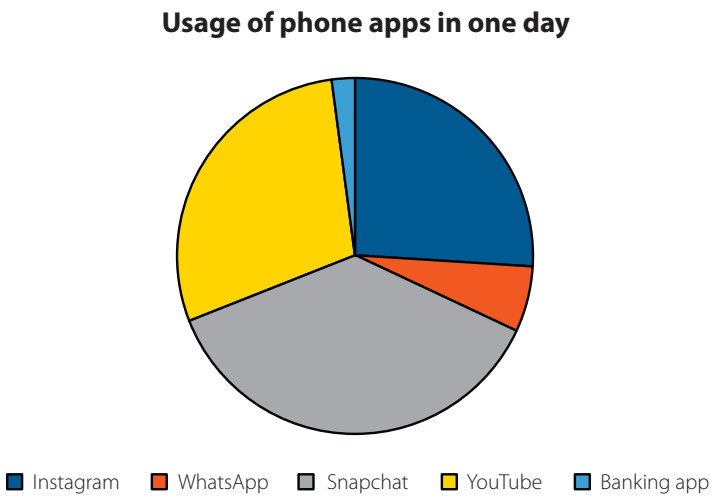
Numerical data can be discrete or continuous. The difference between discrete and continuous data is that discrete data is a finite value that can be counted whereas continuous data relates to values that can be measured, and therefore has an infinite number of possible values. When data is continuous, such as the measured distance of 30 golf practice drives, then we use a **histogram**. Histograms have no spaces between the columns.

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Pie charts and circle graphs

Pie charts (also called pie graphs) and circle graphs are an excellent way to display percentages, with the full circle being 100%. The title and the legend or key give a quick visual summary.

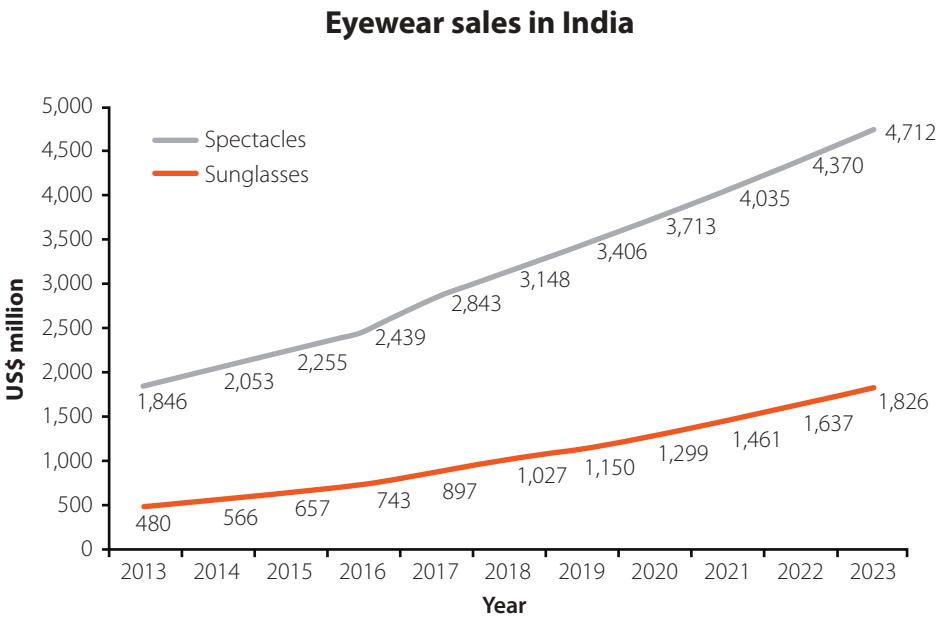


Take note that you need to be careful if you decide to use a pie chart. In order to use a pie chart, you must have some kind of whole amount that is divided into a number of distinct, separate parts. A pie chart is a circle divided into sectors that each represent a proportion of the whole. A pie chart can only be used to compare each part's contribution to the whole, as opposed to comparing parts or groups to each other. Normally we use pie charts in relation to data that relates to percentages of a total. If it is data stated as percentages, then they should add up to 100% (the whole).

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Line graphs

Line graphs describe numerical data that is measured.



Line graphs may have multiple displays of information on them, such as this graph showing the total gambling expenditure in Victoria from 2016 through to 2022.

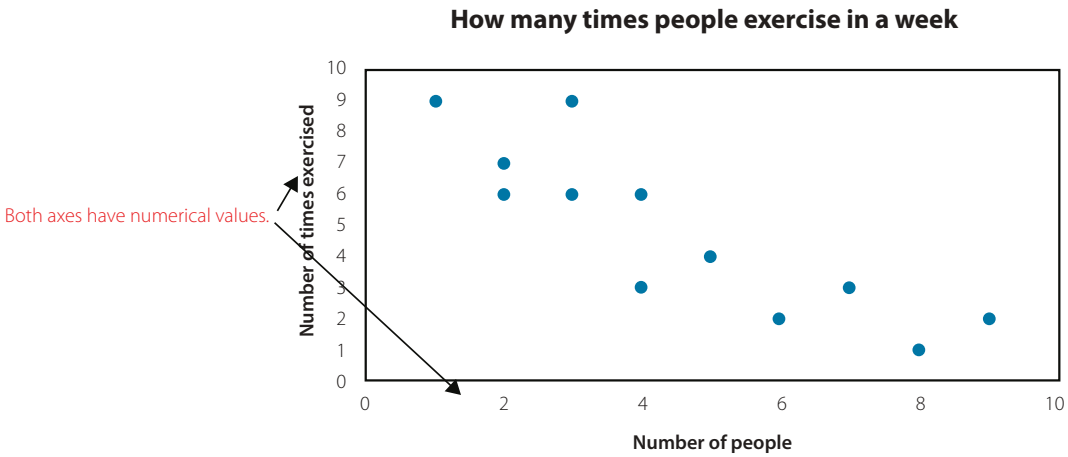


Source: Pokies, all casino and lotteries: VGCCC Annual Report 2021–2022 Sport and race betting: Financial statements | State Revenue Office

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Scatterplots

Scatterplots are used when there are two sets of numerical data.



Do you think there is a relationship between these variables?

Creating graphs using technology

Computer software programs are very useful for plotting charts and graphs of data. The common word processing packages, such as Microsoft Word, can create graphs, but the more powerful option is to use spreadsheet software, such as Microsoft Excel. Spreadsheets are more powerful because they can also do other functions relating to data, such as sorting and filtering data, and undertaking a range of statistical calculations for you.

There are three main stages to using spreadsheets or word processors to plot graphs:

1. Enter the data
2. Select the type of graph and then create the graphs
3. Format and label the graphs appropriately.

Here, we will briefly look at how to access the graphing functions of Microsoft 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.

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Using Microsoft Excel

You can use Microsoft Excel or other spreadsheet software to create graphs from any data you collect, find and enter into the spreadsheet; and there are lots of graph and formatting options available.

The simplest way in Excel to create a chart is to first enter or copy your data into the spreadsheet and select the cells that contain the data that you want graphed. If you want the column and row labels to appear in the chart, include the cells that contain them in your selection.

1. Enter the data

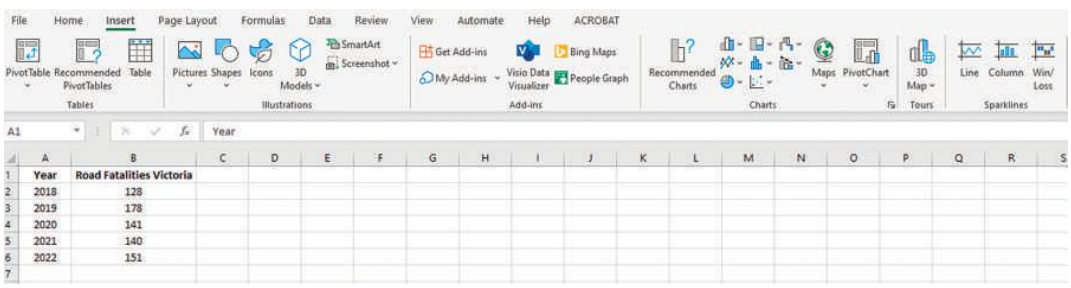
Here is an example with some data about Victorian annual road fatalities.

	A	B
1	Year	Road Fatalities Victoria
2	2018	128
3	2019	178
4	2020	141
5	2021	140
6	2022	151
7		

Source: Transport Accident Commission (TAC) website

Highlight the rows and columns, including the labels, you want to graph.

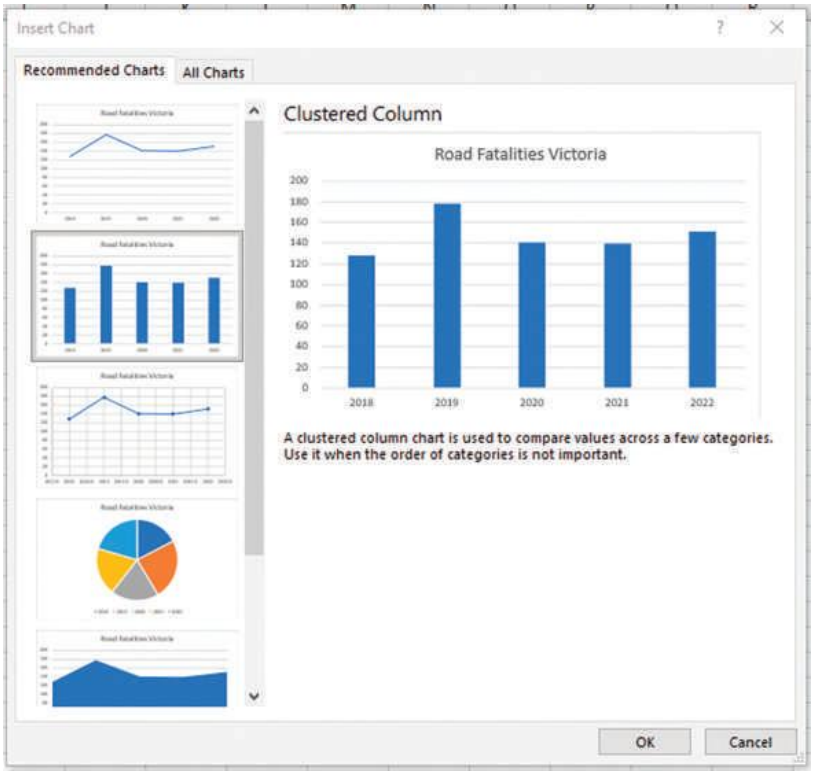
Select the *Insert* tab and select one of the options from the *Charts* group over towards the right.



2. Select the type of graph and then create the graphs

You can select the *Recommended Charts* option and you will see a few key options you can choose:

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In this case a column graph is a good option. Clicking on that option and then selecting *OK* inserts the basic graph into your spreadsheet:

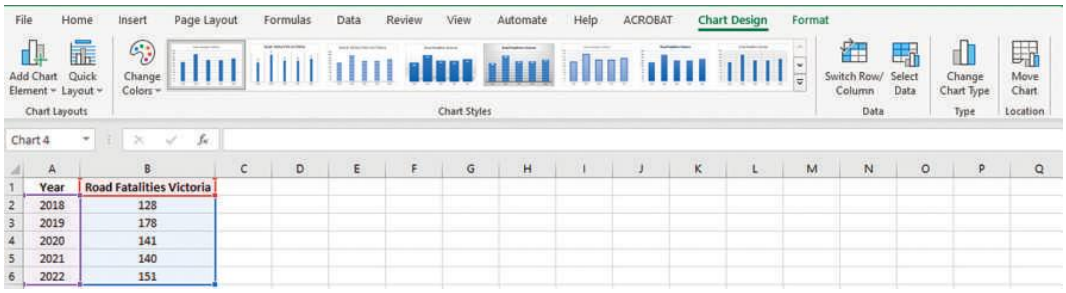


You can also select from the range of other types of graphs and charts that are listed to the right of the *Recommended Charts* option.

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3. Format and label the graphs appropriately

After this basic graph is created, you need to use the *Chart Design* tab to refine it and to add missing elements to the graph, to change the colour etc.



	A	B
1	Year	Road Fatalities Victoria
2	2018	128
3	2019	178
4	2020	141
5	2021	140
6	2022	151

The common elements you will need to add in and adjust include:

- The title of the graph, if you did not have one already in your data
- The horizontal axis – you will need to type in the text you want
- The vertical axis – you will need to type in the text you want – and don't forget the units being used
- The colours and size of the axes, the fonts, the placement of the key (if there is one), and more.

Finally, you should end up with a graph that represents the data clearly, with correct labelling, such as in this example.



It takes a bit of practice, but the quality of your graphs using either Excel or other software programs such as Word will be good, especially compared to doing them by hand on graph paper.

Again, please make sure you ask your teacher for help and advice about using a spreadsheet to create your graphs and charts, especially if you are unsure about how to do this.

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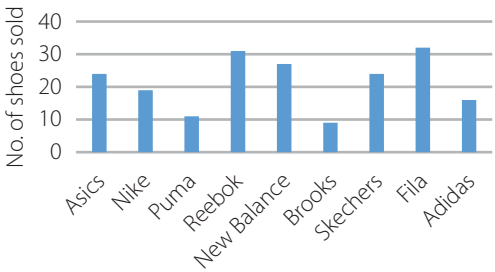
5G Tasks and questions

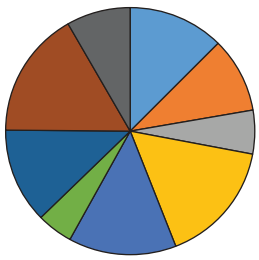
Thinking task

1 Conduct a search of your social media accounts and list the types of data that you find and the key message for each one.

Skills questions

2 The graphs below display the same data about shoe sales. Use them to answer the following questions.





a What would be a suitable title for each graph?

b Can you work out which segment of the pie graph corresponds to each bar in the bar chart?

c Which graph is better at representing the data? Give one reason for your answer.

3 Construct column graphs of the following data, using technology.

a Survey your classmates about what they ate for breakfast today.

b Survey your classmates about what colour drink bottle they have.

c Survey your classmates about their mode of transport to school today.



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4 Construct line graphs of the following, using technology.

- **a** The current 7-day weather forecast.
- **b** The time taken for your classmates to get to school vs the distance they travelled.

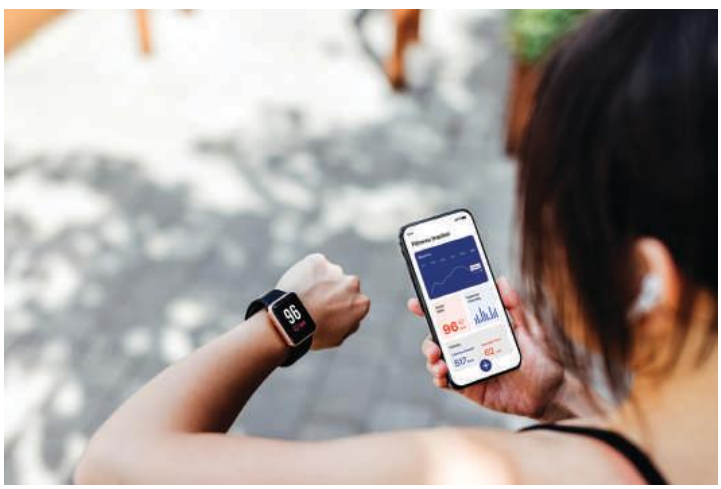
5 Construct pie graphs of the following, using technology. (Hint: You will need to calculate the percentages first.)

- **a** In a class of 25 students, 18 wore the winter uniform, 5 wore the sport uniform and 2 were out of uniform.
- **b** In an extended family photo, 3 were babies, 12 were under 18 years of age, 6 were in their 20s, 11 were aged between 30 and 60, 4 were aged between 60 and 80 and 2 were in their 90s.

Mixed practice

6 Decide which graph might best display the given data, then use technology to graph it.

- **a** Hours you have spent on technology each day in the last week.
- **b** Hours your classmates spent on technology last night.
- **c** Hours of sleep your classmates had last night.
- **d** Favourite take-away meals in your class, by percentage.



Application tasks

7 Using a survey tool, such as Google Forms, conduct a survey of people's favourite sport.

- **a** Use technology to construct a suitable graph displaying your data.
- **b** Give a reason for your choice of data display.
- **c** Draw at least one conclusion from your data.

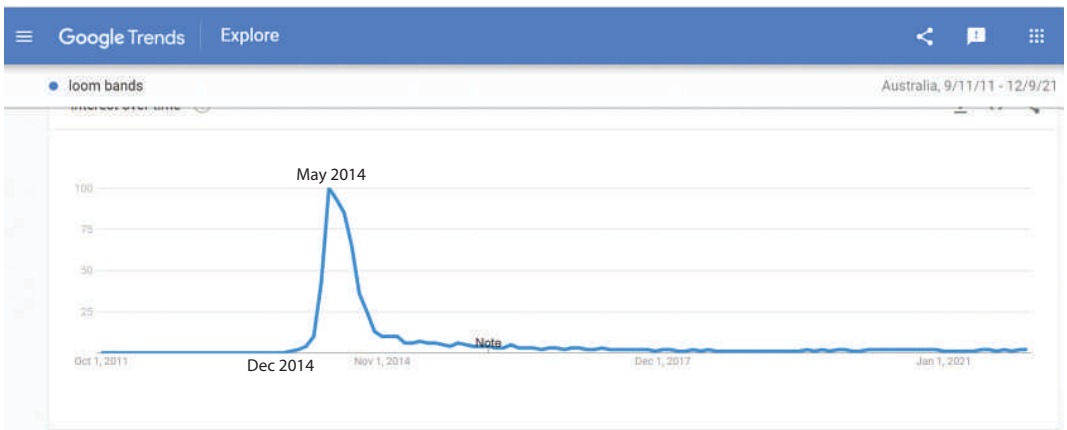
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5H Telling the story

Do you remember the loom band craze from when you were little? If not, conduct an internet search for 'loom band craze'.

We might assume that the inventors of the loom band made a lot of money. But what is the true level of interest in loom bands? Using Google trends, we can see a graph of internet searches for 'loom bands'.





Source: Google trends

This graph tells us quite a clear **story**. There were no internet searches for loom bands from October 2011 until December 2013. Then there was a surge of interest until May 2014. This was followed by a sharp decline in interest, levelling out around October 2014. Internet interest has been low since then.

How would this interest in loom bands translate to sales? When we are telling a story from a graph, we need to use all the skills we have learnt.

Think about the following.

- The topic. What is being discussed?
- The shape of the graph.
- The axis. How does one axis relate to the other?
- The scale. Consider if the scale influences the story.
- Key measures of centre and spread.

We will look at these in detail in Chapter 6.

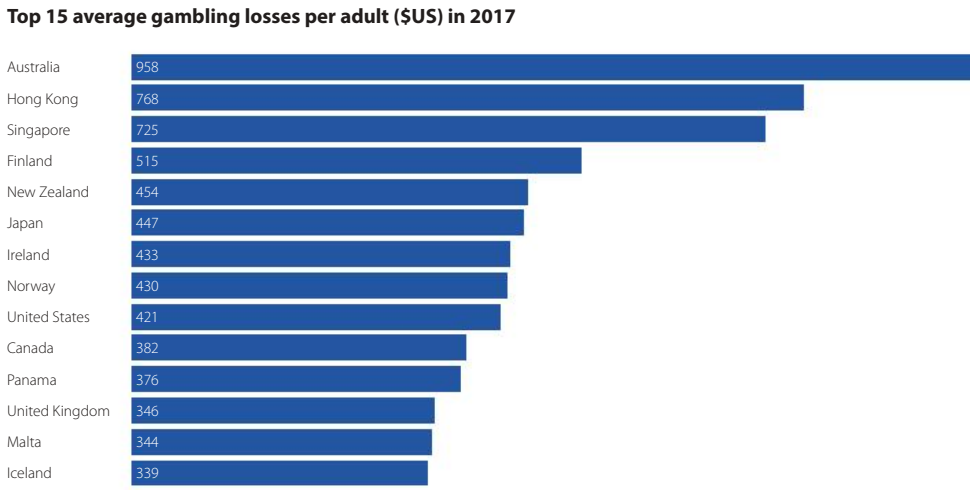
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5H Tasks and questions

Skills questions

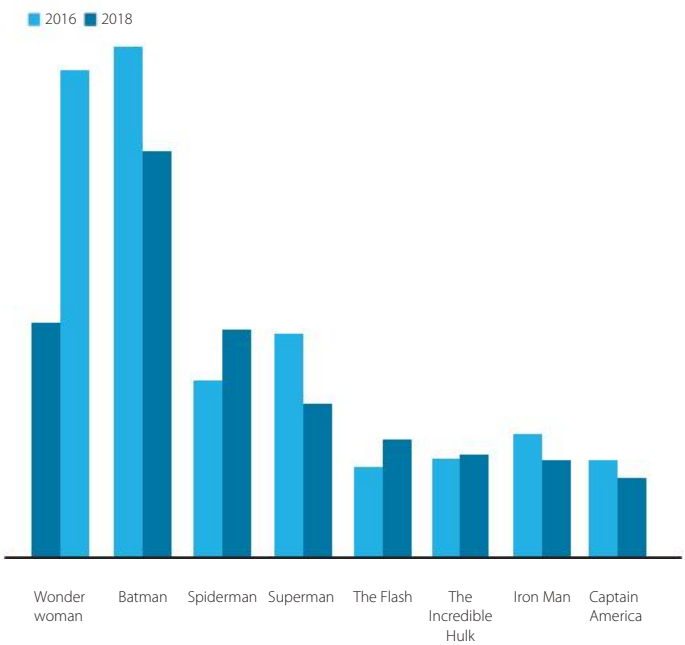
1 State the **topic** for each of these graphs and provide one key message from each graph. The headline is given to you for context.

a 'Mug punters: Aussies are world beaters at losing'



Source: ABC News website

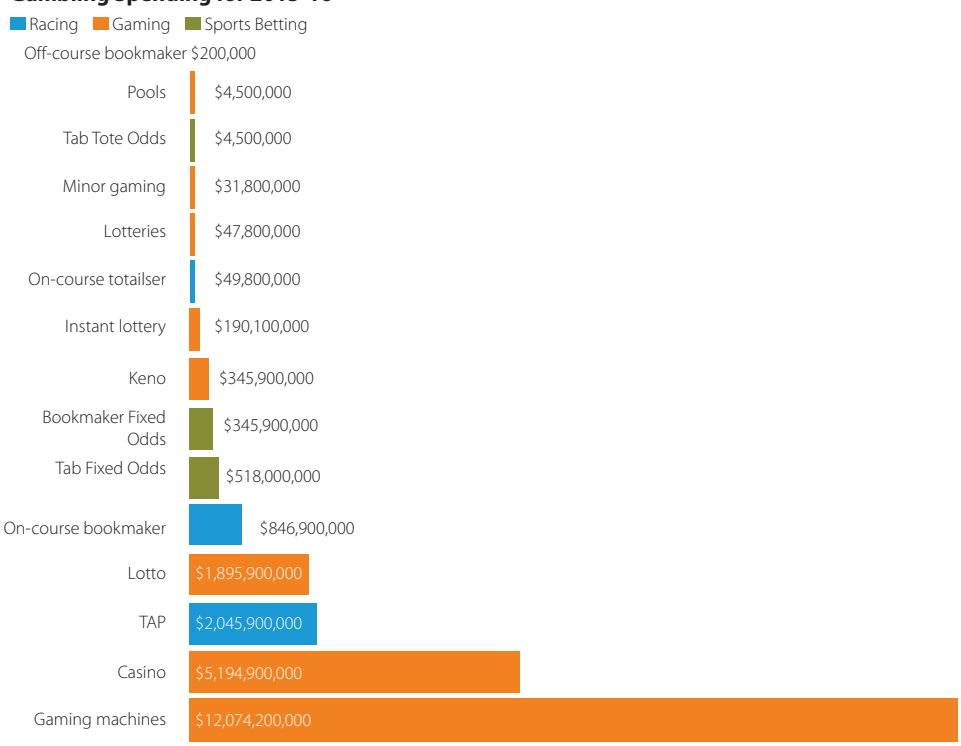
b 'Wonder Woman takes top spot as Australian kids' favourite superhero'



Source: ABC News website

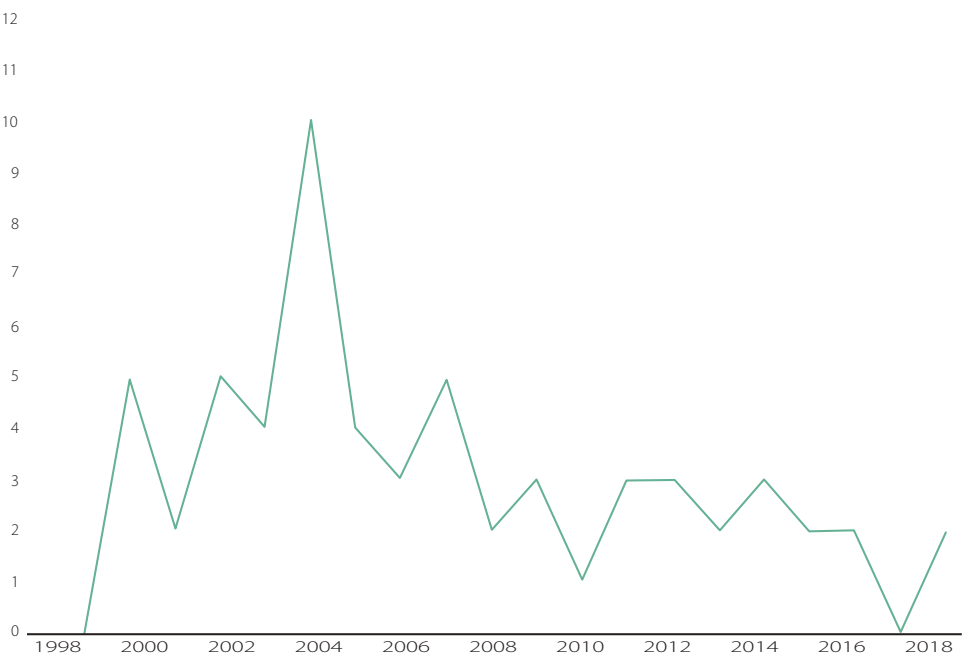
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c ‘Pokies rake in $12 billion a year’



Source: ABC News website

d ‘Australian music is falling out of the charts’

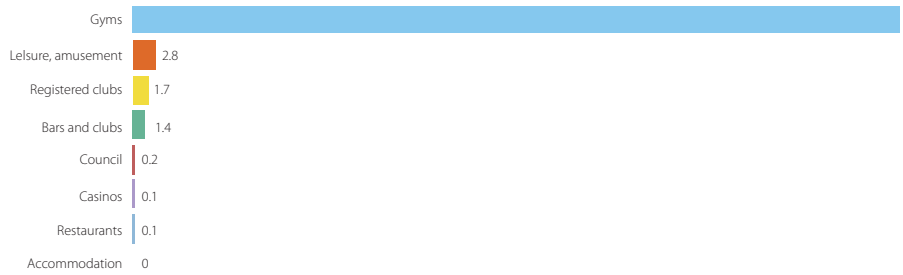


Source: ABC News website

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e ‘You like to Lose Yourself at the gym’

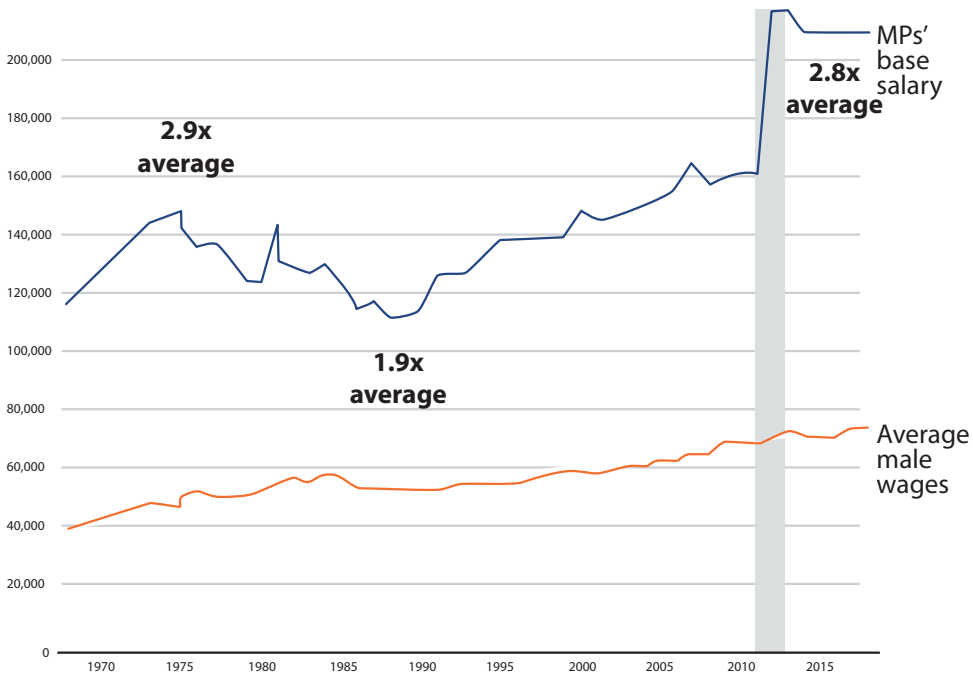
The types of businesses Eminem's 'Lose Yourself' was progammed in during July (%)



Source: ABC News website

2 What does each **axis** tell us about these graphs?

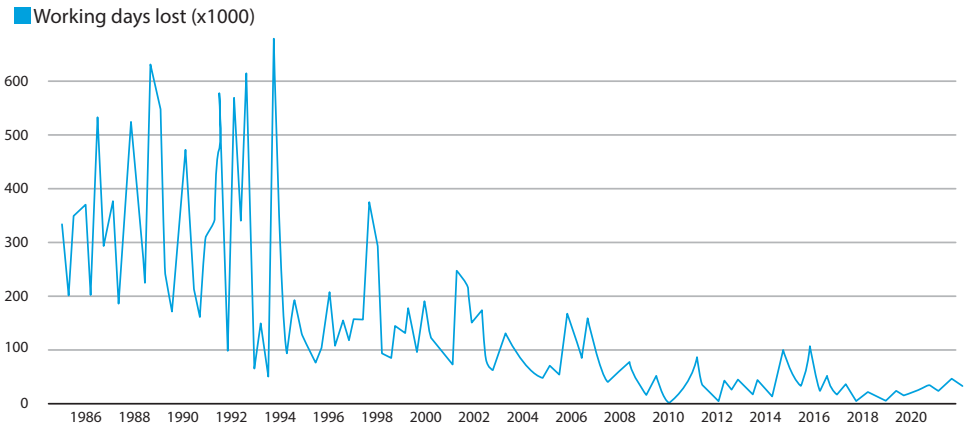
a 2012 was a big year for MPs’ pay packets



Source: ABC News website

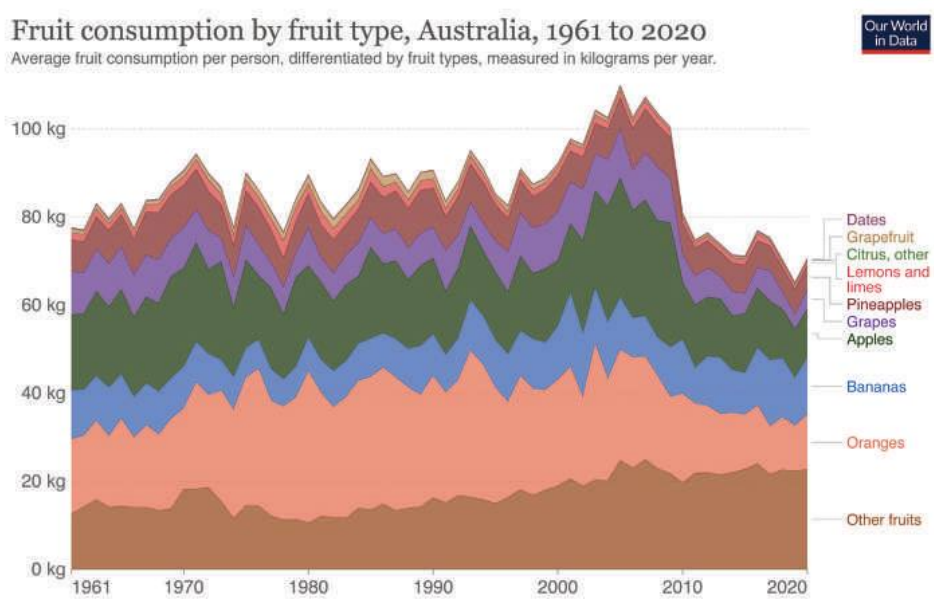
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b Industrial disputes, all industries



Source: ABC News website

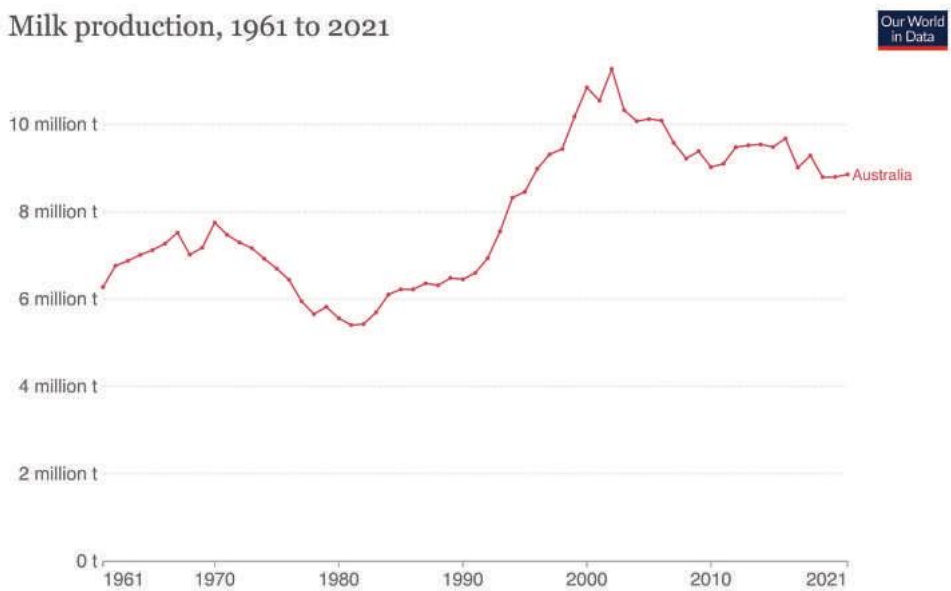
c



Source: ourworldindata.org

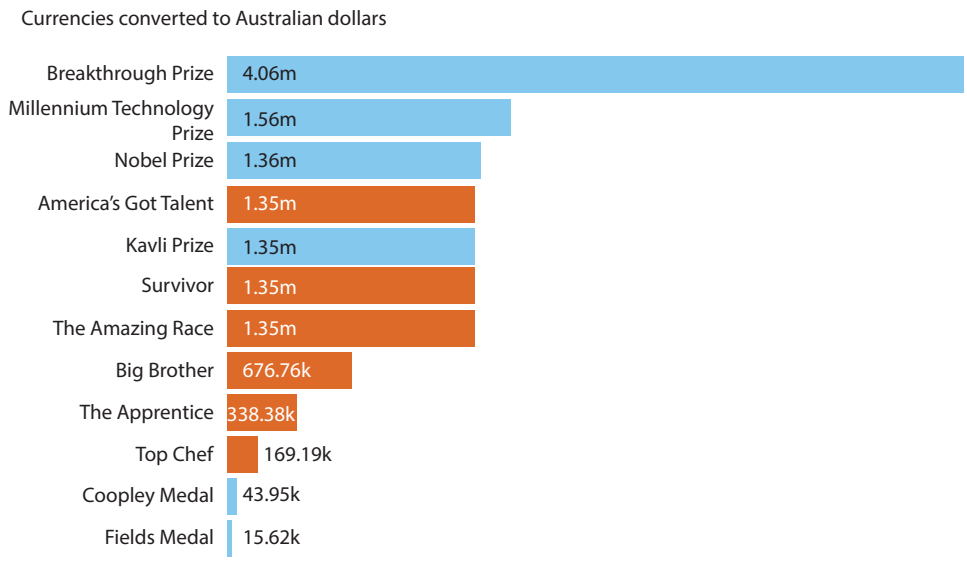
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d



Source: ourworldindata.org

e **Cash prizes: science awards vs reality television winners**

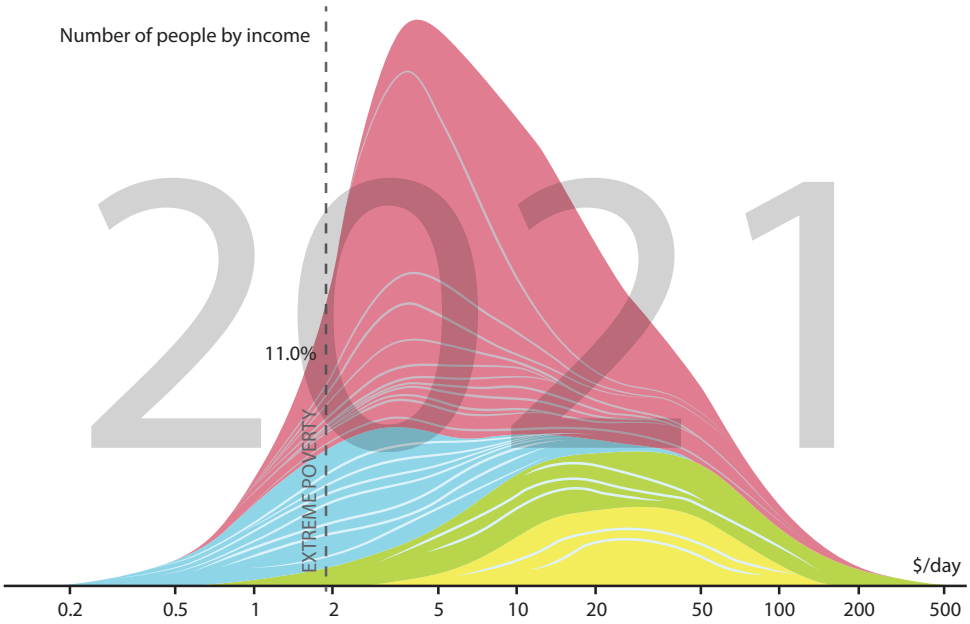


Source: ABC News website

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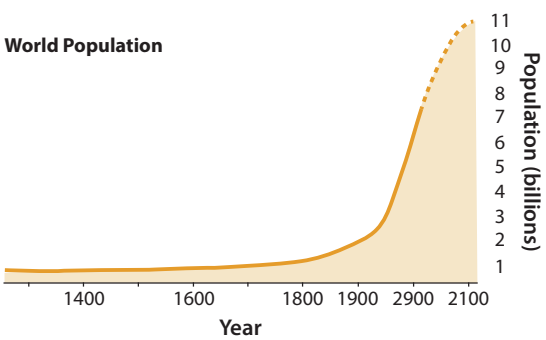
3 What does the **shape** of each graph tell us?

a

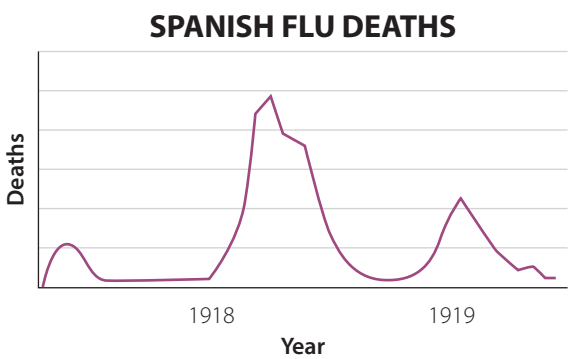


Source: www.gapminder.org

b

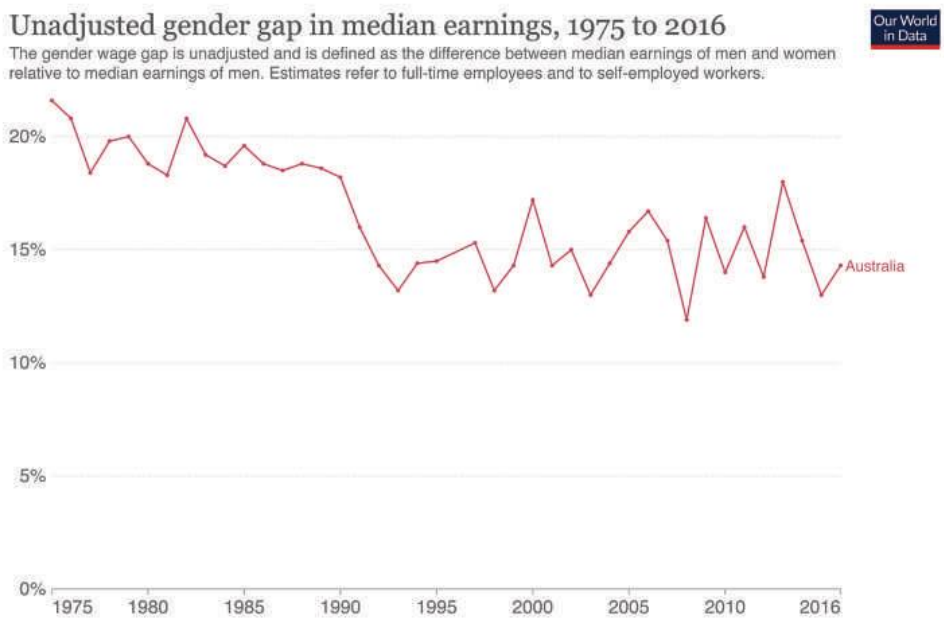


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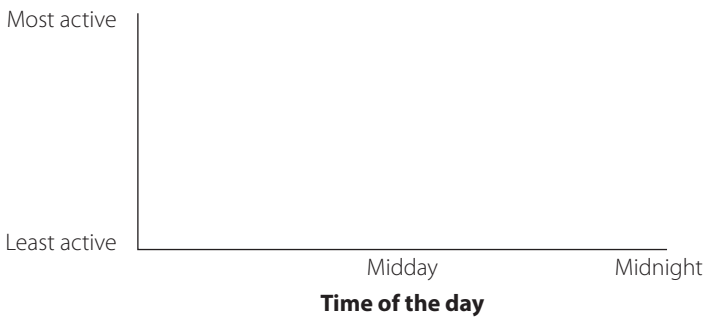
d



Source: ourworldindata.org

Mathematical literacy

4 **a** Make a graph of your physical activity over a typical day.

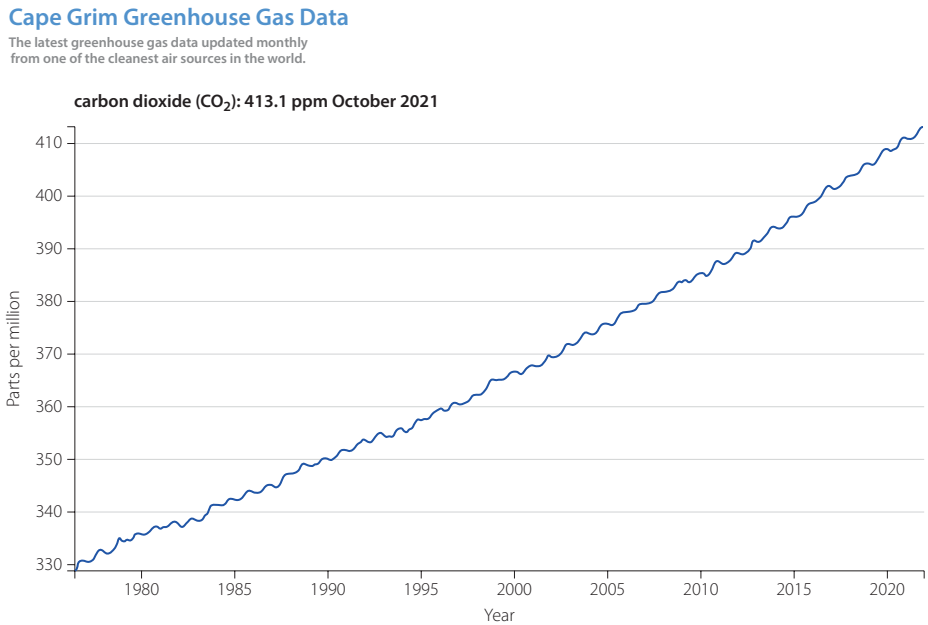


b Switch graphs with a partner and tell the story from their graph.

Thinking task

5 Look at this data from Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO). It shows greenhouse gas data collected from Cape Grim at the remote north-west tip of Tasmania.

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Source: CSIRO website

Apply the data analysis process to this graph.

Think about the following.

- The topic. What is being discussed?
- The shape of the graph.
- The axis. How does one axis relate to the other?
- The scale. Consider if the scale influences the story.

a What is the story that this graph tells?

b Is there a bigger story that we can take away from this graph?

Application task

6 Search the internet for up to three graphs on a topic that interests you. Take a screenshot or download each graph. Include the URL (web address) or citation.

For each graph:

a What is the heading or title?

b What do the axes tell you?

c Is the scale important?

d What does the shape of the graph tell you?

e What is the story or message?

f How has this analysis changed your understanding of the topic?

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5I Distorting data

Data may be distorted or manipulated for morally bad purposes!

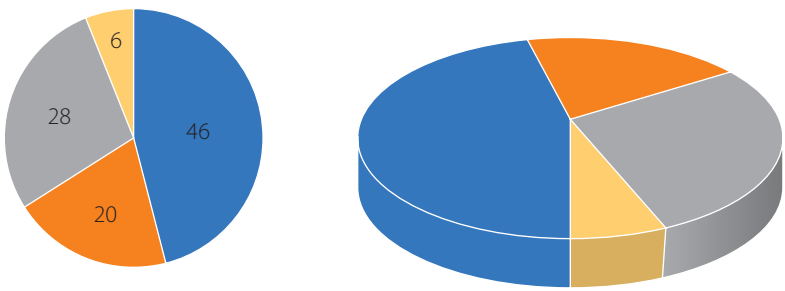
Misrepresenting data can change the story. Without a critical data-eye, it is easy to believe what we see.

Let's look at some of the tricks that are used to manipulate data.

The presentation tricks

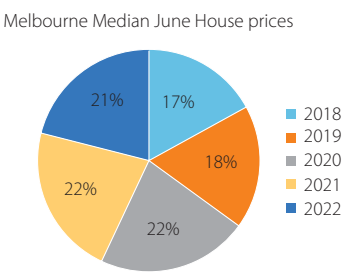
3D presentation tricks

Both of the graphs below display the same data. Using a side-on-view and leaving off the numbers, means that the 6% appears to be much larger than it is!



Faulty pie charts

Is this a correct pie chart and an appropriate set of data to use in a pie chart?



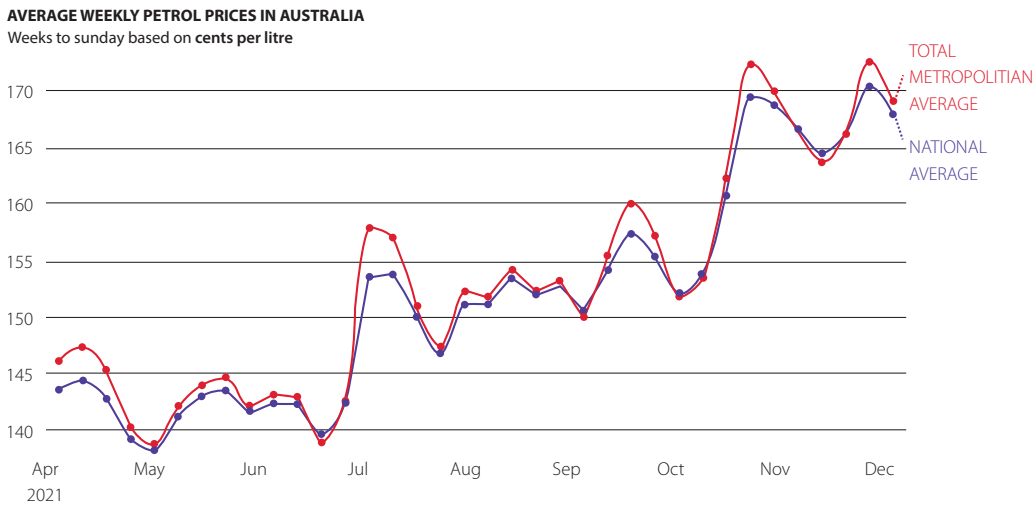
Year	Median June house prices ($1000s)
2018	800
2019	875
2020	1050
2021	1030
2022	1010

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Remember that a pie chart can only be used to compare each part's contribution of a whole, as opposed to comparing parts or groups to each other. In this case, the data is house prices across different years, and is not comparing out of any total or whole amount. The data is incorrectly stated as percentages, although they seem to add up to 100%. This makes the pie chart inappropriate and meaningless, even though the spreadsheet happily created the pie chart.

Not starting the *y*-axis at zero

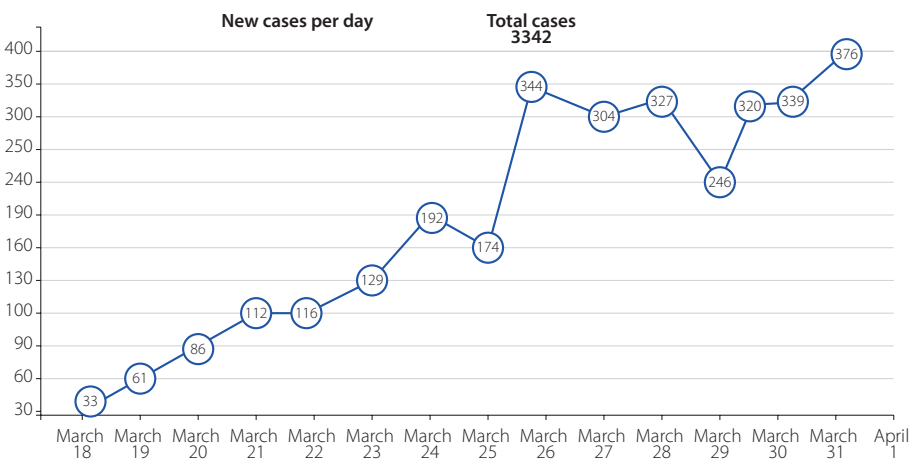
When the *y*-axis doesn't begin at zero, the effect is to make relative changes appear larger. For example, in the graph below, prices appear to change more than they actually do.



Source: Australian Institute of Petroleum

Fudging the scale

If you look at the *y*-axis, you will see that the distance between each scale number is not the same. This changes the graph!

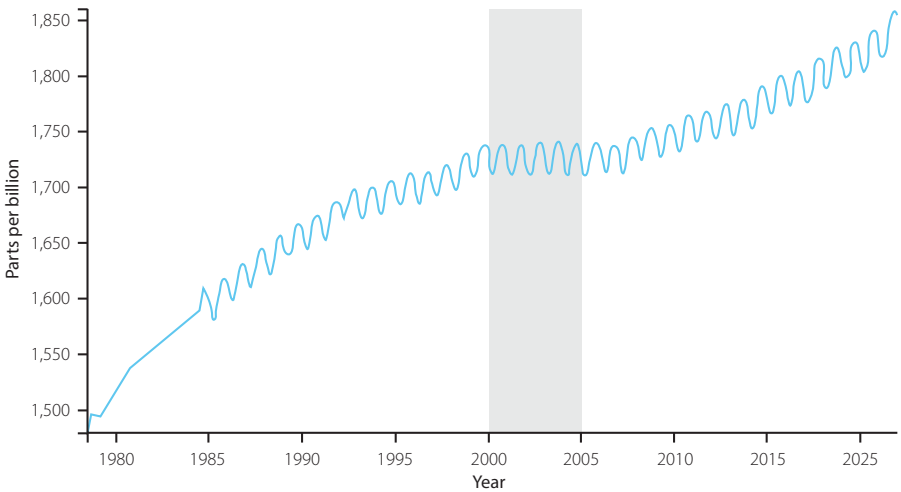


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Cherry-picking the data

Look at the amount of methane in the atmosphere, as measured at Cape Grim by CSIRO.

If we look only at the section of the graph near 2000–2005, we might assume that there is no change and perhaps even a slight decline. If we look at all the available data, however, a different picture emerges.

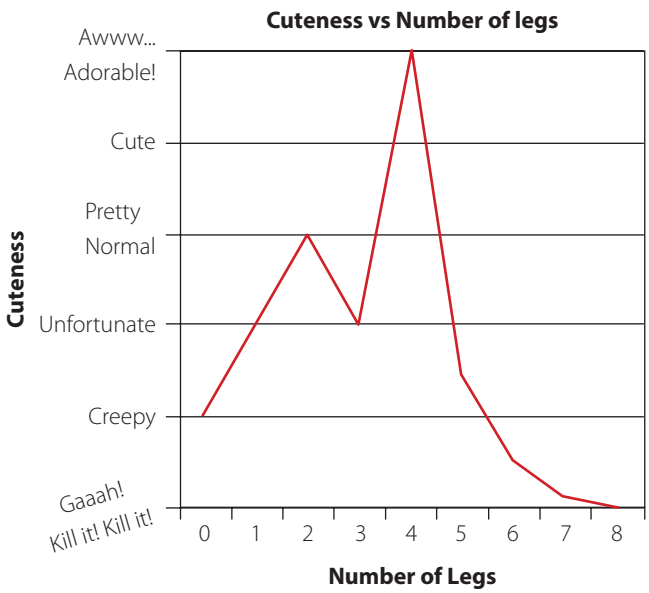


Source: https://capegrim.csiro.au/

5I Tasks and questions

Thinking task

1 Explain the following graph.

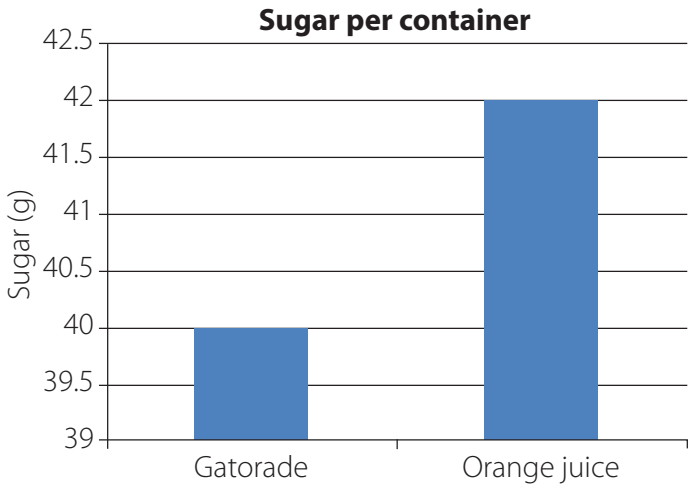


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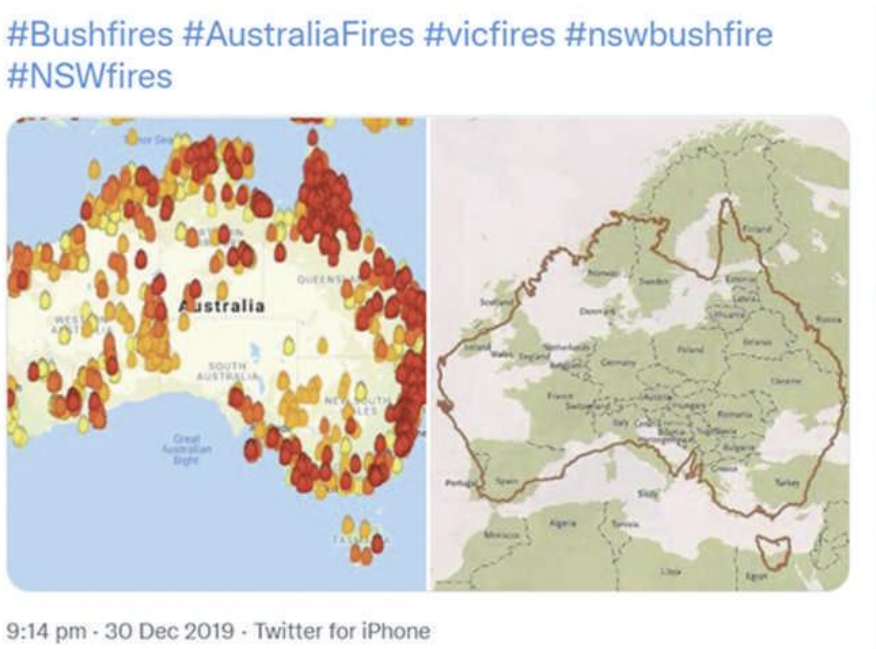
Skills questions

2 For each of the following graphs, give reasons why you think it is misleading.

a



b



Source: X (formerly Twitter)

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Mathematical literacy

3 Conduct an internet search and find an example of a misleading graph to share with your class.

Discuss the ways in which the author is misleading the reader, and give possible reasons for their intentions.

Application tasks

4 For each of the following data sets:

i Create a graph with all the data.

ii Create your own misleading graph.

iii State how the graph might mislead someone who reads it.

a Participation in formal and/or non-formal learning by age groups in 2016–17

Age group (years)	(%)
15–19	89.9
20–24	63.8
25–34	44.6
35–44	39.6
45–54	36.4
55–64	26.2
65–74	10.9

Source: ABS website, 'Work-related training and adult learning, 2016–17 financial year', released 20/12/2017

b TikTok user ratio in the US, 2021, by age group

Distribution of TikTok users in the United States as of March 2021, by age group	%
10–19	25
20–29	22.40
30–39	21.70
40–49	20.30
50+	11

Source: Statista website, 'TikTok users by age', 2022

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c

Month	Ice-creams sold	Drownings
Jan	356	9
Feb	298	4
March	154	1
April	214	0
May	76	0
June	49	2
July	34	0
August	47	1
September	86	0
October	183	1
November	210	3
December	306	5

Source: Education Victoria website, 2022

d Here is the data for road fatalities across Victoria comparing 2022 and 2023 by age group.

Age Group	2022	2023
0 to 4	4	3
5 to 15	5	4
16 to 17	8	3
18 to 20	12	20
21 to 25	23	19
26 to 29	18	22
30 to 39	31	33
40 to 49	28	34
50 to 59	25	32
60 to 69	33	31
70 and over	45	40
Unknown	2	0

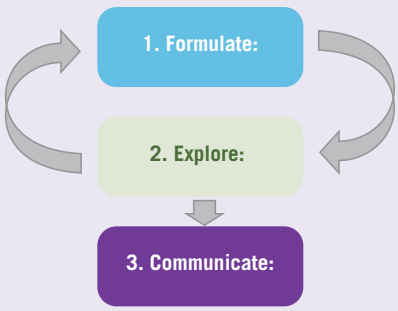
Source: TAC website

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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 Lawn-mowing business



It is the classic Aussie dream to have a lawn to play cricket on, to run under a sprinkler on a hot summer day and to admire the grass!

Lawn mowing is a well-established job in Australia, with many small and large companies in the business.

Your friend decides to start up a lawn-mowing business in the local area, and you have been commissioned to conduct some research for them first.

Before undertaking the research, you plan the following steps.

a What is the purpose of conducting this research?

b What is the big question or questions you would like answered?

c What variables or information are you going to collect?

d Are your variables categorical or numerical?

e How are you going to present your findings?

f What type of graph will be most suitable for your findings?

g What will you title your graph?

h What will you label each axis?

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i How can you prevent your data from being misleading?

One well-known lawn-mowing business in Australia ran a survey on lawn-mowing habits.



Source: Jim's mowing website

j Who did this research, and when?

k What further information would you want to have before accepting this data as unbiased?

l What could be an explanation for nearly one third of the people not having a lawn?

m Do these figures support the business model advocating for people to hire a mowing service? Why or why not?

n Graph the data in a different way. Explain why you chose this form.

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2 Solar panels

In 2022, Australia had one of the highest uptakes of rooftop solar in the world, with solar panels installed in almost one-third of dwellings.

Your task is to create a report on domestic solar panels in Victoria. The format of this report is up to you.

a Research and find data about the use of rooftop solar panels across Australia, and compare usage between different states or between Australia and overseas countries. State where you found your data from, and display the data in tables and graphs.

b Is the claim above about Australia having 'one of the highest uptakes of rooftop solar in the world, with solar panels installed in almost one-third of dwellings' backed up by your data and analysis? Using your data and its representations, explain why – or why not.

c What is the industry recommendation for the minimum solar panel installation for households? What is the price range for installing this solar system?

d Are there Victorian and Federal Government rebates available for installing solar panels? If yes, what are the rebates available for the minimum solar panel installation? List at least 2 conditions that you must meet to be eligible to claim the solar rebates you find.



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Key concepts

- Data can be separated into **categorical** and **numerical** data.
  - **Categorical data** can be divided into groups or categories, such as types of food at the canteen.
  - **Numerical data** can be counted or measured. Examples include the number of devices people own, and the height of your classmates.
- Data can also be categorised into **primary** and **secondary** data.
  - **Primary data** is data you collect for yourself.
  - **Secondary data** is data you obtain from another source, such as the Australian Bureau of Statistics.
  - When using secondary data, it is important to choose a reliable source.
- Data is collected for a particular **purpose**. This purpose might be to answer a question, make a decision, or make a prediction.
- **Surveys** or **questionnaires** can have two different types of question: **open-ended** and **closed** questions.
  - Select the type of question best suited to your purpose.
  - When phrasing questions, be clear and eliminate bias.
- To read data, it is important to be familiar with the key features of the data displays. For instance, when reading a table, pay attention to what each row and column contains. When reading a graph, note what information the axes have.
- There are many ways to organise data, including: tallies, tables, graphs, charts, maps and diagrams
  - **Column graphs, bar graphs and histograms** are similar data displays, where the length of the columns or bars show the values of the dependent variable.

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- **Column graphs** usually display data vertically. It tends to be used for discrete (countable) data, and it has spaces between columns.
- **Histograms** also display data vertically. It tends to be used for continuous (measurable) data, and it has no spaces between columns.
- **Bar charts** are similar to column graphs, and the terms can sometimes be interchanged, although normally the data is arranged horizontally instead of vertically.

- **Pie** charts are useful for showing parts of a whole.
- **Line** graphs are useful for describing numerical data that changes as the independent variable changes.
- **Scatterplots** are similar to line graphs, except, unlike line graphs, the individual data points are not connected using a line.

- When interpreting a data display in a real-world context, there are several factors to consider. These include: what is being discussed, the shape of the graph, the axes, and the scale.

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Chapter 5 review questions

☐ I can identify categorical and numerical data.

1 Jordy is a manager at a hardware store and collects data as part of their job. Identify each of the following sets of data as categorical (c) or numerical (n).

- **a** Employees' annual salary
- **b** Types of tools
- **c** Names of employees
- **d** Quantity of items on the shelf
- **e** Cost price of products
- **f** Length of pipes

2 Sou owns a bakery and surveys customers to determine their favourite product from the shop. The results of the survey are:

Product	Number of customers
Sausage Roll	9
Pie	14
Cake	11
Drink	5

What type of data did Sou collect?

☐ I can identify the data collected for different situations.

3 What data might you collect when deciding where to buy your first house?

☐ I can identify methods for collecting data.

4 Sou, the bakery owner, also wants to collect data to determine the times that customers prefer to shop. Sou will use this data to review opening hours and staffing shifts.

- **a** Sou decides to use a survey to collect the data.
  - **i** Write a closed question Sou could ask to collect the data they need.
  - **ii** Write an open-ended question Sou could ask to collect the data they need.
- **b** What is another method that Sou could use to collect the data?

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5 Jahn, a careers teacher at a school, uses the Jobs and Skills Australia website (www.jobsandskills.gov.au) to identify careers which are currently experiencing skills shortages.

a Is data collected from this site an example of primary or secondary data?

b How reliable would Jahn expect the data to be? Why?

6 A local council creates a questionnaire for youth in the council area to complete.

a Read the following survey question and decide whether it is good or whether it contains bias or is confusing.
Do you like playing basketball and netball?

b If the survey question is not a good question, rewrite it to make it clear and unbiased.

c If the council is planning a remodel of a local park, would this question collect appropriate data to help with the planning? Explain.

☐ I can organise data.

7 Which of the following data sets could best be displayed using a pie chart?

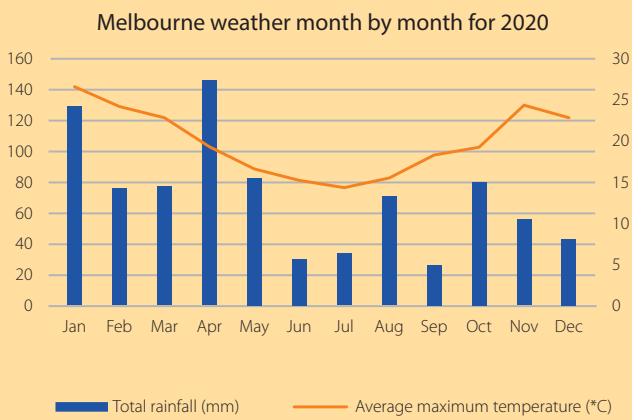
a Times recorded for students running in the 100 m at athletics day.

b Favourite subjects of students in a class.

c The number of downloads of the top 10 songs on Spotify.

☐ I can accurately read and interpret diagrams, charts, tables and graphs.

8 Data collected by the Bureau of Meteorology is presented in the combined bar and line graph below. Use the graph to answer the following questions.

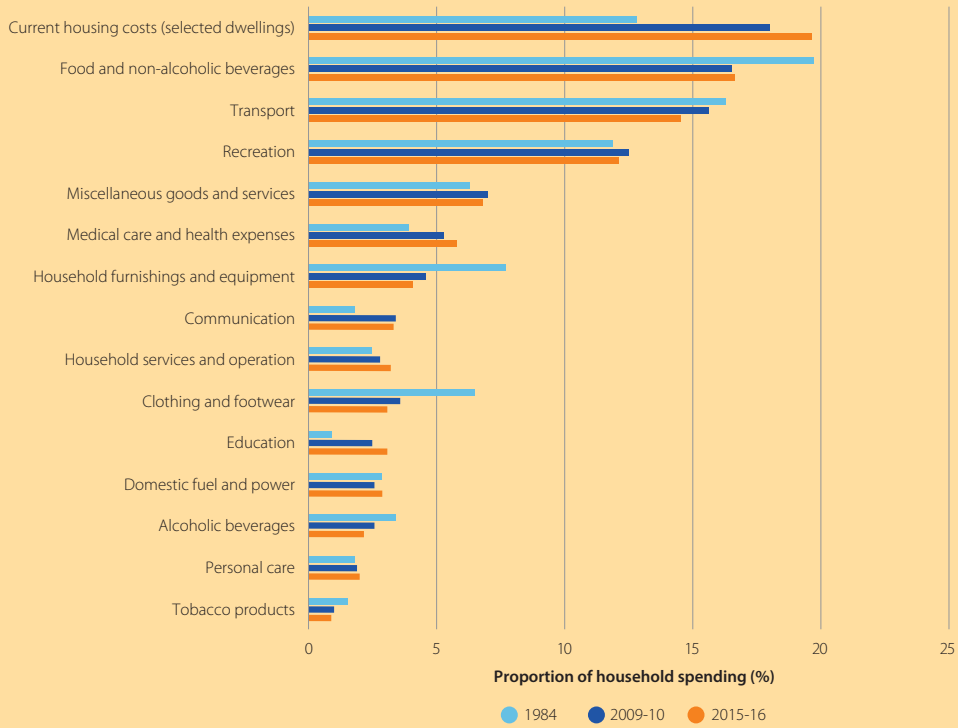


Source: Bureau of Meteorology

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a Which month had the highest total rainfall?
b Which month had an average maximum temperature of 20°C?
c We may expect that the hottest three months are the summer months. Was this the case in 2020?
d How many months experienced total rainfall below 60 mm?

9 This graph from the ABS website shows the proportion of household spending on different goods and services in 1984, 2009–2010 and 2015–2016.



Source: ABS

a In 1984, which category of goods and services did Australians spend most of their income on?
b In 2015–2016, which category of goods and services did Australians spend most of their income on?
c List three categories of goods and services where the proportion of spending has decreased significantly since 1984.
d List three categories of goods and services where the proportion of spending has increased significantly since 1984.

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10 The table below containing data taken from the ABS website shows the median hourly wage for males and females in Australia from 2004 – 2021.

Year	Male	Female	Gender wage gap	Gender wage gap
	$	$	$	%
2004	18.80	17.90	0.90	4.8
2005	19.70	18.80	0.90	5.0
2006	20.10	19.30	0.80	4.0
2007	21.30	20.00	1.30	5.9
2008	22.50	21.30	1.20	5.6
2009	23.30	22.00	1.30	5.7
2010	24.40	23.00	1.40	5.9
2011	25.00	24.00	1.00	4.0
2012	26.30	25.00	1.30	4.9
2013	26.30	25.00	1.30	4.9
2014	28.60	26.70	1.90	6.5
2015	28.80	27.50	1.30	4.5
2016	29.60	28.00	1.60	5.2
2017	30.00	29.00	1.00	3.3
2018	31.30	30.00	1.30	4.2
2019	32.50	31.20	1.30	4.0
2020	36.00	35.00	1.00	2.8
2021	36.00	34.60	1.40	3.9

Source: ABS

a Have male and female hourly wages grown every year?
b In what year from 2004 to 2021 was there the greatest wage gap in dollars?
c In what year was there the greatest wage gap by percentage?
d There is regular discussion in the media and in politics about how we can reduce the gender wage gap. Do you believe the gender wage gap has decreased significantly in the years from 2004 to 2021?

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☐ I can display data using an appropriate graph.

11 For the following sets of data, determine an appropriate graph to display the data and then use technology to graph it.

a Sea swell at Portsea over 7 days

Day	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Swell (m)	2.8	2.1	1.2	0.9	1.4	1.1	1.1

b Number of points scored by each member of a basketball team during a season

Name	Sami	Tiana	Kristy	Lauren	Jade	Alex	Jaz	Zitina
Score	90	124	65	130	187	98	78	203

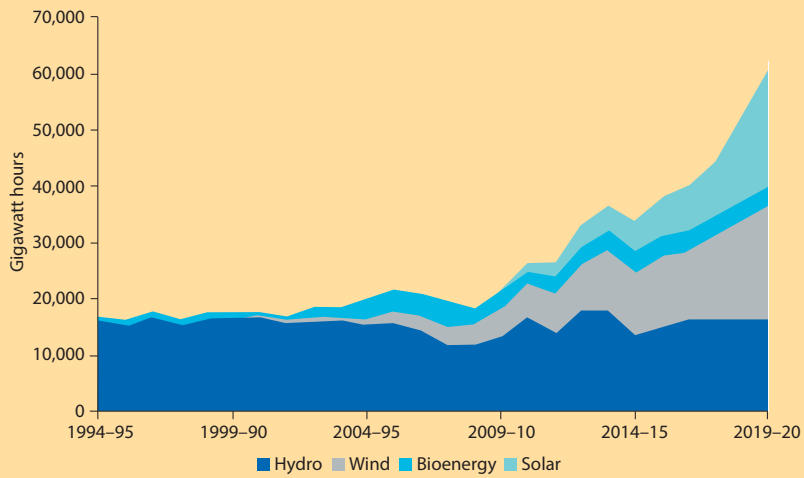
c Favourite video game of students in a year level

Game	Minecraft	Fortnite	Roblox	Rocket League	FIFA	Other
Number	58	16	34	38	42	12

☐ I can interpret graphs.

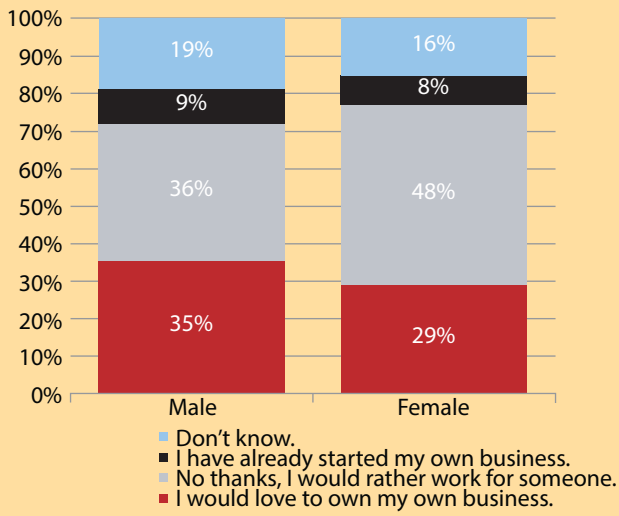
12 Tell the story of the graph for each of the following.

a Australian electricity generation from renewables

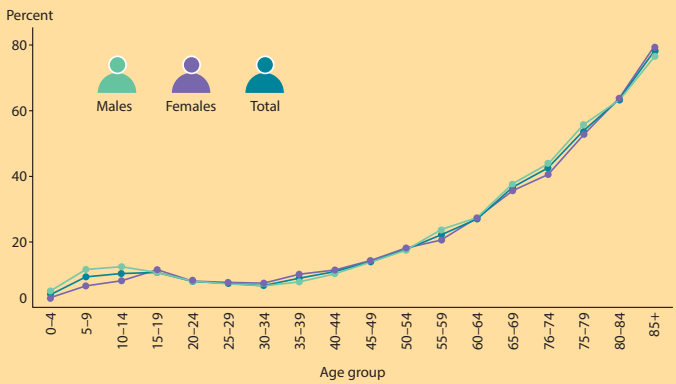


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b Own a business or work for someone: by gender

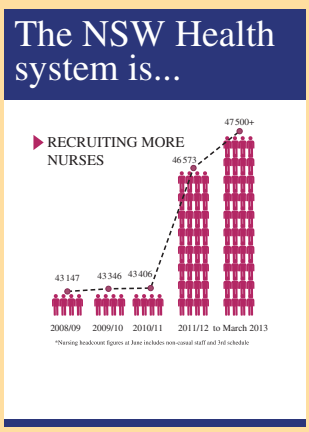


c Percent of population with a disability by age group



☐ I can identify how graphs may be misleading.

13 Explain why the following graph may be misleading. What story are they trying to tell? What might the truth of the data be?



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Key vocabulary

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

Term	Meaning
Ambiguous / Ambiguity	Information that has more than one possible interpretation is ambiguous.
Bias	Prejudice for or against something.
Categorical data	Categorical data refers to items that we can classify into named groups or categories, for example, the names of the days of the week.
Closed survey questions	Questions where the answers are restricted to a given list, for example, multiple-choice questions.
Continuum scale (slider scale)	A continuum scale allows for responses to questions by sliding to and clicking any point on a scale.
Data / Dataset	A piece of information, or a set of information. Data can be categorical (names) or numerical (numbers).
Demographic	A group within a wider population, for example, teenagers as a subset of an entire population.
Graph / Chart	A conventional visual representation and summary of a dataset, for example, a column graph or pie chart.
Infographic	An informal representation and summary of a dataset using graphic and text elements.
Multiple-choice questions	Questions in a survey or test where the possible answers are in a pre-determined list.
Numerical data	Numerical data is obtained by counting or measuring and can meaningfully be summarised using statistics such as mean, range, etc.
Open-ended survey questions	Questions where responses can be provided by participants in their own words, either orally or in writing.
Personal data	Personal data refers to items that are unique and personal to you. It can be classified as either categorical (your name and address) or numerical (your age and height).

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Term	Meaning
Short-answer questions	Test questions where the answer and its working are written down in the test booklet, to be scored by human markers (not auto marked).
Slider scale	See *Continuum scale.*
Survey	A method of gathering data about a research question. The survey form is the same for all participants and may be delivered face to face with an interviewer or electronically.
Table	A collection of data, set out in rows and columns.
Unambiguous	The opposite of ambiguous.
Value	The numerical amount of a magnitude or quantity.

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6 The data story



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 data and statistics. Prompt questions might be:

- What was going on in this photo at the moment it was taken?
- What data and information might be collected and used for analysis?
- How might the data be analysed and for what purposes?
- What different ways might the data be analysed so that it can be compared – and how might it be compared?
- What different tools, technologies or software might be used?
- What research or investigation questions could be undertaken based on this photo?

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Chapter contents

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6B Tuning in
6C The purpose of collecting and comparing data
6D How can we compare different data sets?
6E Key summary statistics – the middle or average
6F Key summary statistics – the spread
Investigations
Chapter review

From the Study Design

In this chapter, you will learn how to:

- read and interpret diagrams, charts, tables and graphs
  (Unit 1, Area of Study 2)
- summarise statistical data and determine commonly used measures of central tendency and of spread
  (Unit 1, Area of Study 2)
- describe, compare and analyse data sets and report on any trends, implications or limitations
  (Unit 1, Area of Study 2)
- explore common measures of central tendency (mean, median, mode) and of spread (range, quartiles)
  (Unit 1, Area of Study 2)
- learn characteristics and properties of data sets and the shape of their distributions
  (Unit 1, Area of Study 2)
- use terminology and language for description, comparison and analysis of data sets, graphs and summary statistics
  (Unit 1, Area of Study 2).

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Chapter overview

Introduction

In many fields of mathematics, it is possible to obtain definitive answers. With statistics, however, the information can be analysed and interpreted in many ways. This can lead to different conclusions being made from the data. Conventions in analysing and comparing data allow for greater consistency in drawing conclusions from the data.
In this chapter, we will consider the purpose of collecting different types of data. We will look at measuring the middle of the data and the spread. Using the data analysis, we will learn to draw conclusions from the data.

Learning intentions

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

- identify the purpose of data collection in real-world scenarios
- understand the purpose of being able to compare data sets
- compare data sets by selecting the most appropriate way to display them, including line graphs, back-to-back stem and leaf plots, and side-by-side column graphs
- calculate measures of central tendency such as the mean, median and mode
- calculate measures of spread such as the range and interquartile range
- read tables
- follow the phases of the statistical cycle in order to complete real-world projects
- apply the problem-solving cycle to complete investigations related to the topics contained within this chapter.

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Spotlight: Dr Allison McIntyre

An interview with a road safety consultant

Tell us about the work you've done and what you do now.

I studied psychology and all of that involves statistics. You have to analyse data, collect data and report on it. That's essentially what I do even now.

After working at the Transport Accident Commission (TAC), I started consulting, mainly in road safety. A lot of consultants understand road safety policy and road safety principles, but I've got this other analytical side. I can use and analyse data and numbers and have a behavioural view of road safety problems, so it's a unique combination.

What maths do you use regularly in your job? Could you give some examples?

One of the key data sets I use is police reported crash data. Every time there's a crash, the police fill out a form and that all gets collected. I'll do some analysis for a particular purpose, perhaps looking at crashes in 60-kilometre-per-hour zones.

When I get this massive data set, thousands and thousands of crashes, I consider how to summarise that in a meaningful way that people will understand. Sometimes it can be quite technical. Other times it might be simpler, for example for the board or to put on the website.

What is the most useful tool or piece of technology that you use regularly in your job?

I use Excel for simpler data sets. In terms of the types of statistical analysis techniques I use, it can be as simple as mean, standard deviation, range, minimum, maximum. I also look at percentage increases or decreases for one year compared to another. There is a lot that you would use Excel for, just because it's familiar and accessible. It creates all the graphs and charts that you want and presents them in a way that the audience has some chance of understanding.

What was your attitude towards maths when you were in school?

I did English, English literature, biology, history and Maths A, so mostly humanities. I was always interested in people and behaviour – why they do what they do. Those subjects were the best to understand people and using maths helps me to understand people. I wasn't massively excited about maths but knew that it was important to have it. For me maths is a tool to answer a question.

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6A Starting activities

Activity 1: Analysing AFL teams



Australian Rules Football (AFL) is considered to be Victoria's 'national' sport.

Devotees of the game follow all the statistics, such as where teams are placed on the ladder, individual player statistics and statistics for many aspects of the game, such as kicking, tackling and scoring.

For this activity, you will investigate statistics for individual teams.

Go to an AFL sports statistics page such as www.afl.com.au and navigate your way to look at 'statistics' (STATS) and 'team rankings.'

Complete the following table. You may want to make a poster of your findings to display.

Statistic	Team Name and Highest/Lowest Calculation	Personal Reaction
Team with highest number of **kicks** for the season.		
Team with lowest number of kicks for the season.		
Difference between highest and lowest number of kicks for the season.		
Team with highest number of **handballs** for the season.		
Team with lowest number of handballs for the season.		
Difference between highest and lowest number of handballs for the season.		
Team with highest number of **disposals** for the season.		

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Statistic	Team Name and Highest/Lowest Calculation	Personal Reaction
Team with lowest number of disposals for the season.		
Difference between highest and lowest number of disposals for the season.		
Team with highest number of **marks** for the season.		
Team with lowest number of marks for the season.		
Difference between highest and lowest number of marks for the season.		
Team with highest number of **goals** for the season.		
Team with lowest number of goals for the season.		
Difference between highest and lowest number of goals for the season.		

Activity 2: Social media usage statistics

Many hand-held devices allow the user to view summary statistics of their daily or weekly usage.

On your own personal device, find the summary statistics.

Make an infographic of your summary statistics.

1 What should you include?

2 What time period are you presenting?

3 Can you make a comparison with other similar data? How will you do this?

4 How should you present the information?

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6B Tuning in

Epic Fail

Sometimes, scientists and medical researchers want the story of their theory to be told so much that they are prepared to falsify their data or results. This is particularly true of one formerly eminent researcher who continued to promote the use of curcumin (the chemical that makes turmeric so 'yellow') as a treatment for cancer.



As a result of the discovery of his fraudulent conduct, he had to resign his position, and many of the articles he authored or co-authored have been retracted due to the following issues: 'original data not provided,' 'manipulations of images' (images are data), 'falsification or fabrication of data', 'concerns and issues with results', and 'unreliable data'.

Discussion questions

Pause for a moment and think about who is affected by the fraudulent use of data and statistics. Certainly, the scientist who has been 'uncovered' is affected, but what about all the 'ordinary' people who believed the research (and many health journals and blogs reported these results) but have not heard about the retractions?

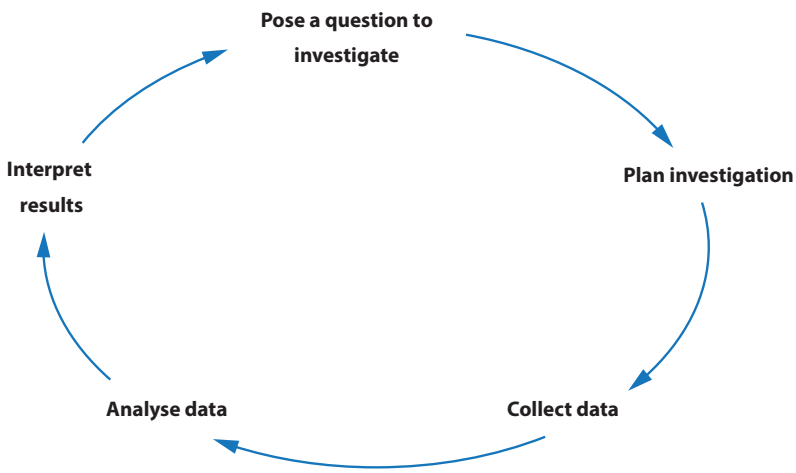
What other consequences follow from scientists and researchers using false or misleading data in their work?

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Check and reflect – don't just accept a 'fact' until you know that the source is current and reliable. This particularly applies to data. The questions you need to ask are: Who collected the data? How was the data collected? When was it collected? Do the results seem odd? Always use your real-world experience to judge whether the information you are being told is reasonable.

The statistical cycle

As we saw in Chapter 5, the statistical cycle steps you through the stages needed in order to investigate an issue, from deciding on the research question(s), planning how to implement the data collection, collecting or finding the data, analysing the data and then interpreting the results. This enables 'a story' to be told, and can provide an evidence-based answer to a question, or give some input into a decision or prediction. This often involves interpreting and making a comparison between two or more different data sets.



We can compare data to tell the story of a change over time, such as comparing the cost of bananas in 2000 with the cost in 2005, 2010, 2015, 2020, and then potentially again in 2025 and beyond. We could graph the changes to see whether there was a gradual change or many price fluctuations. We can compare data sets to find out whether one is 'better' than the other, such as which sports team has the better stats. To compare data sets, we use *descriptive* and *comparative* statistics that help us summarise and compare the data.

Practice questions

1. If you want to find out the three most popular social media platforms used by students in your year level, what would be your first steps?
2. Once your data is collected, how would you organise it?
3. What would be the most effective presentation method to convey your findings?
4. What else could your data tell you?

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6C The purpose of collecting and comparing data

Statistics can tell a story. They can be used to inform or to mislead. Statistics and its many varied representations can inform people about data quickly and visually.

For example, weather statistics have been collected in Australia for thousands of years. In the Countries of Victoria, knowledge was passed on orally in stories and written in the landscape. There are six seasons in what is called the Gariwerd calendar.

Kooyang	Gwangal moronn	Chunnup	Larneuk	Petyan	Ballambar
Late summer	Autumn	Winter	Pre-spring	Spring	Early summer
January-March	March-May	May-July	July-August	September-November	November-January
Eel season	**Honey bee season**	**Cockatoo season**	**Nesting bird season**	**Wildflower season**	**Butterfly season**
Hottest and driest time	Warm, still days	Freezing winds	Dramatic weather changes	Tempestuous weather	Summer heat starts
Scarce surface water	Country starts to cool	Coldest time of year	Wettest time of year	Warmer days	Hot, dry days
High bushfire risk	Cooler mornings	Bleak mists	Rivers run high	Bush bursts into life	Stable weather
Night sky is bright with stars	Red sunrises and golden evenings	Rain		Emu constellation appears	

Source: bom.gov.au

Written recorded weather statistics in Australia date back to 1788. Lieutenant William Dawes constructed a small observatory in Sydney Cove to take measurements. In Melbourne, there was an observatory in what is now the Flagstaff Gardens.



The meteorological stand of Georg von Neumayer's Flagstaff Observatory established in Melbourne in 1865. Source: ABS

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Today, weather statistics are provided constantly – on our phone, on weather apps and as a much-loved segment on the free-to-air news.



A modern weather station measures atmospheric conditions, such as temperature, atmospheric pressure, humidity, wind speed, wind direction and precipitation amounts, to provide information for weather forecasts and to study the weather and climate.

We plan much of our lives around the weather, from what to do or even what to wear each day.

In this case, the purpose of the data is to provide *evidence for decision making*.

Shepparton

Forecast issued at 5:00 am EST on Friday 30 July 2023. Detailed Shepparton Forecast

	Fri. 30 Jul	**Sat.** 31 Jul	**Sun.** 1 Aug	**Mon.** 2 Aug	**Tue.** 3 Aug	**Wed.** 4 Aug	**Thu.** 5 Aug
	Late shower or two.	Possible shower, then late rain.	Early rain then shower or two.	Showers.	Shower or two.	Possible shower.	Possible shower.
Max. Temperature	14°C	19°C	15°C	15°C	13°C	13°C	13°C
Min. Temperature		7°C	8°C	4°C	5°C	4°C	5°C

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The power of comparing data

Data may be measured across different variables and conditions, such as time or location. For example, sales from different stores in a chain of stores may be compared for performance, or weather is reported over different time periods. Climate change is an excellent example of where we have collected weather and climate data over a long period of time, so that it can be analysed and compared, and used as the basis for predictions.

There will be occasions where we will be required to compare different sets of data against each other, for example, for work, when reading something in the media or perhaps for the local sports team. We may have already done this when looking at different phone or data plans or comparing different streaming services.

Comparing data sets allows us to see what the differences are between them and what are the similarities.

The approach we might take when comparing data sets depends on how the data is presented and the size of the data sets.

When we have two sets of data, ask the following questions.

- Do they have the same variables?
- Are they presented in a similar style to allow for comparison?
- Do they have the same shape?
- What is the same?
- What is different?
- What do the differences tell you about the data?

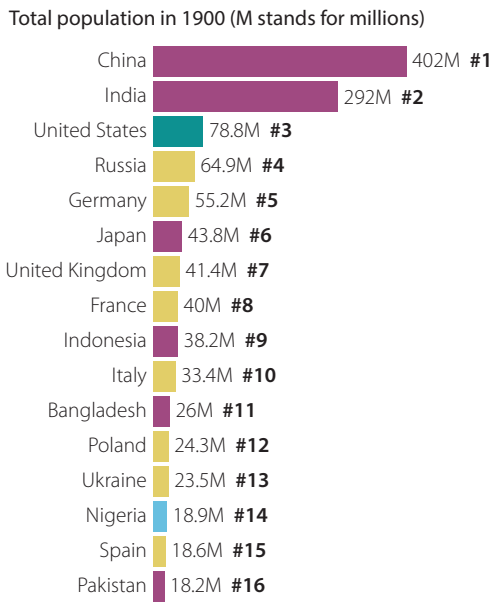


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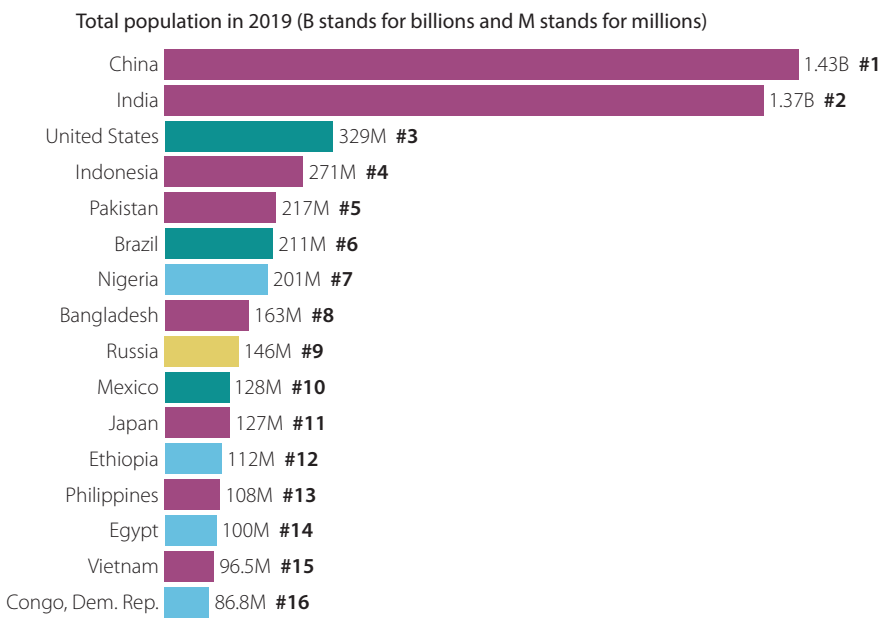
6C Tasks and questions

Thinking task

1 Look at the following two graphs about populations across the globe.



Source: Gapminder Foundation



Source: Gapminder Foundation

a What are some key differences between them?

b Think of at least one purpose for comparing these two sets of data.

c What other analysis could you do to compare the data?

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Skills questions

2 Describe the purpose of data collection for the following.

- **a** Weather forecast
- **b** School population census
- **c** Car imports
- **d** Listeners to a breakfast radio show
- **e** Carbon dioxide levels in the atmosphere
- **f** Sizes for a sports team's uniform

3 Give two reasons for collecting the following data.

- **a** Australian census
- **b** Car crash data
- **c** Confirmed cases of the flu
- **d** Cookies on your web browser
- **e** Personal information when you register at a medical practice
- **f** Location services data from your phone

4 State one purpose for comparing the following sets of data.

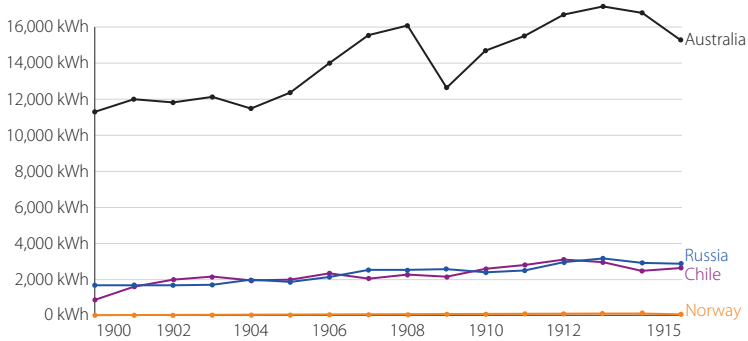
- **a** Ice-cream sales from year to year
- **b** Attendance at a summer music festival each year
- **c** Different genders choosing to study STEM subjects
- **d** Average take-home pay between men and women
- **e** Summer rainfall each year
- **f** Hospitalisations for asthma

5 Consider three pairs of data:

- **i** The data about populations across the globe in the **Thinking Task** above (see Question 1)
- **ii** Coal production per capita, shown below
- **iii** Victorians' total gambling losses on poker machines and sports and race betting, shown below

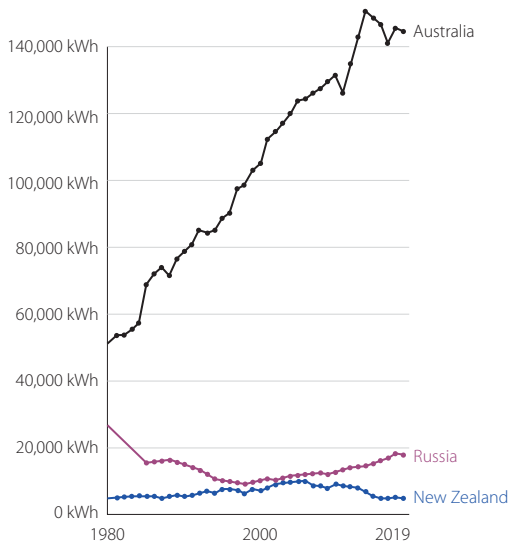
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Coal production per capita, 1900 to 1915



Source: ourworldindata.org

Coal production per capita, 1980 to 2019



Source: ourworldindata.org

Victorians' total gambling losses on poker machines and Sports and race betting

Financial Year:	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Total losses:	($m)	($m)	($m)	($m)	($m)	($m)
Poker machines	2610	2695	2699	1988	1565	2237
Sport and race betting				1645	2331	2578

Source for Sport and race betting: State Revenue Office (SRO) Annual Review 2021-22 Source for Pokies, Casino and Lotteries: Victorian Gambling and Casino Control Commission (VGCCC) Annual Reports 2016-17 to 2021-22

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a Do each of the pairs of data have the same variables?

b Are they presented in a way to allow for comparison?

c What is the same?

d What is different?

e What do the similarities and differences in the variables and the data enable you to say about the data, and what can you therefore say (or not say) when comparing the sets of data in each case?

Mathematical literacy

6 Use the internet to find the origin (etymology) of the words *data* and *statistics*.

Application tasks

7 A car accident repairer collects data or information on clients.

a List the data that may be collected.

b State the purpose of each piece of data that is collected.

c How might this data be stored?

d List three uses of this data to the business.

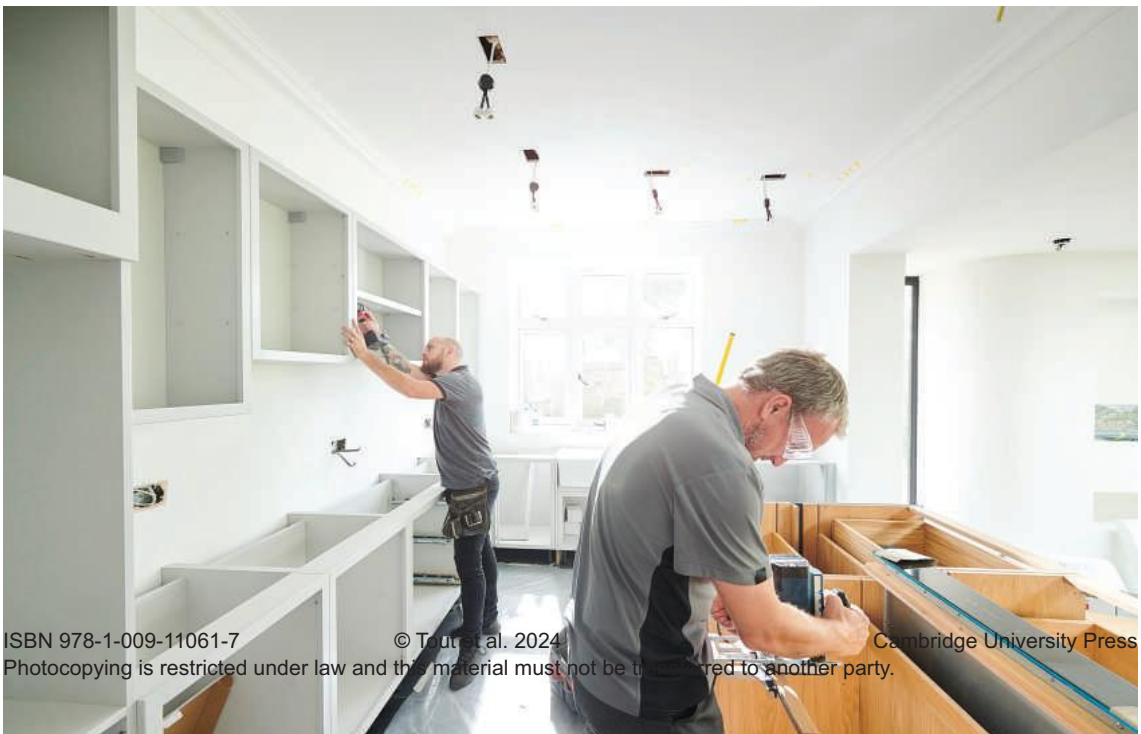
8 A kitchen showroom installer collects data or information on clients.

a List the data that may be collected.

b State the purpose of each piece of data that is collected.

c How might this data be stored?

d List three uses of this data to the business



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9 Consider the following data describing the top ten salaries of international soccer players.

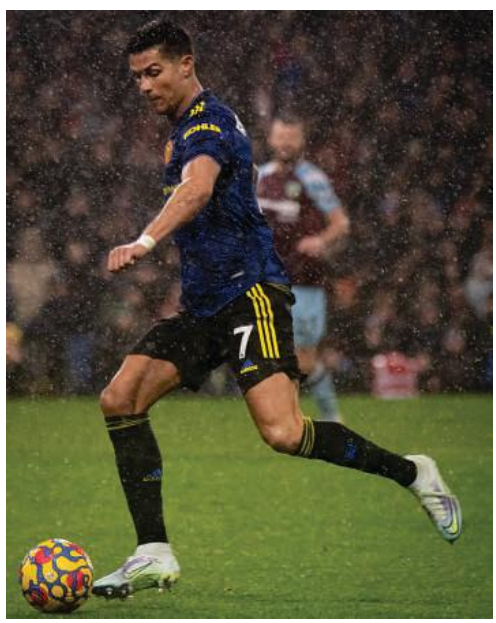
Top salaries	
2021	
Player name	**Salary (millions)**
Lionel Messi	$75
Neymar, Jr	$75
Cristiano Ronaldo	$70
Andres Iniesta	$31
Kylian Mbappe	$28
Robert Lewandowski	$27
Paul Pogba	$27
Gareth Bale	$26
Eden Hazard	$26
Mohamed Salah	$25

Top salaries	
2010	
Player name	**Salary (millions)**
Cristiano Ronaldo	$17
Zlatan Ibrahimovic	$16
Lionel Messi	$14
Samual Eto'o	$14
Ricardo Izecson dos Santos Leite	$13
Karim Benzema	$11
Carlos Tevez	$11
John Terry	$10
Frank Lampard	$10
Thiery Henry	$10

a Create two column graphs – one for each year – with player name on the x-axis and salary in millions on the y-axis, using technology.

b Give one reason why two graphs may be more useful than one in this case.

c Explain why we might want to compare the two sets of data.



In 2021, Cristiano Ronaldo earned a salary of $70 million, plus $55 million in endorsements.

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6D How can we compare different data sets?

Now that we have learnt about the importance of comparing data sets, we will consider how this might be done.

Consider the following data about the percentage of the population with asthma in Australia and in Nepal.

Australia	
Year	% of population with asthma
2000	11.59
2001	11.50
2002	11.37
2003	11.21
2004	11.04
2005	10.87
2006	10.65
2007	10.33
2008	9.99
2009	9.74
2010	9.64
2011	9.66
2012	9.71
2013	9.79
2014	9.92
2015	10.11
2016	10.37
2017	10.71

Nepal	
Year	% of population with asthma
2000	2.97
2001	2.96
2002	2.96
2003	2.96
2004	2.96
2005	2.96
2006	2.98
2007	3.02
2008	3.07
2009	3.13
2010	3.19
2011	3.25
2012	3.32
2013	3.40
2014	3.49
2015	3.58
2016	3.68
2017	3.79

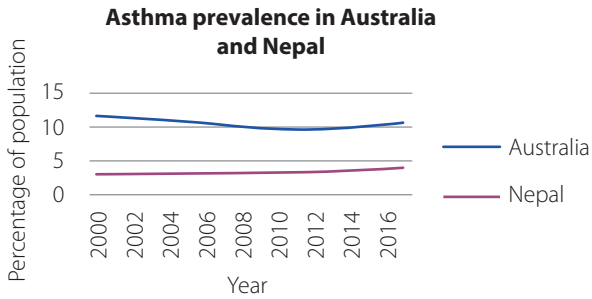
Take a minute and consider the data. What data is in the left column? Right column?

If you were to graph these two data sets for comparison, what would be the most appropriate type of graph?

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Line graphs

In a **line graph**, the differences in the data are clearly seen. Line graphs are particularly useful for graphing continuous data, such as changes over periods of time.



We can make general comparisons from this graph, such as the following:

- Australia's rates of asthma are higher than Nepal's.
- Nepal has seen a steady increase in asthma over the years shown, whereas Australia was in decline but has been increasing since 2012.

Stem and leaf plots

Stem and leaf plots are another way to compare two discrete data sets.

Consider this data about the number of goals shot during two rounds of netball.

Round 1: 52, 60, 16, 36, 28, 49, 48, 43, 48, 45, 50, 64, 72, 20, 72, 25, 38, 35

Round 2: 63, 71, 45, 42, 52, 58, 54, 59, 47, 49, 20, 28, 38, 36, 39, 42, 41, 63

Round 1	stem	Round 2
6	1	
8, 5, 0	2	0, 8
8, 6, 5	3	6, 8, 9
9, 8, 8, 5, 3	4	1, 2, 2, 5, 7, 9
2, 0	5	2, 4, 8, 9
4, 0	6	3, 3
2, 2	7	1

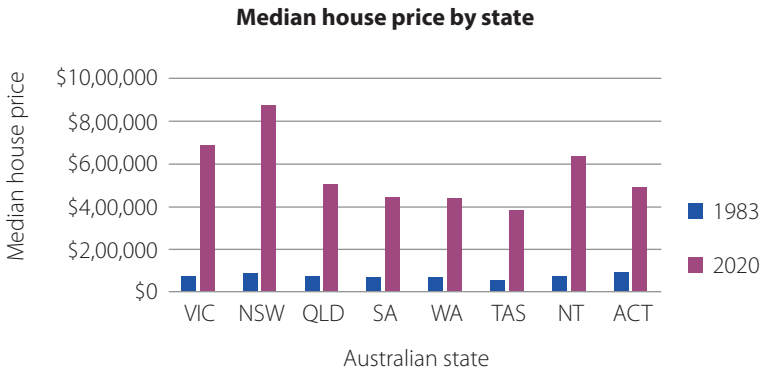
When the data is displayed as a back-to-back stem and leaf plot, it is easy to see the **shape** of each distribution. Remember that 6 | 1 means 16 for Round 1 and 2 | 0 means 20 for Round 2.

Round 1 had more low-scoring games and fewer high-scoring games than Round 2.

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Side by side column graphs

Side-by-side column graphs are also a useful way to compare data.



On this comparison graph, we can see the difference in the median house prices for each Australian state and territory from 1983 to 2020.

6D Tasks and questions

Thinking task

1 Consider the following data from a survey of 100 people aged between 13 and 37.

Their favourite sweet is …

13–18 years	19–25 years	26–37 years
1. Kit Kat	1. Kit Kat	1. Reese's
2. Chocolate	2. Reese's	2. Chocolate
3. Hershey	3. Chocolate	3. Snickers
4. Sour Patch	4. Snickers	4. M&Ms
5. Skittles	5. Sour Patch	5. Kit Kat

Source: ypulse.com

How do you think you could display this data graphically? What makes it more challenging to compare and graph or represent?

Skills questions

2 Decide on the best method for displaying the following data sets for comparison.

- **a** AFL individual player statistics over one season.
- **b** Surfboard sales from a metro store and a coastal store.
- **c** Foot traffic at two different farmers' markets.

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d Wait times at two popular nightclubs.

e Drink sales at two different music venues.

f Number of breakdowns each month on the Eastern Freeway and Tullamarine Freeway.

3 Display the following data sets for comparison. Use technology where possible.

a The number of customers through the door at a popular homewares store in a local shopping strip in Melbourne over one week was as follows.

45, 78, 95, 110, 169, 187, 154

For the corresponding store in a large shopping centre, the numbers were as follows.

183, 192, 245, 231, 234, 298, 267

b A beauty shop had products for up-sale. Two salespeople were monitored for how much they up-sold each week over a period of one month.

	Person 1	Person 2
Week 1	$20	$43
Week 2	$43	$129
Week 3	$86	$20
Week 4	$129	$60

c A new owner of a large campground needed to research how many summer casual staff to hire. They compared two campgrounds of similar size from separate locations but a similar distance from Melbourne.

They found that, over the Christmas-summer holidays, the summer casual numbers were as follows.

	Christmas to New-Year week	First week in January	Second week in January	Third week in January	Last week in January
Campground A	5	8	8	6	4
Campground B	10	12	12	11	8

Mathematical literacy

4 Using the internet, find three examples of data set comparisons in real life. For each example, explain how they are compared and how they might be compared.

Application tasks

5 The Australian Government's *Physical activity and exercise guidelines for all Australians*, recommends the following.

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- Children aged 5 to 13 years should get 9 to 11 hours of uninterrupted sleep.
- Young people aged 14 to 17 years should get 8 to 10 hours of uninterrupted sleep.

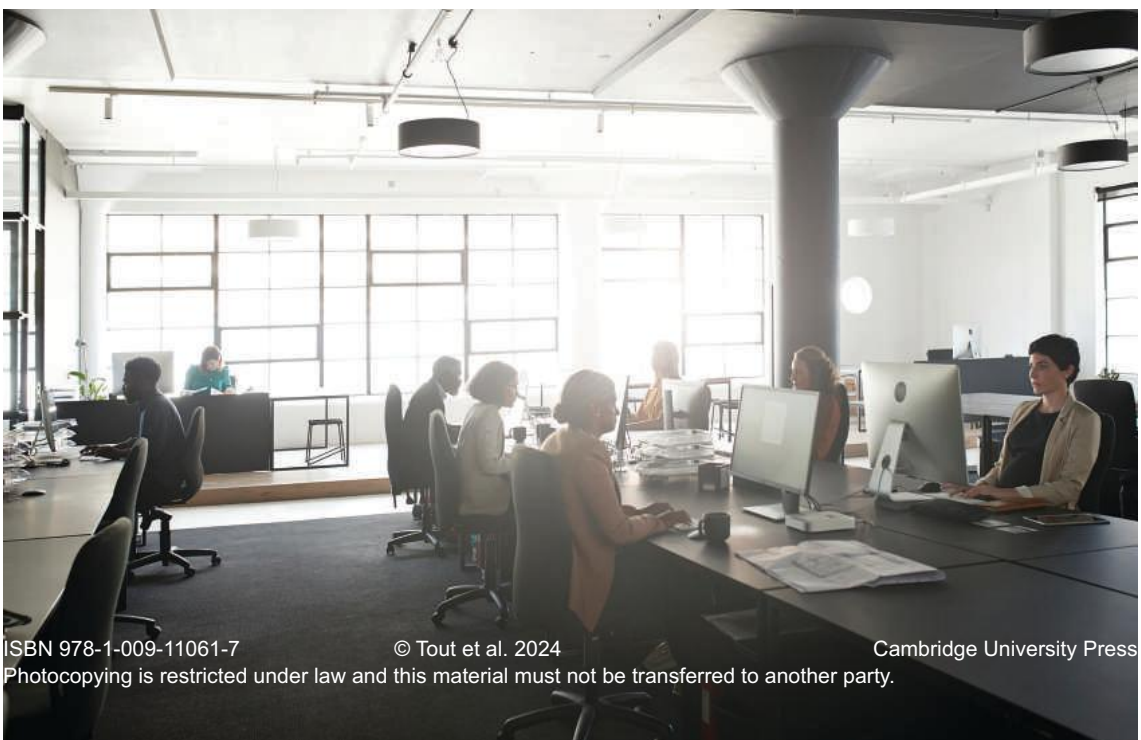
a Survey your classmates and younger siblings to find out how much sleep they get each night.

b Compare the data you have collected against the guidelines. Consider which graph you could use to show this. Use technology to create your graph.

c Make some assumptions from the data, for example, I get more (or less) sleep than the recommended amount.

6 Further information from the *Physical activity and exercise guidelines for all Australians* includes the following.

- More than half (55%) of adults do not meet the physical activity guidelines.
- Two in three (70%) of children aged 2 to 17 do not meet the guidelines.
- Only 3 in 10 pregnant women meet the guidelines.
- Only 2% of teenagers aged 13 to 17 meet the guidelines.
- Almost half (44%) of working-age adults spend much of their work day sitting.
- Physical inactivity is responsible for more than 6% of the cancer burden in Australia, second only to tobacco smoking.
- The diseases most closely linked to physical inactivity are diabetes, bowel cancer, uterine cancer, dementia, breast cancer, coronary heart disease and stroke.



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You can explore these guidelines further on the Australian Government Department of Health and Aged Care website.

Recommendations	1 to 2 years	3 to 5 years	5 to 17 years
Physical activity	At least 3 hours of energetic play per day.	At least 3 hours of activity per day, with 1 hour being energetic play.	At least 1 hour of moderate to vigorous activity, involving mainly aerobic activities per day. Vigorous activities should be incorporated at least 3 days per week. Several hours of light activities per day.
Strength			At least 3 days a week.
Sedentary time	Do not restrain for more than 1 hour at a time.	Do not restrain for more than 1 hour at a time.	Minimise and break up long periods of sitting.
Sedentary recreational screen time	Under 2 years: None. 2 years: No more than 1 hour per day.	No more than 1 hour per day.	No more than 2 hours per day.
Sleep	11 to 14 hours, including naps.	10 to 13 hours. Some will still need naps.	5 to 13 years: 9 to 11 hours. 14 to 17 years: 8 to 10 hours.

a Survey the class to find out how much physical activity each person does in a 24-hour period. Physical activity could include walking to the bus stop or participating in a team sport. Collect information on what kind of activity they do as well as the length of time spent doing each activity.

b Decide how to graph the data.

c Compare the collected data with the guidelines.

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6E Key summary statistics – the middle or average

In our lives, we often talk about averages – it might be about average food or house prices or average wages, the average temperature; or it might be about our bowling averages in cricket, or about the average fuel consumption of cars, or even our average scores on tests at school. The average is a useful piece of information. It's used to give a quick overview or summary of a large amount of data – it gives us a single number that represents the 'middle' of the set of data we are looking at. In this section we will look at three different types of averages: the **mean**, **median** and **mode**, and how they are calculated.

One everyday example is when we are going on a holiday, especially to places we haven't been to before, we often check what the weather is likely to be. Will it be hot or cold, will there be a lot of rain, and so on? We can find information about a town's weather from the **Bureau of Meteorology** (www.bom.gov.au). Below is an example of the sort of data that is available – this is for Mildura.

Mildura weather data

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean maximum temperature (°C)	32.7	32.7	29.3	24.1	19.5	16.0	15.5	17.7	21.1	24.9	28.8	31.7
Mean minimum temperature (°C)	16.3	16.4	13.6	10.1	7.4	5.3	4.4	5.6	7.8	10.1	13.0	15.1
Mean rainfall (mm)	18.2	20.0	18.2	16.0	26.5	29.6	22.6	26.7	23.2	27.7	20.5	18.7
Median rainfall (mm)	8.9	7.6	10.2	12.3	20.6	28.7	20.4	24.0	16.5	20.4	13.0	12.2
Mean number of days of rain ≥ 1 mm	2.2	2.2	2.3	2.6	4.2	5.3	5.1	5.3	4.1	4.2	3.1	2.5

For example, this data shows that the average maximum temperature in **Mildura** for January is 32.7°C, whereas the lowest average minimum temperature for **Mildura** is 4.4°C in July.

This data is based on many years of weather data (about 55 years in this example), and it shows what are called the **average** figures for temperature, and for rainfall, for each month.

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You will see two different terms used above: **mean** and **median**. These are both called **measures of central tendency** because they tell us about the middle of the set of data. They are very useful for helping us quickly summarise data and compare different, but related, sets of data, such as in this weather data.

Measures of central tendency

Measures of central tendency help you find the middle, or the **average**, of a dataset. The three most common measures of central tendency are the **mean**, the **median** and the **mode**:

- **Mean**: the sum of all values divided by the total number of values.
- **Median**: the middle number in an ordered dataset.
- **Mode**: the most frequent value.

The mode is the simplest to work out – it is the most common or frequently occurring value. It's possible to have no mode, one mode, or more than one mode.

The mean is found by adding together all the values we have and dividing by the number of values there are. One issue with the mean is that outliers can significantly increase or decrease the mean when they are included in the calculation. An outlier is a value that differs significantly from the others in a dataset. Since all values are used to calculate the mean, it can be affected by extreme outliers. For this reason, it is sometimes more common to use the median if this issue of outliers occurs. The mean is most useful when the data is more or less evenly spread out.

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.

A very common example of the use of the median versus the use of the mean is in relation to house prices, where a small number of expensive houses can skew the mean house prices upwards. So headlines about house prices might say: "**The latest median property prices in Australia's major cities**".

Average wages are also often reported using median wages, rather than the mean, for similar reasons. And you can see in the example above that median was used for reporting rainfall too.

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The mean

The **mean** is commonly called the *average*, but in mathematical terms we use the formal term 'mean'.

$$\textbf{The mean} = \bar{x} = \frac{\sum x_i}{n}$$

Where $\bar{x}$ 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.

To calculate the mean, consider the following example.

Example 1 Calculate the mean value

A data set contains the following values: 3, 5, 5, 6, 8, 9, 10, 11, 11 and 12. Calculate the mean for this data set.

THINKING	WORKING
STEP 1	
Add all the data values together to find the **sum** of the data set.	$\sum x_i = 3+5+5+6+8+9+10+11+11+12$ $\sum x_i = 80$
STEP 2	
Count the **number** of values in the data set.	$n = 10$ values
STEP 3	
To find the mean, divide the **sum** of the data values by the **number** of values. $\bar{x} = \frac{\sum x_i}{n}$	$\bar{x} = \frac{80}{10}$ $\bar{x} = 8$ The mean value is 8.

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The mode

The **mode** is the most commonly occurring data value.

A data set containing the values of 3, **5, 5**, 6, 8, 9, 10, **11, 11**, 12 has *two* modes.

The numbers **5** and **11** occur more often than the other data values.

The median

The **median** is the data value which represents the *middle* of the data set. This assumes the values have been arranged in ascending numerical order.

To find the middle of a data set, try the **counting-in** method by placing two index fingers on the outside of the data set, and then moving inwards by one place with each finger at the same time until your fingers meet in the middle of the data set (either on one number, or between two numbers). Let's try an example:



Keep counting-in until you find the middle.



In this case, the middle falls between the numbers 8 and 9.

$$\frac{8+9}{2} = 8.5$$

The median is 8.5.

Example 2 Calculating the median

Find the median for the following data points:
3, 4, 4, 6, 7, 10, 12, 13, 15, 16, 17, 17, 18

THINKING	WORKING
STEP 1	
Count how many data points there are and divide by 2	$\frac{13}{2} = 6.5$ Round up to 7
STEP 2	
Find the 7th data point	The 7th data point is 12
STEP 3	
State the median	12 is the median of the data set

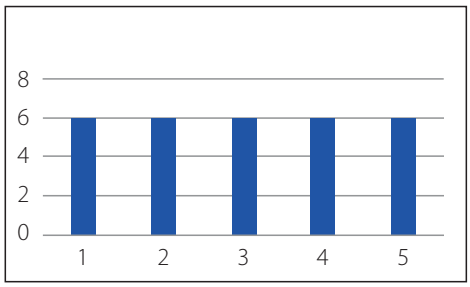
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6E Tasks and questions

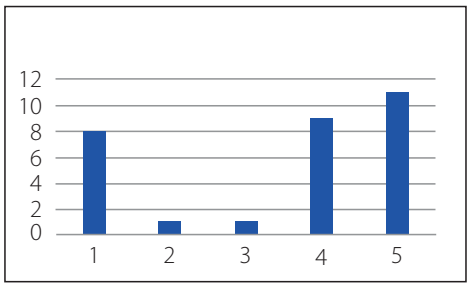
Thinking task

1 Look at the following graphs and decide what the average value, or **mean**, for each graph might be.

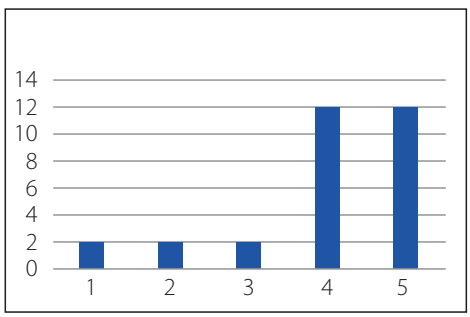
a



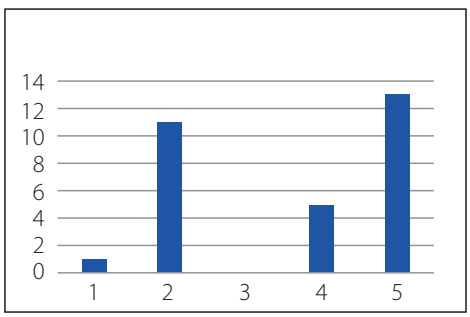
b



c



d



What does the mean tell you about these data sets?

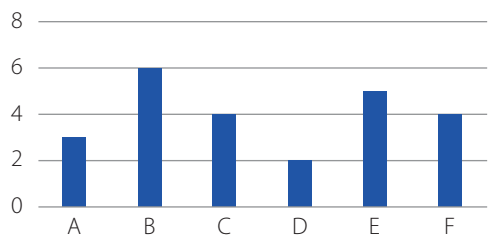
Skills questions

2 Find the **mode** of the following data sets.

a 2, 5, 1, 3, 6, 4, 7, 4, 8, 4

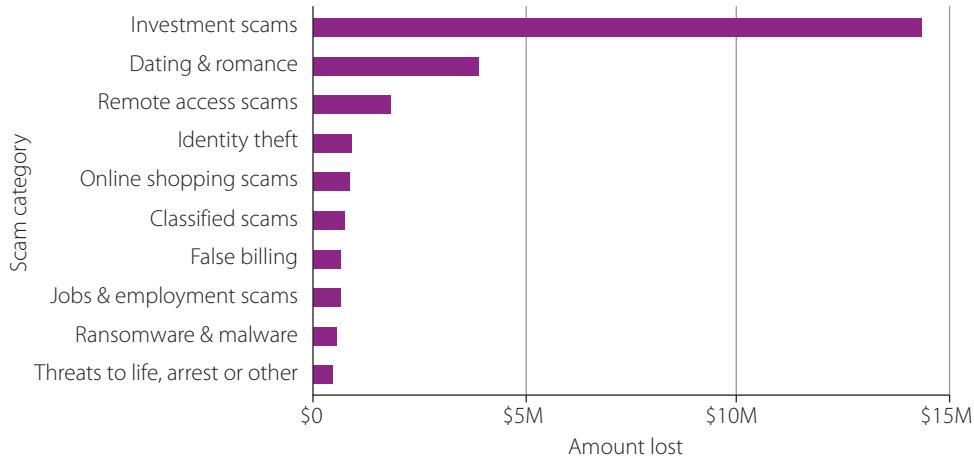
b 1, 1, 2, 2, 3, 3, 3, 4, 4, 5, 5

c

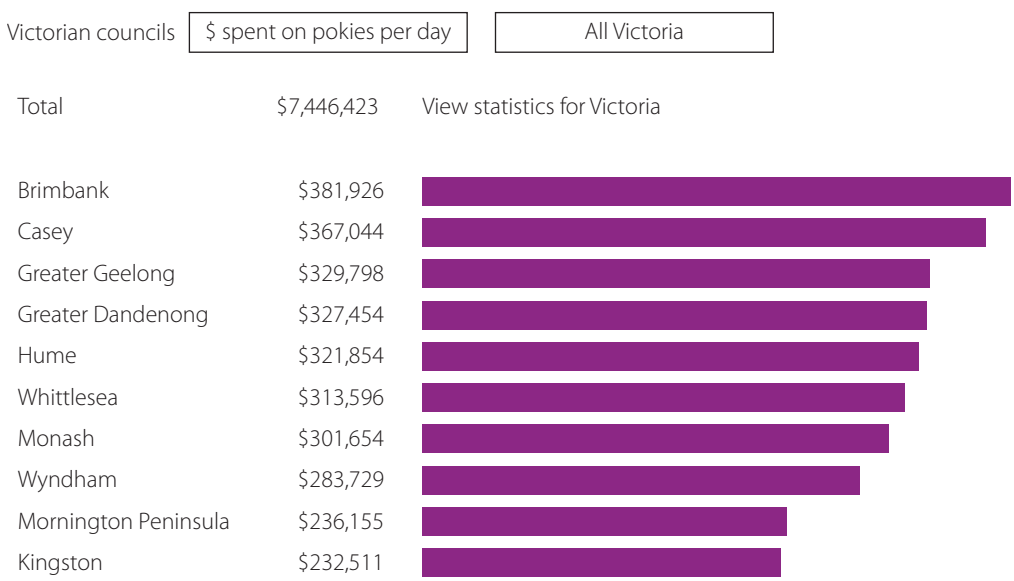


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d



e



Source: responsiblegambling.vic.gov.au

3 Find the **median** of the following data sets.

a 1, 1, 3, 4, 6, 6, 7, 9, 10, 11, 14, 17, 21

b 0, 0, 0, 1, 1, 2, 4, 5, 7, 8, 8, 8, 10

c 34, 34, 36, 37, 40, 43, 54, 57, 63, 68, 70, 79, 90

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d In this case, remember to treat the data on the left separately from the data on the right.

	Stem	
9	2	0, 3, 4,
9, 8	3	5, 8, 9
8, 5, 3	4	2
2	5	1, 6, 5
4	6	0
7, 5, 4	7	

e 1002, 387, 745, 346, 298, 1782, 945, 887, 666, 489, 201, 254

f A popular sports-shoe shop collected the following data on the number of unisex shoes which were sold over one weekend, in UK sizing.

UK size	6	6.5	7	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	13
Number sold	1	0	3	4	27	30	29	20	11	18	24	30	27	16	4

4 Find the **mean** for the following data.

a 65, 67, 64, 69, 62, 61, 60

b 2, 4, 3, 3, 6, 2, 6, 4, 7, 8, 6, 4, 6, 9, 5

c 409, 409, 678, 564, 544, 345, 509, 678, 765, 440, 548

d For the WWE top 20 wrestlers in 2021 shown in the table below, find the mean for the following.

i Matches played

ii Wins

iii Losses

iv Draws

		Matches	**Wins**	**Losses**	**Draws**
1	Drew McIntyre	72	55	14	3
2	Riddle	66	45	20	1
3	Bianca Belair	63	32	27	4
4	Charlotte Flair	62	29	27	6
5	Big E	61	46	13	2
6	Jey Uso	60	23	36	1

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		Matches	Wins	Losses	Draws
7	Shayna Baszler	59	27	30	2
8	AJ Styles	58	21	37	0
9	Bobby Lashley	58	29	28	1
10	Dominik Mysterio	54	35	19	0
11	Jimmy Uso	52	22	30	0
12	Rey Mysterio	51	34	17	0
13	Sheamus	51	16	34	1
14	Damian Priest	50	46	4	0
15	Xavier Woods	50	27	22	1
16	Finn Balor	48	26	22	0
17	Montez Ford	48	19	28	1
18	Roman Reigns	48	28	20	0
19	Angelo Dawkins	47	20	26	1
20	Kofi Kingston	47	23	22	2



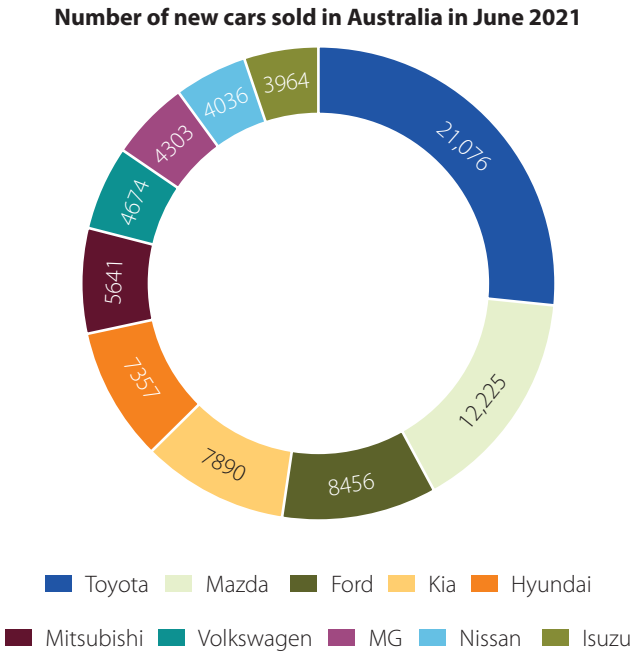
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5 Find the mean, median and mode of the following data. (Round your answers to 1 decimal place where necessary.)

a 0, 0, 1, 2, 2, 3, 5, 6, 6, 7, 8, 8, 8

b 24, 25, 25, 26, 28, 28, 28, 30, 34, 36, 36

c



d These are the daily maximum temperature figures for March for a town.

20°C	27°C	27°C	31°C	34°C	27°C	20°C	19°C
18°C	24°C	27°C	21°C	19°C	23°C	28°C	20°C
21°C	19°C	18°C	20°C	23°C	24°C	25°C	21°C
20°C	22°C	17°C	18°C	19°C	22°C	17°C	

Mathematical literacy

6 Write the definition for the words below in the following ways:

i the everyday meaning

ii the mathematical meaning

Average, mode, distribution, bar (graph), range, column (graph), mean, median, point, value.

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Application tasks

7 The Tokyo 2020 Olympics saw Australia's Keegan Palmer win the skateboard gold medal!

a Find the mean and median of the top six placegetters, and include all three attempts for each skater as one data set. (Round your answers to 1 decimal place.)

b State which statistic (mean, medium or mode) helps you understand the data better, and give a reason why or why not.

Men's Park – Final – Men's Park Final – Results

#	Country	Athlete	Run			Best score
			1	2	3	
	AUS	K. PALMER	94.04	5.86	95.83	95.83
	BRA	P. BARROS	86.14	73.50	22.99	86.14
	USA	C. JUNEAU	82.15	84.13	7.00	84.13
4	BRA	L. FRANCISCO	80.24	80.62	83.14	83.14
5	AUS	K. WOOLLEY	17.03	82.04	2.17	82.04
6	PUR	S. PINIERO	5.20	75.17	74.53	75.17

8 Many households in Australia own a pet.

a Using the internet, find the cost of six to eight different brands of dog food. Make sure that the selected food is the same weight, for example, 1 kg or 2 kg.

b Find the mean, median and mode of the cost of dog food from your sample.

c Did any of the three statistics (mean, median or mode) help you to understand the data? Explain why or why not.



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6F Key summary statistics – the spread

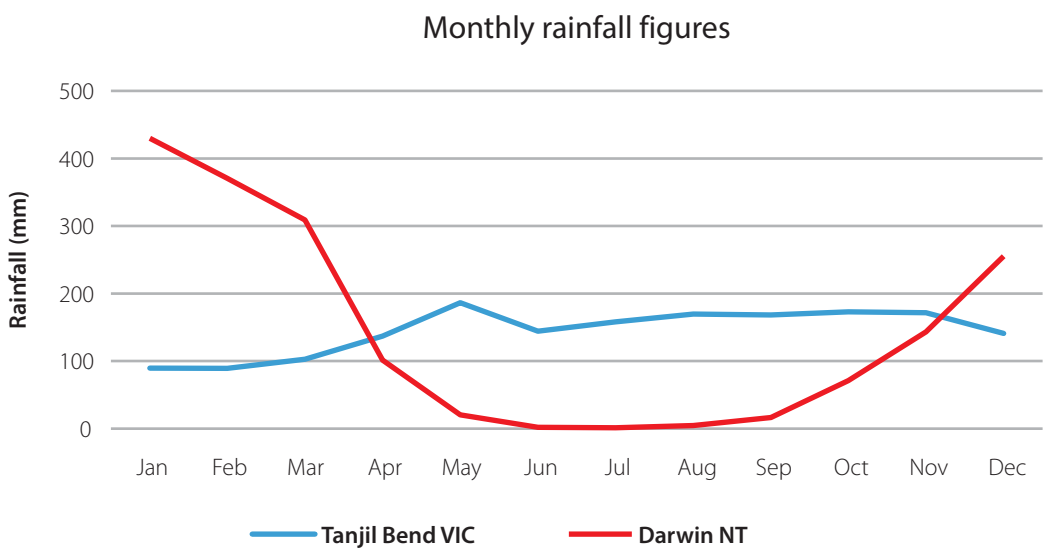
Even though you might be able to calculate the average or median values for the data you are analysing, this alone may not tell you all you want. Quite different sets of values can have the same mean or median, but be quite different in other ways.

A major difference that is important in analysing data is the variation amongst all the values – how spread out all the values are. Are they all quite close together, or do they vary a lot from the average?

This can be seen in another example of weather data. Here is the weather data about average monthly rainfall in mm for Tanjil Bend in Victora and Darwin in the Northern Territory.

Town	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tanjil Bend VIC	89	89	103	137	187	144	158	170	168	173	172	141
Darwin NT	430	371	309	102	20	2	1	5	17	71	143	255

In both cases the mean, when rounded to a whole number, is 144 mm. But the variation or spread of values over the months of the year is very different, as can be quickly seen by this line graph of the data.



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There are two simple, and common, ways of looking at a set of data to be able to compare how the data is spread. These are called the **range** and the **interquartile range**.

The range

To illustrate the range, here are two simple different sets of data with the same average.

Set 1 values: 4, 4, 6, 6

Set 2 values: 1, 1, 7, 11

Mean for Set 1: $\bar{x} = \frac{4+4+6+6}{4}$

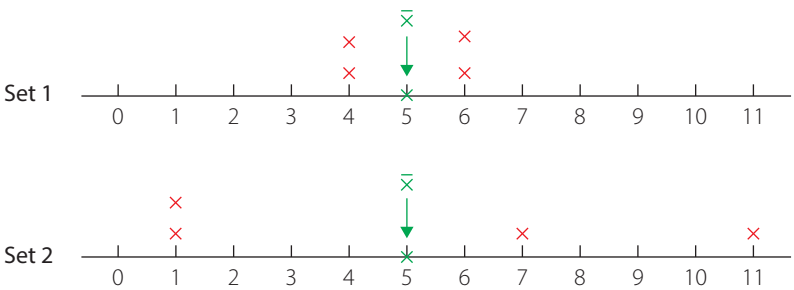
$\bar{x} = 5$

Mean for Set 2: $\bar{x} = \frac{1+1+7+1}{4}$

$\bar{x} = 5$

The middle (median) of both sets of data is also 5.

These two data sets are shown on a number line below.



So, both sets of data have the same mean and median, yet the spread of the data is quite different, with the first set only going from 4 up to 6, while the second set goes from 1 up to 11.

The **range** of the data tells us about the difference between the highest and lowest number. For Set 1, the range is 6 – 4 = 2, and for Set 2 the range is 9 – 1 = 8, yet the spread is different.

In our weather data for Tanjil Bend and Darwin, above, the range in each case would be:

Tanjil Bend: The highest value is 187, while the lowest value is 89, therefore the range is 98.

Darwin: The highest value is 430, while the lowest value is 1, therefore the range is 429.

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In this example, the range quickly shows that there is a big difference between the two sets of rainfall data.

The problem, however, 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 values. This means that one or two extreme values or 'outliers' can dramatically affect the range. For example, 3, 3, 4, 5, 5, 5, 6 and 3, 3, 4, 5, 5, 5, 20 are almost identical distributions, but the first set of numbers has a range of 3, and the second has a range of 17.

A measure of spread that is not so dramatically affected by one or two extreme values is the **interquartile range**.

Quartiles and the interquartile range (IQR)

Quartiles are scores that divide the distribution into quarters.

The first (or lower) quartile (Q1) is the score below which 25% or $\frac{1}{4}$ of the data points lie.

The second quartile (Q2) (which is the same value as the median) – the data points below which $\frac{2}{4}$ or $\frac{1}{2}$ or 50% of the scores lie.

The third (or upper) quartile (Q3) is the score below which 75% or $\frac{3}{4}$ of the scores lie.

The interquartile range is the difference between the first and third quartiles – i.e. it is the range of the middle 50% of the data.

$$\textbf{IQR} = \textbf{Q3} - \textbf{Q1}$$

We know that the quartiles each cover 25% of the set of scores. The IQR covers the middle two quartiles, so it measures the **range of the middle 50% of all the scores**.

The following two examples show you how to calculate the interquartile range.

Example 3 Finding the IQR for an odd-numbered data set

Find the IQR of the data set: 3, 3, 4, 4, 5, 6, 6, 7, 8, 8, 9

THINKING	WORKING
STEP 1	
Find Q2, the median.	3 3 4 4 5 (6) 6 7 8 8 9
STEP 2	Q2
Put brackets around the lower and upper data.	(3 3 4 4 5) 6 (6 7 8 8 9)

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STEP 3

Find Q1 and Q3, i.e. the median of the numbers within each pair of brackets.

(3 3 (4) 4 5) (6) (6 7 (8) 8 9)

Q1 Q2 Q3

Q1 = 4

Q3 = 8

STEP 4

Calculate the IQR by using the formula IQR = Q3 – Q1

IQR = Q3 – Q1

IQR = 8 – 4

= 4

Example 4 Finding the IQR for an even-numbered data set

Find the IQR of the data set: 1, 3, 5, 8, 9, 16, 16, 17, 20, 21

THINKING	WORKING
STEP 1	
Find Q2, the median. Because we have an even number of data points, the median lies between two data points, in this case between 9 and 16.	1 3 5 8 9 ↓ 16 16 17 20 21 Q2
We find the halfway point between these numbers by adding them together and dividing by 2.	$Q2 = \frac{9+16}{2}$ $= 12.5$
STEP 2	
Put brackets around the lower and upper data.	(1 3 5 8 9) ↓ (16 16 17 20 21) Q2

... continued

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STEP 3

Find Q1 and Q3, i.e. the median of the numbers within each pair of brackets.

Place brackets around the lower and upper data.

(1 3 (5) 8 9) | (16 16 (17) 20 21)

Q1 Q2 Q3

Q1 = 5

Q3 = 17

STEP 4

Calculate the IQR by using the formula IQR = Q3 – Q1

IQR = Q3 – Q1

IQR = 17 – 5

= 12

6F Tasks and questions

Thinking task

1 Think of two real-life examples where the range may be an important statistic. Use the internet for inspiration.

Skills questions

2 For each of the following data sets, answer the questions below.

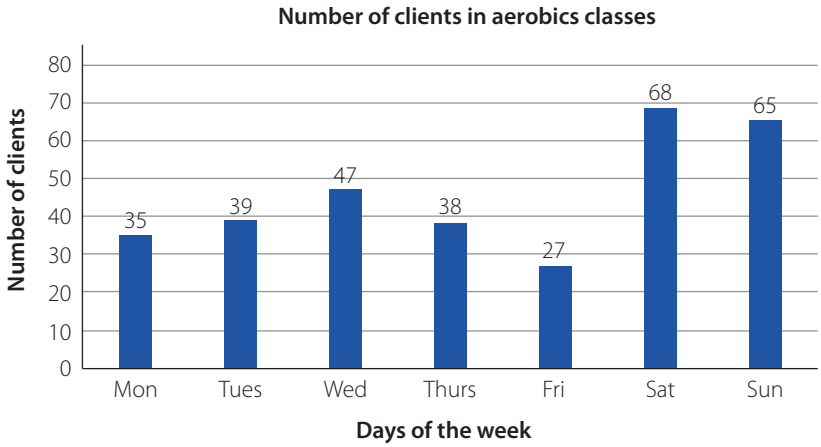
- **i** State the range.
- **ii** Find the upper and lower quartiles, Q1 and Q3.
- **iii** Give the interquartile range, IQR.
- **iv** Give your opinion on whether the range and the interquartile range help you to understand the data.

a 1, 3, 4, 4, 7, 9, 12, 21

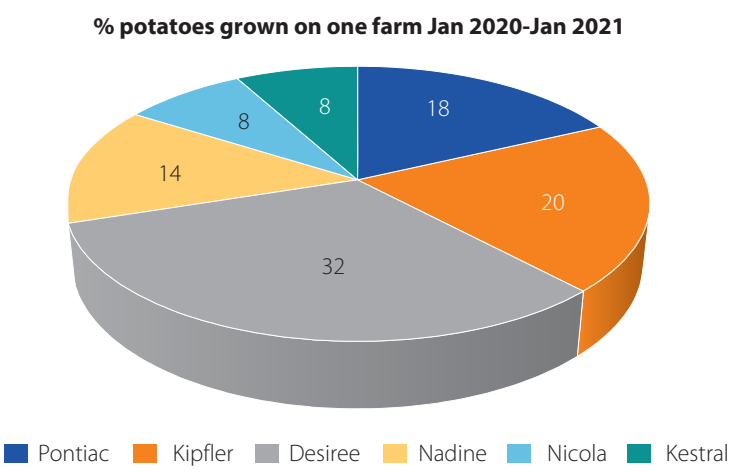
b 2001, 198, 3024, 2099, 1989, 356, 3018, 1984, 2003

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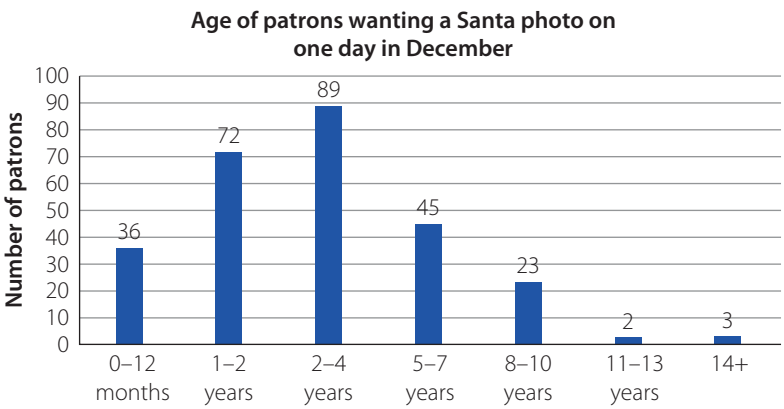


d



Total amount of potatoes grown over the year: 1000 tonnes

e



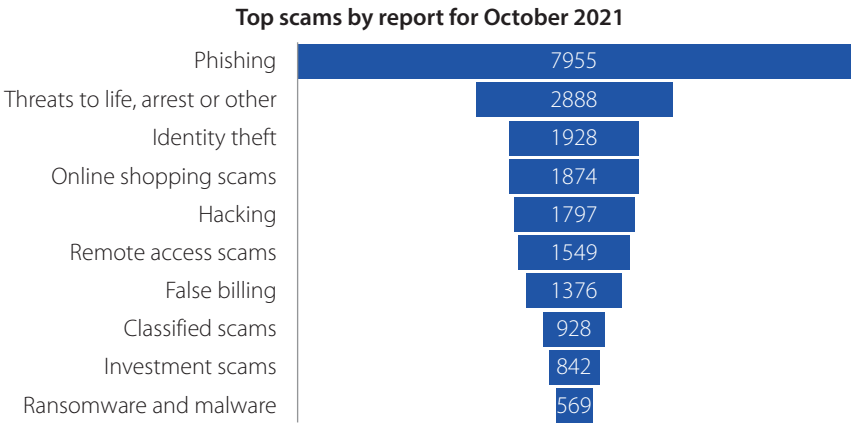
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Mathematical literacy

3 What are some of the meanings of the word 'spread'? Explain how its everyday meanings and the mathematical meaning relate to each other.

Application tasks

4 The Australian Government website Scamwatch provides information and help to the public about scams. Consider the information below and answer the questions.



Source Source: Australian Government Scamwatch website

a Which category of scams had the highest number of reports?

b Which category of scams had the lowest number of reports?

c What is the range of people reporting a scam to Scamwatch?

d What are the quartiles of this data? What is the interquartile range?

e What is the total number of scams reported for this time period?

f Which is the most useful statistic to help understand this set of data?

5 Search for and find a set of long-term weather data for a town or suburb that you are interested in, and that has weather data collected for it. You need to access the data from the Bureau of Meteorology, similar to the data used above in sections 6E and 6F above.

Use the search term 'Bureau of Meteorology Australia Climate statistics for [name of your town, or another place of interest]'.

When you find the climate statistics for your town on the Bureau website, you'll see data for temperature, rainfall, 'other daily elements', and so on.

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Copy the data for each of the following measures for the 12 months of the year and paste it into a blank spreadsheet:

- Mean maximum temperature (°C)
- Mean minimum temperature (°C)
- Mean rainfall (mm)
- Mean number of days of rain ≥ 1

For at least two of the above rainfall measures, undertake the following:

a Create line or column graphs displaying the data for each month, using your spreadsheet.

b Calculate at least two measures of central tendency and at least one measure of spread for the measure per month.

c Prepare a short summary to accompany your graphs that explains the weather patterns you found from your analysis.

6 On the stock market, the **trading range** is an important indicator of the true value of a company's shares. Research the trading range and explain briefly why it is monitored.



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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 Investigating health data

During the Covid-19 pandemic in 2020–2021, three Melbourne teenagers collated Covid-19 statistics and presented them daily on a webpage for Victorians. Here is some background information from their website as it was in 2023.

Who are we?

CovidBaseAU is run by three close friends living in Melbourne. We are Jack, Wesley and Darcy.

How we started

Back in 2020, Jack began to track Covid-19 data out of interest through Victoria's second wave. He struggled to find detailed data to understand what was going on and the context behind it. Over time, Jack built up a basic and manual Excel spreadsheet, where he tracked the data for personal use. In around February 2021, the three of us decided we had the skills to take what Jack had been tracking at a basic level to the next level. Since then, we've continued to grow and grow to what we are today.

The three of us

Jack

Jack had the original idea to start CovidBaseAU after tracking data on a smaller scale through 2020. He manages our data sets through a number of spreadsheets, checking over everything to ensure accuracy. Jack is the person who decides what data we publish, whether it be a new tweet or a new table for the website. Jack is also the one who manages most of our social media.

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Darcy

Darcy is the nerd of the group. He does all the coding and has written countless bots which have saved us hours of time. These include scraping the data from the images posted each day by different state governments on twitter, the daily vaccine pdfs and other government websites. Darcy then codes everything in the form of a twitter bot to post on social media or in tables onto our website, which update automatically when data is published.

Wesley

Wesley has a number of different jobs. To start with, he does all the annoying miscellaneous jobs which pop up almost every day. He does a lot of graphic design and art, making a number of graphics. Wesley also does a lot of work tracking Covid-19 events and does a lot of writing towards our timeline.

Source: www.covidbaseau.com

Choose a health issue that affects Victorians to investigate.

a Using an internet search, find data on a health issue of your choice that affects Victorians. You may, for example, want to consider vaccination rates for different diseases or flu statistics.

b Using a spreadsheet application, copy over data that is relevant to your investigation. Be aware that too much data can be tricky to navigate, so choose only two variables at a time and have between 12–20 data values.

c Insert a title for your data, including a hyperlink to the source of your data.

d Use your data to make an appropriate graph. Label the axes and include data values.

e Describe the spread of your data.

f Describe the middle of your data.

g Explain which of mean, median and mode is the most relevant statistic to help understand your data.

h Explain what the data is showing and draw a conclusion from the data.

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2 The changing climate

It is clear that the global climate has changed, and the reasons for this are well understood. The global changes, however, affect different regions of the world in different ways, so Australia may change in different ways or at different rates to other parts of the world. Also, changes in climate extremes – such as heatwaves and downpours – are more pronounced than changes in the average climate.

Big Data (massive amounts of data) is being collected and analysed to generate realistic solutions to the climate change problem.

Source: www.climatechangeinaustralia.gov.au/en/changing-climate/

Investigate historical data which may tell a story about climate change in Australia.

Explore the following sites which present significant data about the changing climate.

- Bureau of Meteorology Climate Data Online (www.bom.gov.au/climate/change/)
- Climate Change in Australia (www.climatechangeinaustralia.gov.au/)

Your task is to find and analyse some sets of data related to climate change.

a What data can be found about Australia's climate on these sites? List three different data sets that are available.

b Download two data sets to investigate. Use a spreadsheet application to work with the data.

c Decide the most appropriate way to display the data and graph each data set using technology.

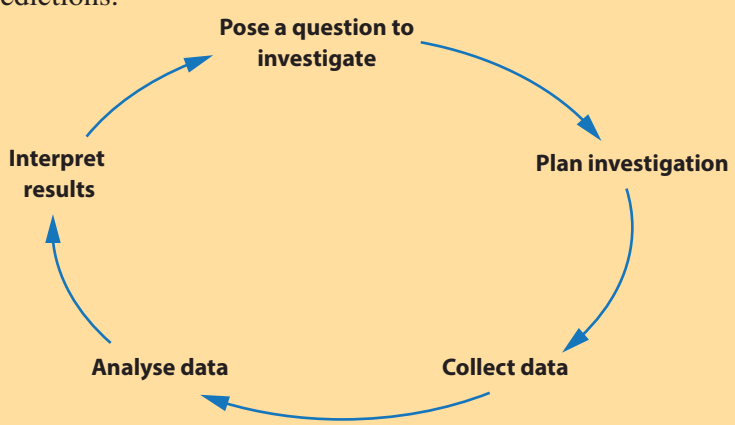
d For each set of data, calculate at least two measures of central tendency and one measure of spread. What do these statistical measures tell you about the data?

e Produce an infographic presenting the results of your analysis of the data. Include a paragraph telling the story of what is shown in the graphs and results.

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Key concepts

- The **purpose** of collecting data is to provide evidence for decision making.
- The purpose of **comparing** sets of data is to identify similarities and differences.
- Data sets can be compared by displaying the data **in tables, line graphs, back-to-back stem and leaf plots** and **side-by-side column graphs**.
- There are two types of **summary statistics: measures of central tendency** and **measures of spread.**
  - The **measures of central tendency** tell us about the middle of the data. These are: the **mean, median** and **mode.**
    - The **mean** or **average** is $\overline{x} = \frac{\sum x_i}{n} = \frac{\text{sum of values}}{\text{number of values}}$
    - The **mode** is the most commonly occurring data value.
    - The **median** is the data value which represents the middle of an ordered data set.
  - If we have an *even* number of values in the data set, we identify the middle two values, and find the average of these.
  - The **measures of spread** provide information about the shape of the data and how 'wide' the data is.
    - The **quartiles** are the data values at the one-quarter mark (lower quartile), half-way mark (median), and three-quarter mark (upper quartile) of the data set.
    - The **interquartile range** (**IQR**) is the upper quartile minus the lower quartile.
    - The **range** is the maximum value – the minimum value
  - The **statistical cycle** is a useful process to help us make evidence-based predictions.



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Chapter 6 review questions

☐ I can identify the purpose of collecting data.

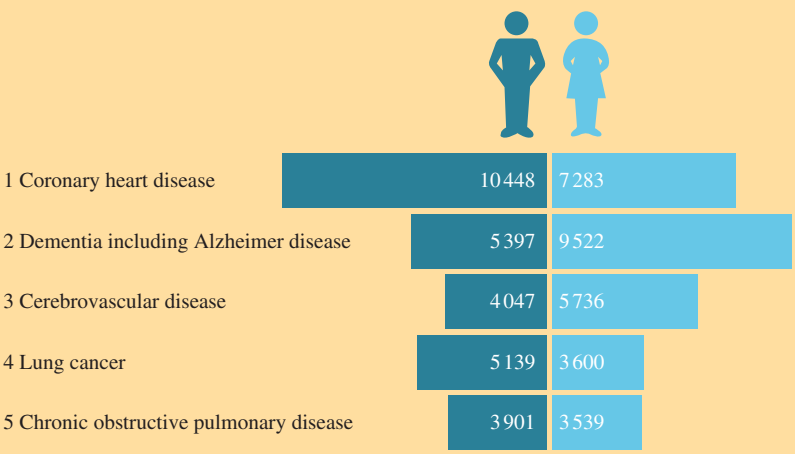
1 Describe the purpose of data collection for the following.
- **a** Stocktake in a retail store
- **b** Traffic survey

2 A hospital collects data about the patients that present to the emergency department.
- **a** List the data that may be collected.
- **b** State the purpose of each data piece that is collected.
- **c** How might this data be stored?
- **d** List three uses of this data to the hospital.

☐ I can identify the purpose of comparing data sets.

3 Consider the following graph which compares the leading causes of death for females and males.

Leading underlying causes of death, by sex, 2019



Source: Australian Government Australian Institute of Health and Welfare website

Why might health professionals want to compare these two sets of data?

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☐ I can compare data sets.

4 A gardening company has three teams that work together to complete jobs. The number of jobs completed for each team is shown below.

	Team A	Team B	Team C
Monday	3	5	4
Tuesday	5	5	6
Wednesday	6	5	3
Thursday	4	5	5
Friday	5	5	4
Saturday	2	0	0
Sunday	1	0	0

a What is an appropriate graph to compare the teams?

b Graph the data sets so they can be compared.

☐ I can calculate measures of central tendency – mean, median and mode.

5 Calculate the mean, median and mode for the following data sets. (Round your answers to 2 decimal places where necessary.)

a The number of visitors to the zoo every hour during one day.
24, 12, 25, 32, 25, 18, 23, 21, 18, 14, 8, 2

b The number of people living in each apartment in an apartment block.
2, 3, 5, 4, 2, 1, 4, 2, 2, 1, 2, 3, 2, 3, 4

6 The number of students in each senior homeroom class is listed below.

Year 10	Year 11	Year 12
23	18	16
24	19	15
22	18	17
23	20	16
21	19	18
24	17	17
22	20	16
23	18	15

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Complete the table below by calculating the mean, median and mode for each year level.

	Year 10	Year 11	Year 12
Mean			
Median			
Mode			

☐ I can calculate measures of spread – range and IQR.

7 The results of three subject exams are displayed in the table below.Which subject had a greater spread of results?

Maths (%)	Science (%)	English (%)
67	87	99
98	98	56
78	78	75
56	68	45
67	56	65
45	75	83
87	99	75
67	84	55
87	39	56
98	56	73
56	54	49
78	75	65
40	93	76
90	50	81

Calculate the range and interquartile range for each set to answer this question.

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☐ I can put all these skills together.

8 Happy Cones Ice Cream Company owns two ice-cream shops, one at the beach in a coastal town and one in a suburban neighbourhood. The owners collect a lot of data to run the shops effectively.
The table below shows the number of ice-creams sold each day in a week for each shop.

	Coastal $	**Suburban $**
Monday	24	54
Tuesday	34	53
Wednesday	42	43
Thursday	37	64
Friday	45	57
Saturday	120	63
Sunday	136	59

a List two other sets of data which might be collected by this business. Explain the purpose of collecting this data.
b Construct a suitable graph to compare the data in the table above.
c What observations can you make from the graph when comparing the sales made by each shop?
d Calculate the measures of centre and spread for each shop and draw conclusions from your analysis of the data.

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Key vocabulary

Here is a list of the key maths terms and their meanings used in this chapter.

Term	Meaning
Central tendency	A statistic that is used to represent a 'middle' or 'typical' value for a data set. See *Mode*, *Median* and *Mean*.
Convention	An agreed method, arrived at over a long period of time, for setting out or performing mathematical routines so that users understand each other.
Data / Data set	A piece of information or a set of information. Data can be categorical (names) or numerical (numbers).
Graph / Chart	A conventional visual representation and summary of a data set, for example, a column graph, line graph or pie chart.
Infographic	An informal representation and summary of a data set using graphic and text elements.
Interquartile range	The upper quartile (Q3) minus the lower quartile (Q1).
Line graph	A conventional visual representation and summary of a data set, where the data points are joined by a continuous line that indicates any *trend* in the data. The horizontal axis is usually a time variable, such as days of a week or months of a year.
Mean	The average value of a set of numerical data, found by adding up the values then dividing by the number of values. The value will typically lie near the centre of the data set.
Median	The middle score when all the values are arranged in order from smallest to largest. Unlike the *mean*, the median is not affected by extremely high or low values in the data set.
Mode	The score that occurs most often in a data set. It can happen that there are two such values, in which case the data set is bi-modal.
Quartiles	Quartiles are the values that divide an ordered data set into four (approximately) equal parts. The lower quartile (Q1) divides off (approximately) the lower 25% of data values. The second quartile (Q2) is the *median*. The upper quartile (Q3) divides off (approximately) the upper 25% of data values.

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Term	Meaning
Range	The difference between the highest and lowest values in a data set. It is a measure of how far the scores are spread out.
Side-by-side column graph	Displays data that arises when a variable has to two or more criteria. Each variable has two or more adjacent rectangles that show the criteria values.
Spread	A statistic that indicates how widely the values of a data set are distributed, for example, the *range*.
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.
Summary statistics	Values that show the *central tendency* and the *spread* of a data set, for example, minimum value, Q1, Q2 or median, Q3, maximum value.
Table	A collection of data which is set out and summarised in rows and columns.
Trend	A description of the overall direction of change in a data set, for example, increasing or decreasing trend.

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7 Organising your money



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 – organising your own money. Prompt questions might be as follows.

- What activity might be depicted in this photo?
- What financial transactions might be involved?
- What financial and monetary matters and decisions might be involved?
- What numbers and calculations might need to be used?
- What different tools, technologies or software might be used?
- What research or investigation questions could be undertaken, based on this photo?

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Chapter contents

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7B Tuning in
7C Rates of pay
7D Pay scales, awards and the pay gap
7E Payslips
7F Types of employment
7G Bank accounts and statements
Investigations
Chapter review

From the Study Design

In this chapter, you will learn how to:

- demonstrate understanding and perform calculations related to personal financial services such as bank statements
- demonstrate understandings and perform calculations of fees and interest charged by banks and other financial institutions in relation to amount borrowed, interest rate, time and risk

(Unit 1, Area of Study 3).

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Chapter overview

Introduction

We live in a financially driven society, where managing our own money is an essential skill. Understanding how to read a payslip and our rate of pay, and how to check our bank account balances and statements are important everyday activities. By understanding where our money is kept and how to access and manage it, we can aim for financial well-being and security.

In this chapter, we will learn about ways to keep our money safe from scams, and ways to avoid bad spending and poor investment choices. Importantly, we will examine pay slips, learn how to read and check these, and how to manage your bank account.

Learning intentions

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

- read and interpret payslips and check their accuracy
- demonstrate an understanding of rates of pay for different time periods
- check that you are being paid according to the correct pay scale for your role
- demonstrate an understanding of the conditions for different types of employment
- demonstrate an understanding of bank transactions, savings and banking apps
- apply the problem-solving cycle to complete investigations related to the topics contained within the chapter.

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Spotlight: Geoff Davis

An interview with a fund manager

Tell us about the work you've done and what you do now.

My role is co-head of investment management at Merricks Capital. It's an investment fund with two-and-a-half billion dollars of funds, and I'm the portfolio manager for the main wholesale fund. And in that role, I'm managing a range of different investments and a team. Ultimately, we deliver value to our investors.

What maths do you use regularly in your job? Could you give some examples?

In financial markets there are concepts which can seem complex, but they're usually quite basic because they need to be broadly understood by the hundreds of thousands of people using them every day. They'll dress them up to make them seem fancy with different names around 'swaps' and 'derivatives' and 'options'. But they're quite basic in their construction.

There's a lot of data that you have to be very comfortable with to decide whether something will make a good investment. Right now, there are rising interest rates – an interest rate is expressed as a percentage, so the maths is pretty simple – but you need to understand what that means in economic terms. That's the level of mathematics that I'm using on a day-to-day basis.

What is the most useful tool or piece of technology that you use regularly in your job?

The formulas we use aren't that long, so we mainly work in Excel. Or for a market perspective we use Bloomberg, which is a system that provides real-time market information. It's a massive database which is essential to investment funds.

What was your attitude towards maths when you were in school? Has it changed over time?

I didn't love mathematics. I liked the practical application of it much more than the theoretical. Looking back, I realise how valuable it was, and so I'm glad I persisted with it to get comfortable with numbers. Very rarely do you get the benefit of learning without the discomfort. Those that find it easy will still have points of discomfort.

Look for the practical applications, where it makes the maths tangible, to explain why you're learning this. It can be as simple as not needing a calculator to divide a bill because you can just do it in your head.

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7A Starting activities

Activity 1: Thinking about money

1. Do you think that Australia should have digital currency? Make a list of the pros and cons of using digital currency compared with using banknotes and coins.
2. Find out the purpose of the Reserve Bank? What is their duty to Australia?
3. Conduct a quick search on the internet to find out what to be wary of when it comes to scams. Find a 'scam quiz', like the one on the Victorian Government's Consumer webpage, and see if you can spot a scam from a genuine request.
4. Make an information poster clearly explaining one of the financial concepts above.

Activity 2: Credit ratings



If you have applied for a loan or credit card of any description in Australia, you will have a **credit rating**. This is a score that a lender will assess to see if we are trustworthy to lend money to.

Credit ratings can be lowered if you do not pay your bills on time, if you make a late payment on a loan or credit card, or if you miss a payment.

Checking our credit rating can alert us if we have been the victim of identity theft, for example, where someone has taken a loan under our name. We can easily check our credit rating for free over the internet. Some experts say that we should check our credit rating every few years.

1. Do a quick search to find where you can check your credit rating.
2. Discuss which factors in life might negatively impact a credit score.
3. Discuss which factors in life might positively impact a credit score.

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4 Meet Brendan. Brendan has finished his plumbing apprenticeship and is searching for a job on a building site.

During Brendan's apprenticeship, he had a credit card with a $2000 limit on it. Brendan managed his credit well, always paying off the balance at the end of each month when he received a statement.

Complete the table below, and decide for each scenario whether Brendan's activities might have the following.

- A positive (+) effect on his credit score.
- No (0) effect on his credit score.
- A negative (–) effect on his credit score.

Provide reasoning for each decision.

Life activity	Impact on credit score (+, 0, –)	Reasoning
Brendan has always made payments before the deadline on his credit card and has not been charged additional interest.		
Brendan applied for a higher limit on his credit card of $5000.		
Brendan applies for a new contract job and gets it. He can now expect a regular wage every two weeks for the duration of the contract.		
Brendan applies to rent a property with three of his mates and is successful.		
Brendan decides to use a Buy now-Pay later loan to pay for some more household items.		
Brendan struggles to make the next credit card payment which makes his payment late. He is charged more interest.		

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Life activity	Impact on credit score (+, 0, –)	Reasoning
Brendan decides to apply for another credit card with a limit of $2000.		
Brendan's ute breaks down so he takes out a car loan of $24 000 to pay for a second-hand vehicle.		
Brendan misses the first repayment from the Buy now-Pay later loan.		
Brendan's building site is shut down for safety reasons and his contract is terminated. Brendan misses payments on both credit cards.		
Brendan seeks help from a financial counsellor to get back on track with his finances.		
Brendan gets a new permanent position and has a regular wage again.		
Brendan cancels both credit cards.		
Brendan pays off the Buy now-Pay later loan.		

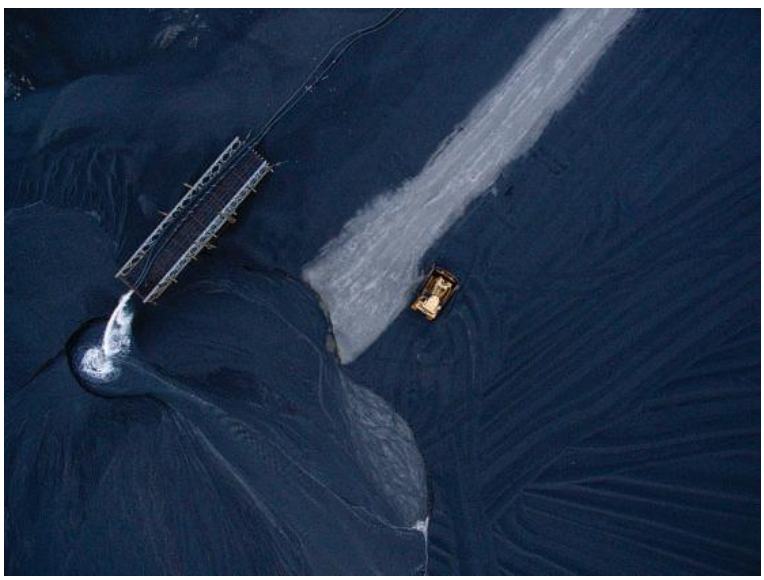


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7B Tuning in

Epic Fail

In 1969, Australia was experiencing a massive mining boom for nickel. The Poseidon Company found promising deposits and excitement spread quickly through the news. Poseidon's share price soared from a starting price of 80c per share to nearly $280 per share in only 6 months!



Poseidon Nickel was mining in Mount Windarra which is 22 kilometres northwest of Laverton in Western Australia.

Investors rushed in to buy Poseidon shares, convinced that this was the start of a nickel mining boom in Australia.

As investors struggled to pay for the shares in Poseidon as its price rose, they bought into other nickel companies in Australia, further fuelling the boom.

By February 1970, these same investors realised that the nickel ore was actually a lower grade than originally thought. Additionally, the cost of extracting the nickel meant that profits were much lower than forecast. These investors then started selling like crazy, spiralling the share price down until, by April 1972, the price was around $72 per share.

By 1974, Poseidon could no longer afford to keep going and was put into receivership. In 1975, the company was delisted from the stock exchange.

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Many people lost a lot of money from the nickel boom and crash. They believed they could make a quick dollar, but instead faced a train-wreck situation.

Discussion questions

1. Why did investors lose money as a result of the nickel boom and crash? Could something similar happen today?
2. Do you think that investment is always this risky? Can you think of an example of a risky investment, and an example of an investment that is less risky?
3. What factors contributed to the initial success of Poseidon Nickel, and how did these same factors ultimately contribute to its downfall?
4. In retrospect, were there any signs or indicators that should have warned investors about the eventual collapse of the nickel boom? If so, what were they and why do you think they were ignored?
5. Do you think the government or financial institutions had any responsibility for the collapse of the nickel boom? Why or why not?
6. How has the rise of social media and instant communication affected the speed and intensity of economic booms and busts, and what implications does this have for investors and the economy as a whole?
7. What changes, if any, could be made to prevent similar booms and busts in the future? How can investors better protect themselves from financial risks?

It's your money, so do your research before investing in shares or property. And don't invest any money that is essential for you to live your life, like paying for housing and food. It's a risk, so tread very carefully.

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The Reserve Bank

The Reserve Bank of Australia (RBA) is responsible for managing the availability of money in Australia. Its duty is to contribute to the stability of the currency, full employment and the economic prosperity and welfare of Australian people.

This includes printing and issuing physical banknotes and coins. These banknotes and coins are transported to banks and other financial institutions who keep them in secure locations. These days, most money is issued digitally.

Where do we keep our money?

The days of keeping cash under a mattress are long over. There are many financial institutions available for us to safely keep our money.



Scams

Keeping our money safe is challenging when most financial transactions happen online. Getting into the habit of checking our accounts and looking over past transactions can help us spot irregularities.

Brendan had noticed a large volume of missed calls on his mobile from 'Nico' from the NBN. Brendan has been with the NBN for a long time and used a telco for his provider. Nico's message said that if Brendan did not call back with his credit card details, he would be in trouble with the authorities. Sound familiar?

The government has places to report scams like these to help keep us safe. One of the sites is Scamwatch (www.scamwatch.gov.au/report-a-scam).

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Keeping track of our pay

Employees are entitled to receive at least minimum pay for their work. Despite this, underpayment of staff, called wage theft, is a significant issue in Australia. Some of the biggest names in retail, food processing and hospitality have been investigated by the Fair Work Ombudsman (FWO) for wage theft. It is not always done deliberately. Often companies have not recorded hours correctly, are paying staff the wrong award rate or do not pay penalty rates correctly.

Consider the following scenario:

> Bella worked at a local restaurant after school. Once she turned 18, she was able to serve drinks and do a couple of bar shifts.
>
> After moving to work at another restaurant where a friend of hers was working, she was shocked to see that her new pay was twice the amount that she had been receiving at her previous job. Bella, now 22, said she hadn't been paid the correct award, given that one of her duties was to serve alcohol.
>
> She calculated her lost wages as more than $7000 and reached out to her former employer.



What can you do to ensure this does not happen to you? Firstly, check your payslip carefully to ensure hours are recorded correctly and you are being paid the correct award minimum rate. We will cover this later in the chapter. If you are not sure what your rates should be, or if you suspect that you are being underpaid, then you could do the following.

- Speak to your employer to resolve the issue.
- Contact your union if you are a member of one.
- Request help from the Fair Work Ombudsman.

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Understanding the mathematical calculations

There are a range of calculations and applications of mathematics that help us when undertaking financial calculations.

For example, Yousef works for 6 hours and is paid $21.95 per hour.

We could write this as a mathematical sentence (or formula):

hours worked × *rate per hour* = *total pay.*

$6 \times 21.95 = 131.70$

We then put the units in to make sense of the maths.

Yousef earned $131.70 (gross pay).

As we have seen in Chapter 2, when deciding what maths we need to use, including when creating equations or formulas, the words in the text can give us a clue about which operations we should use. In section 4D and 4E, we reviewed how to turn word formulas into algebraic symbols.

Practice questions

1 Write definitions of the following money-related words.

- Finance
- Financial institution
- Bank
- Currency
- Credit
- Debit

2 For each of the words above, give one real-life example.

3 Make a list of all the scams that you and your classmates have heard about or experienced.

4 List information that you should never give to a person or organisation that you don't know or trust.

5 Investigate where and how to find your payslip if you have a job, apprenticeship or traineeship.

6 Using the internet, make a list of all the institutions where you might keep your money in Australia.

7 18-year-old Cassie originally worked a retail job at $16.37 per hour. She accepts a job offer to be a bartender at a local bar for $20 per hour. After working there for 10 hours per week for 30 weeks, her friend tells her about the special rates for juniors serving alcohol, meaning she should be paid a minimum of $28.46 per hour. How much money does her employer owe her?

8 If you earn $19.90 per hour, and work a five hour shift, how much did you earn during your shift?

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7C Rates of pay

Pay may be calculated in many ways. A rate of pay has two components – a time or quantity of work component and a cost component. For example:

- $ per hour
- $ per day
- $ per job lot or unit
- Weekly rate
- Monthly rate
- Yearly salary

As of 1 July 2023 the National Minimum Wage is $23.23 per hour or $882.80 per week.

Weekly, fortnightly, monthly, and annual calculations

When calculating with pays and earnings, you often need to work out income or expenses for different time periods: weekly, fortnightly, monthly, or on an annual basis. Below are the key calculations you will need to know.

Fortnightly or weekly values compared to each other

- For a fortnightly value, you need to double the weekly amount.
- For a weekly value, you need to halve the fortnightly amount.

Annual or yearly values compared to weekly or fortnightly values

- For annual or yearly values, you need to multiply a weekly value by 52.
- For annual or yearly values, you need to multiply a fortnightly value by 26.
- For weekly values, you need to divide an annual or yearly value by 52.
- For fortnightly values, you need to divide an annual or yearly value by 26.

Monthly values compared to yearly or annual values

- For a monthly value, divide a yearly value by 12.
- For a yearly value, multiply a monthly value by 12.

Also, in finances it is often common to either round the answers to your calculations to the nearest whole dollar or whole cent.

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7C Tasks and questions

Thinking task

1 Sam checks his payslip and realises he has been overpaid by $350.00. Who owns the money now it is in Sam's account? What should Sam do? Who has the responsibility to report and fix the error? Research the answer to these questions via the Fair Work website.

Skills questions

2 Calculate the gross pay for the following.

a 10 units at $19.95 per unit

b 15 units at $22.95 per unit

c 8 units at $17.00 per unit

d 12 hours at $15.75 per hour

e 4 and a half hours at $18.25 per hour

f $9\frac{3}{4}$ hours at $16.50 per hour

3 Calculate the following pay, including the higher overtime rates.

a 8 hours at $15.75 per hour, and 3 hours at $19.75 per hour

b 7 hours at $12 per hour, and 5 hours at $14.40 per hour

c $7\frac{1}{2}$ hours at $12.50 per hour, and 5 hours at $14.90 per hour

d 16 hours at $12 per hour, and $3\frac{1}{2}$ hours at $15.55 per hour

e 8 hours at $15.00 per hour, and 3 hours at $30.00 per hour

f 17 hours at $18.50 per hour, and 5 hours at $17.75 per hour

4 For the yearly wages below, calculate the hourly rate using the following steps.

- First, find the weekly pay for the following wages (using 52 weeks = 1 year).
- Now for the same numbers, find the daily pay (using 5 days per working week).
- Lastly, assume there are eight paid working hours in a day. Find the hourly rate.

a $89 128

b $47 000

c $68 000

d $23 000

e $18 608

f $39 197

5 Find the fortnightly pay for the following annual wages (using 26 fortnights = 1 year).

a $52 000 **b** $74 000 **c** $63 000 **d** $25 000

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6 Calculate the yearly salary from the following.

a $753.80 per week

b $1653.85 per week

c $1189.50 per week

d $837.90 per week

e $1507.60 per fortnight

f $3615.38 per fortnight

g $2890.75 per fortnight

h $1986.78 per fortnight

7 **Mixed practice**

a What is the pay for 9 and a half hours work at $18.75 per hour?

b Find the weekly pay of a yearly salary of $68 000.

c What is the yearly salary for $1703 per fortnight?

d What is the pay for 3.5 hours work at $16.50 per hour, plus 5 hours at $17.95 per hour?

e Find the hourly rate when paid $51 000 per year.

8 Calculate the pay for the following scenarios.

Pay rate schedule		
Mon – Fri	$17.20 /hr	8:00 am – 5:00 pm
Mon – Fri	$21.10 /hr	5:00 pm – midnight
Saturday	$18.60 /hr	8:00 am – 3:00 pm
Saturday	$23.90 /hr	3:00 pm – midnight
Sunday	$19.20 /hr	10:00 am – 2:00 pm
Sunday	$25.20 /hr	2:00 pm – midnight
Public holiday	$37.20 /hr	Flat rate

a Tali works from 8:00 am to 3:00 pm on Monday, Tuesday and Wednesday, and from 10:00 am to 2:00 pm on Sunday.

b Sanam works from 6:00 pm till midnight on Monday, from 4:00 pm to midnight on Saturday and from 2:00 pm to midnight on Sunday.

c Jiayin works Monday, a public holiday, from 4:00 pm to midnight, from 8:00 am to 1:00 pm on Thursday and Friday, and from 9:00 am to 5:00 pm on Saturday.

d Raksa works from 3:00 pm to midnight on a normal Monday, from 2:00 pm to 9:00 pm on Tuesday, from 1:00 pm to 6:00 pm on Wednesday and Thursday, and from 2:00 pm to midnight on Saturday.

Mathematical literacy

9 Employees who work on farms picking fruit are paid **piece rates**. What are piece rates?

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Application task

10 An owner of a small retail business does not use bookkeeping software to calculate pay for her staff, instead she collects the data and calculates the pay using an Excel spreadsheet.

The table below displays the pay data for her staff for one week. Some staff are paid a salary and the others are paid per hour. Calculate the **total** weekly wage paid to all the employees of her business (before tax).

Name (initials)	Role	Wage type	Wage rate	Number of hours worked
FG	Manager	Salary	$82 000 / year	45
TF	Full-time Sales Assistant	Salary	$65 500 / year	38
JD	Part-time Sales Assistant	Hourly	$29.70 / hour	22
RR	Junior Sales Assistant	Hourly	$23.76 / hour	12
TB	Stock Filler	Hourly	$22.45 / hour	15
GB	Cleaner	Hourly	$27.22 / hour	9



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7D Pay scales, awards and the pay gap

In Australia, the government sets a **minimum wage**. The minimum wage is the reference value for different industries. These minimum wages are set out in **industrial awards**.

An industrial award is a legal document that is negotiated with the Fair Work Commission.

When you first start working in an industry, you usually begin at the bottom of the **pay scale**. The pay scale is a series of steps in which the pay increases, based on how long you've been employed.

Unfortunately, sometimes there is a difference between the wages earnt by women and men at different stages in life. This is known as the **gender pay gap**.

Gender pay gap by state and territory in 2022

Lowest	Highest
South Australia **7%**	Western Australia **21.9%**

Gender pay gap by industry in 2022

Lowest	Highest
7.3% Public Administration and Safety	**25.3%** Professional Scientific and Technical Services

Full-time average weekly earnings of women ◀ ***$1575.50***

14.2%

Women earn on average $261.50 per week less than men

$1837.00 ▶ *Full-time average weekly earnings of men*

Source: Australian Government Workplace Gender Equality Agency website

7D Tasks and questions

Thinking task

1. Visit the Fair Work government website and find the minimum wage for six different industries.
2. Visit the Workplace Gender Equality Agency government website and find the page containing information on 'The ABS data gender pay gap'.
   - **a** What is the gender pay gap in Victoria?
   - **b** What are some of the reasons for the gender pay gap?

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Skills questions

3 Look at the following pay scale for junior apprentices in the hospitality industry in 2023.

Minimum rates for junior apprentices

Year of apprenticeship	% of standard weekly rate	Minimum weekly rate (full-time employee)	Minimum hourly rate
		$	$
1st year	55%	547.25	14.40
2nd year	65%	646.75	17.02
3rd year	80%	796.00	20.95
4th year	95%	945.25	24.88

Source: Fair Work Ombudsman

a What is the minimum pay per hour in the first year of an apprenticeship?

b What is the minimum pay per week in the first year of an apprenticeship?

c What is the minimum pay per hour in the fourth year of an apprenticeship?

d What is the minimum pay per week in the third year of an apprenticeship?

e What is the difference between the minimum hourly pay in the first year and the fourth year?

f What percentage of the full pay does a third-year apprentice receive?

Mathematical literacy

4 Write definitions for the following words.

- Employee
- Employer
- Wages
- Pay scale
- Apprentice



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Application task

5 Visit the Fair Work government website and find the 'Find your award' page. (Alternatively, use a search engine to reach the same page.) Assume that you are either a first-year apprentice, first-year trainee or level-one worker. Remember to take into account meal breaks etc. These are set out in the awards, usually under a heading called 'Breaks'. Find these for the award you select.

- **a** Choose one industry of interest from the list of awards.
- **b** Find your weekly wage if you worked 8:00 am to 4:00 pm, Monday to Friday.
- **c** Find your weekly wage if you worked 12:00 pm to 8:00 pm, Monday to Friday.
- **d** Find your weekly wage if you worked 10:00 am to 4:00 pm, Monday to Friday, and 4 hours on a Saturday.
- **e** Find your weekly wage if you worked 10:00 am to 6:00 pm for 3 weekdays, 4 hours on a Saturday and 6 hours on a Sunday.
- **f** Find your weekly wage if you worked 10:00 am to 6:00 pm for 3 weekdays, 10:00 am to 6:00 pm for 2 weekday public holidays and 6 hours on a Sunday.
- **g** Make an infographic describing the allowances you could be paid for under your award.



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7E Payslips

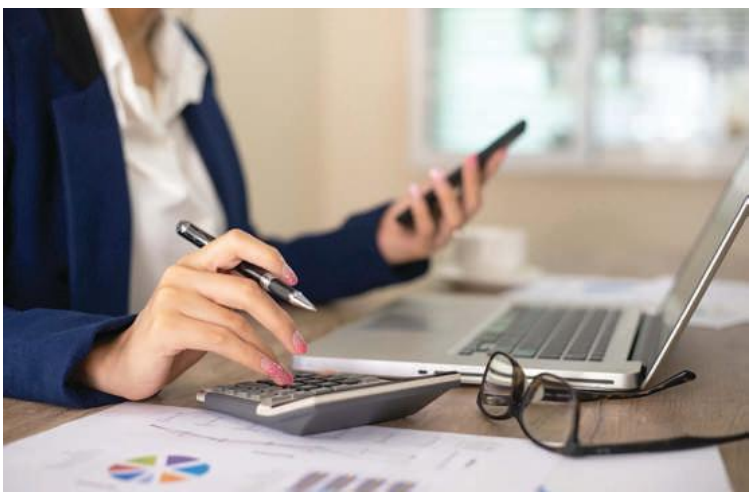
Employers are legally required to provide employees with payslips. Payslips must record your rate of pay, how many hours you have worked and your pay, before and after tax. The payslip must also show any deductions or bonuses.

7E Tasks and questions

Thinking task

1 Most businesses use payroll software to generate payslips. They also employ accountants and bookkeepers to manage the payment of their staff. When workers are underpaid, often the owners or directors of companies claim that they were unaware that this was occurring.

Who is responsible for ensuring workers are paid correctly? What can be done to make sure underpayment does not occur?



Skills questions

2 Find and share a payslip from someone in your class.

Locate the following on the payslip.

- **a** Date
- **b** Rate of pay
- **c** Employer's Australian Business Number (ABN)
- **d** Pay before tax (gross pay)
- **e** Take-home pay after tax (net pay)

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3 Look at the following payslip and answer the questions.

PAYSLIP

Date: 1.1.2023
Drinkwater Hold Pty. Ltd.
ABN: 123 456 789 10
Pay Period: 30/12/2022
to 30/1/2023

Employee: M. Mitchell
ID: 35421
Status: Casual
Rate of pay: $18.75 per hr.

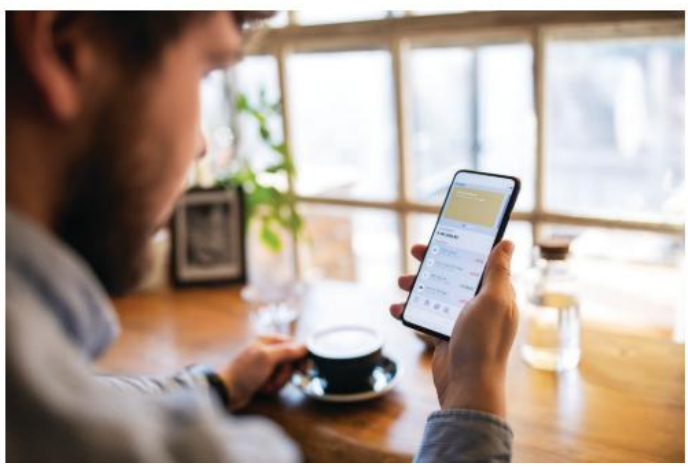
	Units	Rate	Total
Wages for ordinary hours worked	5	$18.75	$93.75
	Total gross		$93.75
Taxation		$0.00	$0.00
	Total		$0.00
Deductions	1		$32.90
	Total net		

a Write a mathematical sentence describing how the total was calculated.

b Give one reason why no tax was paid.

c Think of one reason for the deduction in pay.

d Calculate the total net pay for this time period.



4 Find out online what the minimum wage in Australia is.

Make a chart of the hourly wages of each person in your class and check against the minimum wages you found.

Why do younger workers receive a reduced percentage of the adult minimum wage?

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5 Look at the following payslip and answer the questions.

River King

Fortnight ending 23/2/2023	Pay date 25/2/2023		Employee No: 103569	Name Organisation & ABN Status: Part time	

Pay			Allowances/Deductions		
Rate	Hours	Value	Description	Value	
$18.95	42	$795.90	Vic Super	$83.57	

Entitlements:
Annual leave: 0.00
Sick leave: 64.76

Total gross pay: $712.33
Tax paid: $140.76
Net pay: $517.57

a Write an equation showing how the net pay was calculated using the gross pay and tax.

b How many days were in the pay period?

c If the superannuation was calculated using 10.5%, write an equation showing how this was calculated.

d Write an equation showing the rate of pay × the hours worked.

e Was sick leave included in the gross pay?

Mathematical literacy

6 The definition of **wage** is the money paid for the completion of work. List four other words that also mean this.

Application tasks

7 Create a payslip for the following worker:

Name: J E Citizen
Employer: XYZ Caterers Pty Ltd; ABN: 12 345 678 910
Pay period: 17th June to 30th June
Pay date: 4th July
Wages for ordinary hours worked: 28 hours @ $32.50 per hour
Tax withheld: $40.00

Remember to include the following:

- Date of payment and period of work
- Employer's and employee's name
- Employer's Australian Business Number (if applicable)
- Rate of pay
- Hours worked
- Pay before tax (gross pay)
- Tax
- Take-home pay after tax (net pay)
- Superannuation paid (check for the current superannuation percentage rate calculated on the gross pay)

To calculate the tax, look up the tax scale on the Australian Taxation Office website.

As you can see, it gets complicated, but the PDF tables will be a useful reference.

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7F Types of employment

There are different types of employment in Australia.

- Full-time permanent
- Part-time permanent
- Full-time contract
- Part-time contract
- Casual
- Fixed term
- Shift work
- Daily hire and weekly hire
- Probation
- Apprentices and trainees
- Outworkers



Young people in Australia typically start their employment on a casual basis. Casual employees are usually paid a higher rate than permanent employees. This is to make up for the lack of entitlements, such as sick leave, holiday pay and redundancy, that permanents receive but casuals do not. The extra amount that casuals receive, usually around 25%, is set out in the industrial awards and can be found at Fair Work Australia.

7F Tasks and questions

Thinking task

1 **a** Find the minimum amount of hours for part time and full time work.

b Find the minimum wage for casual and part time at your age in an industry you want to join.

c What is the extra amount received for casual workers? What is this as a percentage?

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Skills questions

2 Examine the information below and answer the questions about Brandon's wages and earnings.

PAYSLIP

Date of Payment: 11/09/23
Pay Period: 25/08/ 2023 to 08/09/2023

Employer name: Moondust Services
ABN: 123 456 789 10

Employee Name: Brandon
Employment Status: Part-time Contract
Name of Award: Cleaning Services Award
Classification under the Cleaning Services Award: Junior Part-time Employees of shopping trolley collection contractors only – Level 1 – 17 years
Hourly rate: $15.71 Annual salary: $10119
Bank details: BSB: 012345 Account: 456 789 10
Annual leave entitlement: 2.4 days as at 11/09/2023

Entitlements	Unit	Rate	Total
Wages for ordinary hours worked	16 hrs	$15.71	$251.36
		Gross Payment	$251.36

Deductions	$0.00-
Taxation	$0.00-
Net Payment	$0.00-

Employer Superannuation Contribution	
Young Person's Awesome Fund	
Contribution	$27.65

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Junior – Part-time – Employees of shopping trolley collection contractors only – Level 1

Classification	Hourly pay rate	Monday to Friday - shift starting before 6am or finishing after 6pm	Non-rotating shift - finishes after midnight and at or before 8am	Saturday	Sunday
Under 16 years	$11.78	$13.31	$13.31	$16.90	$21.02
16 years	$13.09	$14.79	$14.79	$18.78	$24.47
17 years	$15.71	$17.76	$17.76	$22.54	$29.37
18 years	$18.32	$20.71	$20.71	$26.28	$34.25
19 years	$20.94	$23.67	$23.67	$30.05	$39.15
20 years	$23.56	$26.64	$26.64	$33.81	$44.05

a Looking at the payslip, what type of employment does Brandon have?

b What is Brandon's hourly rate of pay?

c What is the time period for Brandon's pay?

d Write the calculation to show how the gross payment is obtained.

e How much does Brandon earn per year?

f How much does Brandon's employer pay into his superannuation fund in a full year at this rate?

g What would the gross payment be if Brandon were 19 years old?

h If Brandon switched to working on Sundays at age 20, what would his rate of pay be? How much would he receive per fortnight?



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3 Some of the award payments for a particular industry are outlined below.

Adult - Full-time and part-time

For these workers, full-time employment is 38 hours per week.

Classification	Weekly pay rate	Hourly pay rate	Saturday – day workers – first 2 hours	Saturday – day workers – after 2 hours	Sunday- day workers	Public holiday
Level 1	$820.23	$21.59	$32.39	$43.18	$43.18	$53.98
Level 2	$827.43	$21.78	$32.67	$43.56	$43.56	$54.45
Level 3	$855.83	$22.52	$33.78	$45.04	$45.04	$56.30
Level 4	$879.33	$23.14	$34.71	$46.28	$46.28	$57.85
Level 5	$925.23	$24.35	$36.53	$48.70	$48.70	$60.88

Casual

Classification	Hourly pay rate	Saturday – day workers – first 2 hours	Saturday – day workers – after 2 hours	Sunday- day workers	Public holiday
Level 1	$26.99	$37.78	$48.58	$48.58	$59.37
Level 2	$27.23	$38.12	$49.01	$49.01	$59.90
Level 3	$28.15	$39.41	$50.67	$50.67	$61.93
Level 4	$28.93	$40.50	$52.07	$52.07	$63.64
Level 5	$30.44	$42.61	$54.79	$54.79	$66.96

a For a Level 1 worker, what is the regular hourly pay rate for the following.

i Permanent full-time and part-time worker?

ii Casual worker?

b What is the difference between the two hourly pay rates? Give two reasons for this difference in pay.

c What is the weekly pay rate for a full-time Level 3 worker?

d If a casual worker on Level 3 works a 38-hour week, how much do they receive?

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e Explain what pay a casual worker receives if they are sick and cannot work or take a holiday.



f Calculate the pay for working 20 hours on weekdays, 2 hours on a Saturday and 5 hours on a Sunday for the following workers.

- **i** Level 1 permanent worker
- **ii** Level 1 casual worker
- **iii** Calculate the difference between the pay received by the casual and permanent worker.

g Calculate the pay for working 10 hours on weekdays, 8 hours on a Saturday, and 4 hours on a Sunday for the following workers.

- **i** Level 1 permanent worker
- **ii** Level 1 casual worker
- **iii** Calculate the difference between the pay received by the casual and permanent worker.



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Mathematical literacy

4 Explore the advantages and disadvanges of the different types of employment. Present your findings in a table format.

Type	Advantages	Disadvantages
Permanent		
Contract		
Casual etc …		

Application task

5 **Redundancy** is when your employer decides that your permanent role is no longer required, and they can legally terminate your employment. Redundancy does not apply to casual workers. Fair Work Australia states that redundancy payments must be based on your length of employment with that employer.

Period of continuous service	Redundancy pay
At least 1 year but less than 2 years	4 weeks
At least 2 years but less than 3 years	6 weeks
At least 3 years but less than 4 years	7 weeks
At least 4 years but less than 5 years	8 weeks
At least 5 years but less than 6 years	10 weeks
At least 6 years but less than 7 years	11 weeks
At least 7 years but less than 8 years	13 weeks
At least 8 years but less than 9 years	14 weeks
At least 9 years but less than 10 years	16 weeks

Calculate the redundancy payments for the following.

a 2 years of employment at $412.00 per week.

b 9 years of employment at $756.00 per week.

c 4 years of employment on a wage of $52 000 per year.

d 3 years of employment on a wage of $76 000 per year.

e 5 years of employment at $3204 per month.

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7G Bank accounts and statements

In Australia, your pay is deposited into a nominated bank account or an institution account.

Which account your money goes into is up to you! Once you have your first account, it is easy to set up additional accounts with the same financial institution.

There are many options to choose from, but most accounts fall under two categories.

1. **Transaction accounts** – These are for your everyday use and can also be called debit accounts.
2. **Savings accounts** – These are set up to help you save money.

One option is for your pay to go into a transaction account, then for you to move some money to your savings account each pay cycle.

A **bank statement** can be accessed via your online account, or these days we often access our banking information and statements through the bank's application on our smart-phones. If you choose, it can be mailed out to you through the post also, but that is not very common these days.

Debits and Credits: A **debit** to your bank account occurs when you use funds from the account to buy something or pay someone. When your bank account is debited, money is taken out of the account. The opposite of a debit is a **credit**, in which case money is added to your account.

Bank of Southern Lands

Address of bank

Everyday savings account
Bank account statement

Bank of Southern Lands
1 Melbourne Place
Melbourne
VIC 3000

Address of customer

Brandon Chad
PO Box 1
Seymour
VIC 3660

Date of transaction

Money out

Money in

How much money after transaction

Date	Description	Debits	Credits	Balance
18 May	Centrelink		303.20	465.00
18 May	ColesWorths	78.00		387.00
18 May	Hardware	143.00		244.00
19 May	7-11	4.50		239.50
19 May	Wages		169.00	408.50
21 May	Fasttimes	145.99		262.51
22 May	Dinner	18.00		244.51
24 May	7-11	11.60		232.91
25 May	ColesWorths	176.00		56.91
26 May	Wages		118.00	174.91

Description of transaction

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Transferring money between your own accounts on a banking app requires you to write the amount you wish to transfer, and select the accounts you wish to transfer between.

To pay or transfer money to another person's account, the most common ways to do this are by using the following:

- BSB and Account number
- BPay
- Pay ID

The **BSB** is a 6-digit bank code. First two digits = Bank, third digit = State, fourth to sixth digits = Branch. For example, BSB 063 520 means: 06 for Commonwealth Bank, then 3 for Victoria, then 520 for the Mildura branch.

BPAY is a key way Australians pay their bills. It is a service which enables bill payers to transfer funds electronically from their bank accounts to the billers. It is offered as a payment option by over 170 Australian financial institutions through their phone and Internet banking services.

There are more and more ways available to pay or transfer money each year with the ongoing advances of technology.

Discuss with your class all the different ways of paying that you know of.

7G Tasks and questions

Thinking task

1 Using the internet, choose one bank or financial institution and make a table with all the transaction and savings accounts they offer. Write at least one advantage and one disadvantage for each account you find.

For example:

Account	Advantages	Disadvantages
Everday account	No fees Pay ID Debit card	
etc …		

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Skills questions

2 For the following bank statement, calculate the missing balance amounts indicated by the Roman numerals **i-x**.

Bank of Southern Lands

Everyday savings account

Bank account statement

Bank of Southern Lands
1 Melbourne Place
Melbourne
VIC 3000

Brandon Chad
PO Box 1
Seymour
VIC 3660

Date	Description	Debits	Credits	Balance
16 Sept	M transfer – Wages		314.00	642.40
17 Sept	Banh Mi	17.50		**i**
18 Sept	Haircut	60.00		**ii**
19 Sept	Spotify	5.00		**iii**
19 Sept	Petrol	56.51		**iv**
20 Sept	ColesWorths	11.00		**v**
22 Sept	Parking	2.00		**vi**
23 Sept	M transfer – Wages		413.00	**vii**
24 Sept	Ice-cream	5.00		**viii**
24 Sept	Clothes	149.00		**ix**
24 Sept	ColesWorths	18.00		**x**

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3 For the following statement, calculate the missing amounts indicated by the Roman numerals **i-x**.

Bank of Southern Lands

Everyday savings account

Bank account statement

Bank of Southern Lands
1 Melbourne Place
Melbourne
VIC 3000

Brandon Chad
PO Box 1
Seymour
VIC 3660

Date	Description	Debits	Credits	Balance
3 July	IGA	18.00		196.00
3 July	M transfer – Bank of Mum and Dad		50.00	**i**
3 July	Birthday money Yia		120.00	366.00
3 July	Spotify	**ii**		361.00
3 July	YouTube	11.99		**iii**
3 July	Sushi	**iv**		345.41
3 July	IGA	21.00		324.41
3 July	Movies	17.50		**v**
3 July	Grilled	**vi**		283.91
3 July	Myki top-up	30.00		253.91
3 July	TimeOut	14.00		**vii**
3 July	Beverages	**viii**		99.91
3 July	Souvlaki	**ix**		90.92
3 July	Ice-cream	4.50		86.42
3 July	M transfer – Wages		80.00	**x**

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Mathematical literacy

4 An abbreviation is a shortened or contracted version of a word; for example, 'est.' is an abbreviation for 'established'. Find all the abbreviations you can related to banking, and explain them.

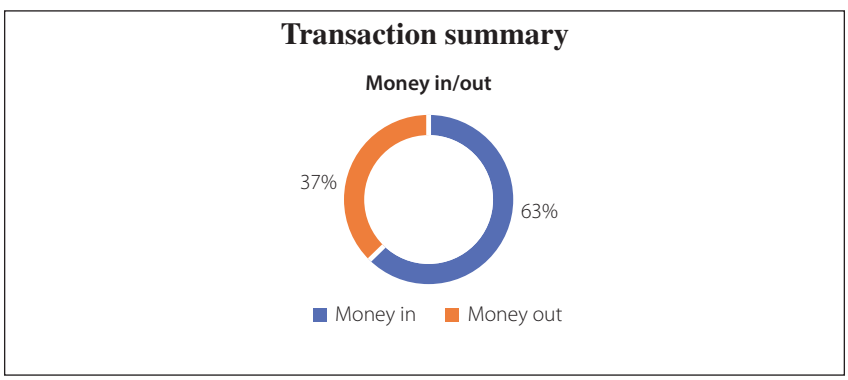
Application tasks

5 Find three different banking sites online and compare some of their savings or investment accounts and the interest rates they offer. Answer the following questions.

- **a** Which bank offers the highest interest rates and what are the terms of that account?
- **b** What is the disadvantage of the account that saves the most money?
- **c** What are some possible advantages of each of the account types you found across the different banks?
- **d** Which account would you choose for your own situation and why?



6 Some banking apps allow you to see a summary of how you spend your money. Look at the following summary and answer the questions.



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Summary of spending

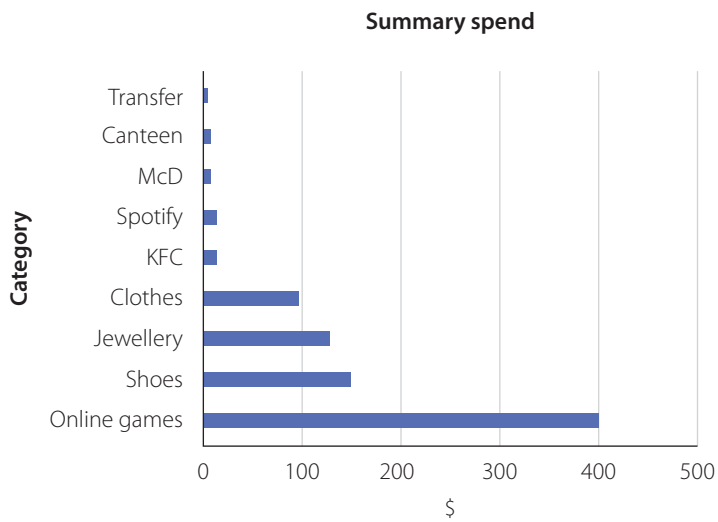
$823.00

Summary amounts only

Month of August

Your detailed report

Merchant	Amount
Video games	$400.00
Shoes	$150.00
Jewellery	$127.00
Clothes	$96.00
KFC	$14.00
Spotify	$13.00
McDonalds	$10.00
Canteen	$8.00
Transfers	$5.00



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a What is the total amount of money spent this month?

b How much money was spent on bills?

c What were the top four categories of spending this month?

d How much money was spent on food this month?



e How much money was spent on jewellery, clothes and shoes?



f Write a mathematical sentence explaining the doughnut graph 'Money in/out'.

g Write a mathematical sentence explaining the margin, spend and savings.

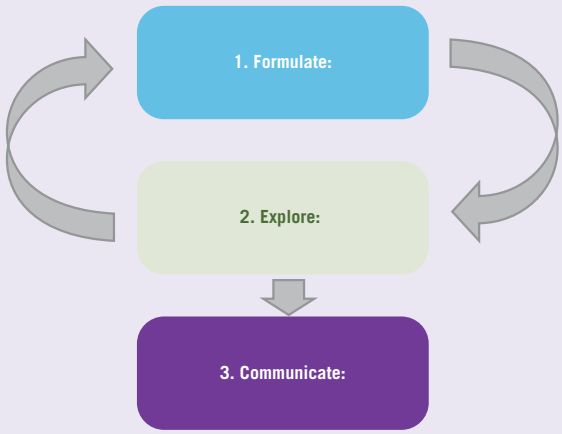
h If available, view your own spending summary for a month.

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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 Pay to pocket



Congratulations! You are working for a fast-food company.

You have the following shifts

- Mon 4:00–8:00 pm
- Wed 5:00–9:00 pm
- Fri 6:00–11:00 pm
- Sat 2:00–8:00 pm.

On weekdays, your pay is $15.50 per hour between 8:00 am and 6:00 pm, and $17.90 per hour from 6:00 pm to 8:00 am. Weekends are a flat rate of $18.50.

Superannuation is paid by your employer based on your gross pay. The superannuation rate that is to be paid in 2023-24 is 11%.

You will not meet the tax threshold and so will not pay tax for this week.

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During the week you do the following things.

- Buy two birthday presents which are $40.00 each.
- Spend $18 on food.
- Transfer $30.00 to a friend.
- Spend $60.00 on clothing.
- Pay a bill worth $56.00.
- Spend another $6.50 on food.
- Top-up your Myki with $20.00.

a Using the templates provided below, or using your own versions, create the following.

i A bank statement for one week.

ii A sample payslip for one week.

Bank of _____

Everyday savings account

Bank account statement

Bank of _____
Bank address

Name
Address

Date	Description	Debits	Credits	Balance

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Pay slip

Date of payment:

Pay period to:

Employee's name:

Employee's status:

Name of award: Cleaning Services Award

Classification under the Clearning Services Award:

Hourly rate: $

Bank details:

Day	Hours between 8am and 6pm	Gross pay	Hours between 6pm and 8am	Gross pay	Daily total
Monday					
Wednesday					
Friday					
Saturday	Flat rate of $18.50 regardless of time				
Gross pay total					

Deductions			
Taxation			
		Total deductions	
		Net payment	

Employer superanuation contribution	
Contribution	$

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b Use the information about your spending to create a graph showing your income and expenditure for the week.

c List at least three more expenses, with the costs, that you would consider as normal in your week.

d Include these extra expenses to make a second, different graph of your weekly income and expenditure.



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2 The cost of raising me so far

Your task is to find out about the cost of raising a child to the age of 18 in Australia. In your investigation, work through and document the following.

a Make a mind map of what you think are the different types of costs of raising a child from birth to 18.

b Try to put some figures against each cost category to work towards an estimate for the annual cost for each. It might help to break the costs into age related stages, such as babies, toddlers, kindergarten, primary school and high school. The age stages will help you think of the comparative and different expenses associated with each stage.

c Enter the costs for each year against each of your different cost categories in a spreadsheet. Total your estimates of the costs over the 18 years and create an appropriate graph or graphs to summarise and display your data.

d Research the average cost of raising a child in Australia. You will find different sources of information and reports. For example, the Australian Institute of Family Studies has research, or find the Choosi Cost of Kids Report that was released in 2023. Compare your own estimates with what you found in Australian research about such costs.

e Present your findings in a Word document or PowerPoint format. Include copies of one or two relevant spreadsheet graphs or charts.

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Key concepts

- It is a legal requirement to provide **payslips** to employees. These payslips must include details of their pay, including their pay rate, hours worked, tax calculation, deductions and bonuses.
  - It is important to check your payslip to ensure you are being paid the correct hourly rate, as well as for all of the hours you work.
- Pay may be calculated in many ways. **Pay rates** can be hourly, weekly, yearly or per item.
  - **Money earned = pay per unit of time × number of units of time.**
    - For instance, if you earn the adult minimum wage of $19.84 per hour, if you work an 8 hour shift you will earn $19.84 × 8 = $158.72 that shift.
- **Minimum wages** are set by Australian Government Awards.
- The **pay scale** determines how much you get paid, based on factors such as work experience.
  - When you are under 21, your minimum wage is a percentage of the adult minimum wage. As you get older, this percentage increases.
- The difference in the wages earned by women and men is called the **gender wage** gap.
- There are many different types of employment, including **full-time, part-time** and **casual**.
  - Different types of employees will have different wages and entitlements.
    - For example, **casual** employees typically receive a higher hourly rate, but are not eligible for paid leave like **permanent** employees. Unlike permanent employees, casuals do not have a guaranteed number of work hours per week and can be dismissed without notice.
- Wages are usually deposited into bank accounts. Bank accounts generally fall under the following two categories.
  - **Transaction** accounts, which are for everyday use
  - **Savings** accounts, which are to help you save money
- You can transfer money between your own accounts, as well as to other people.

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Chapter 7 review questions

☐ I can identify key features of a payslip.

1 Look at the payslip below and answer the following questions.

Paid by
Cools Ice-Cream
Company
ABN: 74 675 475 465

Karen Rudman
11 Skillo Street
Mary Creek 3987

Pay Period: **01/10/2023 – 31/10/2023**	Payment Date: **30/10/2023**	Total Earnings **$4,566.21**	Net Pay: **$3,251.42**

			THIS PAY	YTD
SALARY & WAGES	**HOURS**	**RATE**		
Base salary	79.8	57.22068	$4,566.21	$13,698.63
Other previous earnings				$7,345.32
		TOTAL	**$4,566.21**	**$21,043.95**
TAX				
PAYG Tax			$871.00	$4,450.00
		TOTAL	**$871.00**	**$4,450.00**
SUPERANNUATION			$433.79	$1,301.37
Australian Super			$0.00	$697.81
		TOTAL	**$433.79**	**$1,999.18**

LEAVE	ACCRUED	USED	BALANCE
Annual Leave Accrual in Hours	0.0000	0.0000	8.3300

PAYMENT DETAILS	**AMOUNT**
	$3,251.42

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Identify the following for the current pay period.

a Date the employee was paid.
b Rate of pay.
c Employer's Australian Business Number (ABN).
d Pay before tax (gross pay).
e Take-home pay after tax (net pay).
f Amount of tax paid.
g Amount of superannuation paid.

☐ I can calculate wages using pay rates.

2 Calculate the gross pay for the following.

a 12 units at $13.45 per unit.

b $6\frac{1}{2}$ hours at $22.45 per hour.

3 Two employees in a warehouse both work 84 hours in a fortnight but are paid differently. Jax is on a salary of $64 500, and Sid is on an hourly rate of $34.50/hour.

Calculate the fortnightly gross pay for each employee.

4 A shift worker earns $34.65/hour working their regular shift, and $51.98/hour working overtime. The table below shows the hours they worked in a week. Calculate their weekly gross wage.

Day	Regular Hours	Overtime Hours
Mon	8	$2\frac{1}{2}$
Tue	6	0
Wed	8	1
Thu	7	0
Fri	8	4

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☐ I can read pay scales.

5 Look at the pay scale for Teachers in the Department of Education. Teachers commence on Level 1-1 and progress up the pay scale every year.

Classroom Teacher	**Range 2**	
	2–6	$98 047
	2–5	$90 638
	2–4	$87 412
	2–3	$84 302
	2–2	$81 301
	2–1	$78 408
	Range 1	
	1–5	$75 618
	1–4	$72 927
	1–3	$70 332
	1–2	$67 829
	1–1	$65 415

a What is the graduate salary for a Teacher? (Graduate salary is their wage in the first year of teaching.)

b What is the salary for a Teacher in their third year of teaching?

c What is the difference in salary between a Teacher in their tenth year of teaching and a Teacher in their first year of teaching?

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☐ I can identify different types of employment.

6 The award pay rate for Nannies is tabled below.

Adult - Full-time and part-time

Classification	Weekly pay rate	Hourly pay rate	Monday to Friday – 7:00 pm to 7:00 am	Saturday	Sunday	Public Holidays	Overtime – First 3 hours	Overtime – After 3 hours
Level 1	$719.20	$18.33	$22.72	$22.72	$28.40	$47.33	$28.40	$37.86
Level 2	$768.30	$20.22	$24.26	$24.26	$30.33	$50.55	$30.33	$40.44
Level 3	$837.40	$22.04	$26.45	$26.45	$33.06	$55.10	$33.06	$44.08
Level 4	$913.70	$24.04	$28.85	$28.85	$36.06	$60.10	$36.06	$48.08

Casual

Classification	Hourly pay rate	Monday to Friday –7:00 pm to 7:00 am	Saturday	Sunday	Public Holidays
Level 1	$23.66	$27.45	$27.45	$33.13	$47.33
Level 2	$25.28	$29.32	$29.32	$35.39	$50.55
Level 3	$27.55	$31.96	$31.96	$38.57	$55.10
Level 4	$30.05	$34.86	$34.86	$42.07	$60.10

a What is the weekly pay rate for a Level 2 full-time Nanny?

b Calculate the pay that a casual Level 2 Nanny would receive for working a 40-hour week, working Monday to Friday between the hours of 7:00 am and 7:00 pm.

c Calculate the difference in the weekly wage for the Nanny in part **a** and the Nanny in part **b**. Why are the weekly wages different?

d Calculate the pay that a casual Level 4 Nanny would receive for working from 4:00 pm to 10:00 pm on a Friday.

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I can read bank statements.

7 For the following statement, calculate the missing amounts.

Bank of Southern Lands

Everyday savings account
Bank account statement

Bank of Southern Lands
1 Melbourne Place
Melbourne
VIC 3000

Brandon Chad
PO Box 1
Seymour
VIC 3660

Date	Description	Debits	Credits	Balance
12 May	Optus	45.00		1123.20
12 May	Wage		850.45	**i**
13 May	Soopermart	**ii**		1888.33
13 May	Bakery	4.50		**iii**
13 May	Nics and Nacks	22.50		1861.33
14 May	Family allowance		85.88	**iv**
15 May	Florist	66.00		**v**

I can put all these skills together.

8 Harvey has finished his first week of work as a casual swim instructor at his local pool. The following items are shown below: the award pay rates for casual swim instructors, Harvey's timesheet and his first pay slip.

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Swimming Instructor Award – Casual

	Ordinary hours	Saturday, Sunday and Public holidays
	% of minimum hourly rate	
	125%	130%
	$	$
Level 1	25.41	26.43
Level 2	26.15	27.20
Level 3	28.08	29.20
Level 3A	29.59	30.77
Level 4	30.80	32.03
Level 4A	32.29	33.58
Level 5	34.03	35.39
Level 6	33.74	35.09
Level 7	35.05	36.45

Timesheet

Date	Day	Start time	Finish time
24/01/2023	Monday	4:00 pm	7:00 pm
25/01/2023	Tuesday	_____	_____
26/01/2023	Wednesday	_____	_____
27/01/2023	Thursday	3:30 pm	8:00 pm
28/01/2023	Friday	_____	_____
29/01/2023	Saturday	8:00 am	1:00 pm
30/01/2023	Sunday	_____	_____

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Payslip

Pay Slip
Employer name: Swim and Splash
ABN: 12 345 678 910
Employees Name: Harvey Shark
Employment Status: Casual
Award: Fitness Award
Date of Payment: 03/02/23
Pay Period:
Classification: Level 1

Entitlements	**Unit**	**Rate**	**Total**
Wages for ordinary hours worked	7.5 hrs	$25.41	$190.58
Wages for Penalty Rate 1 – Saturday	5 hrs	$27.20	$136.00
Wages for Penalty Rate 1 – Sunday			
		Gross Wage	$326.58
Deductions			
Taxation			
		Net Payment	$326.58
Employer Superannuation Contribution Super rate 11%			
		Contribution	$35.92

a Check Harvey's timesheet for the week. Are the hours listed correctly on his payslip?
b The classification level which Harvey must be paid at is Level 1. Are the pay rates listed on his payslip correct?
c Why is Harvey not required to pay tax for this pay period?
d Harvey's supervisor, Hannah, is classified as a Level 4 swimming instructor. She works the exact same hours that Harvey does in the week. Calculate Hannah's gross pay for the week.

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Key vocabulary

Here is a list of the key maths terms and their meanings used in this chapter.

Term	Meaning
Apprentice	A person learning a trade.
Bank	A government-guaranteed provider of financial services.
Borrower	A person seeking a loan which will be repaid over time.
Casual employee	A worker on a higher hourly wage but without guaranteed hours of work and without access to sick leave or long service leave.
Contract employee	See *Fixed-term employee*. Can be full-time or part-time.
Credit	A credit in a bank statement is when money is added to your account.
Credit rating	Credit ratings (or scores) are calculated using the information found in your banking and loan histories and transactions, such as how many credit accounts you have and how long they've been open, whether you make payments on time, your account balances and more. It can be used to decide whether to give you credit or lend you money.
Currency	The types of notes or coins used in a country, for example, $50 note or 20 cent coin.
Daily-hire or weekly-hire employee	Workers with no guaranteed hours or days of work who are hired to fill short-term vacancies.
Debit	A withdrawal of funds from your bank account.
Employee	A person paid to carry out a job.
Employer	A person who hires and pays others to carry out a job.
Finance	The business of getting and spending money, in business or government.
Financial institution	General term for borrowers and lenders in commercial markets, including banks.

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Term	Meaning
Fixed-term employee	A person hired for a specific length of time, for example, for a family-leave replacement.
Interest	Funds that a borrower pays or a lender receives which are charged for the use of the loan money.
Interest rate	The percentage amount that applies during the course of a loan.
Outworker	A person who works making goods, usually at home, and is paid on a *per item* basis.
Pay scale	A set table of payments to workers, approved by the government.
Per annum	The amount 'per year', often abbreviated as 'p.a.'.
Permanent employment	Often referred to as *ongoing* employment; where an employee is guaranteed a job for as long as they wish to retain it. Can be full-time or part-time.
Principal	The total amount of dollars involved in a loan.
Probation employee	A person who might be 'on a trial' for a few months, so the employer can assess their suitability for the role.
Redundancy	When your employer decides that your permanent role is no longer required, and they can legally terminate your employment. Redundancy does not apply to casual workers.
Trainee employee	A person who is learning about a new employment role.
Wage	The money paid by an employer to an employee for doing their job.

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8 Your money at work

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 – managing your personal finances related to work, study, loans and taxation. Prompt questions might be:

- What might be going on in this photo?
- What financial and monetary matters and decisions might be involved?
- What numbers and calculations might need to be used?
- What different tools, technologies or software might be used?
- What research or investigation questions could be undertaken, based on this photo?

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Chapter contents

Chapter overview and Spotlight

8A Starting activities
8B Tuning in
8C GST
8D Personal taxation and superannuation
8E Interest, loans time and risk
8F Instalments
8G Student loans
8H Credit
8I Lock-in contracts, subscriptions and joining fees

Investigations
Chapter review

From the Study Design

In this chapter, you will learn how to:

- read, interpret and perform calculations related to financial services such as with banking, utility bills and GST
- demonstrate understandings and perform calculations of fees and interest charged by banks and other financial institutions in relation to amount borrowed, interest rate, time and risk
- describe, calculate and interpret different income related taxes, payments and deductions and their impact on income, such as pay scales, personal tax, withholding tax, PAYE and PAYG

(Unit 1, Area of Study 3).

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Chapter overview

Introduction

Congratulations! You have your first (or second?) job! What now?
In the previous chapter, we looked at how to read a payslip and keep track of bank accounts.

When we work, our employer contributes a portion of our pay each week to a compulsory scheme, saving money for our retirement. Another portion of our pay (once we start earning enough) will go towards taxes. Taxes pay for most of the things that make Australia a good place to live, such as access to health care and safe public transport.

If we start a traineeship, apprenticeship or further study, we may have to apply for a loan to help pay for equipment, tools or tuition fees.

In this chapter, we will investigate these things and more. We will learn about HECS debt and VET and apprenticeship loans. We will take a journey through taxation, and importantly we will learn about interest, whether it is helping you grow your savings, or charged on a loan.

Learning intentions

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

- explain what GST is, calculate GST from the total amount paid, and calculate the selling price after GST
- understand personal taxation and superannuation, and undertake related calculations
- explain what interest, simple interest and compound interest are, and undertake related calculations
- make informed decisions about repaying loans, including choosing a longer or shorter loan period, and calculating instalments with and without interest
- describe student loan schemes such as HECS-HELP and VET-HELP debts, and undertake relevant calculations
- understand what credit is and different types of credit, to make informed choices about accessing credit
- distinguish between lock-in contracts, paid subscriptions, and joining fees and one-off charges
- apply the problem-solving cycle to complete investigations related to the topics contained within the chapter.

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Spotlight: Rodrigo Matos Lima

An interview with a café owner

Tell us about the work you've done and what you do now.

I did a graphic design diploma back in Brazil but as soon as I finished, I went to Europe and worked in hospitality. I learnt to make coffee and became a manager of a café. When I moved to Australia, I thought it would be a good idea to do it for myself and so I opened a café.

What maths do you use regularly in your job? Could you give some examples?

Ideally you want to break down the cost of an item to be one-third the cost of the produce, one-third for overheads and then one-third profit. It doesn't work out all the time, but you can use that as a rule you try to stick to. Every time you bring in a new product, you have to work that out.

Another thing is GST. For everything that you sell, you pay 10% of that as tax. You need to make sure, at the end of the quarter, that you've saved that 10% or else it's going to kill you. Let's suppose you sell $500 of goods a day, then $50 is what you've got to pay back as GST. It's very simple maths that I use.

What is the most useful tool or piece of technology that you use regularly in your job?

I have an iPad with Square, which processes credit and EFTPOS payments. Now everyone is passing on the card fees to the customer, and it can calculate the 1.5% fee and add it on. Customers didn't want to pay for the fees at first, but it doesn't make much difference to individuals. For a business, if you pay $25 every day, it all adds up.

What was your attitude towards maths when you were in school? Has it changed over time?

I thought it was good until things got more difficult. My wife is the best teacher, so I have learnt a fair bit with her. It helps that I want to know it now because I have to use it for work.

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8A Starting activities

Activity 1: Taxation

On a whiteboard or large screen, create a table with three columns.

1 In Australia, individuals and companies pay a range of taxes, including some that are rates payable to local government bodies. The main tax from a personal perspective is the federal income tax we pay as part of our employment. List all the services that your taxes pay for. Use the categories of local government (councils or shires), state government and federal government. Can you think of at least twenty items for each column?

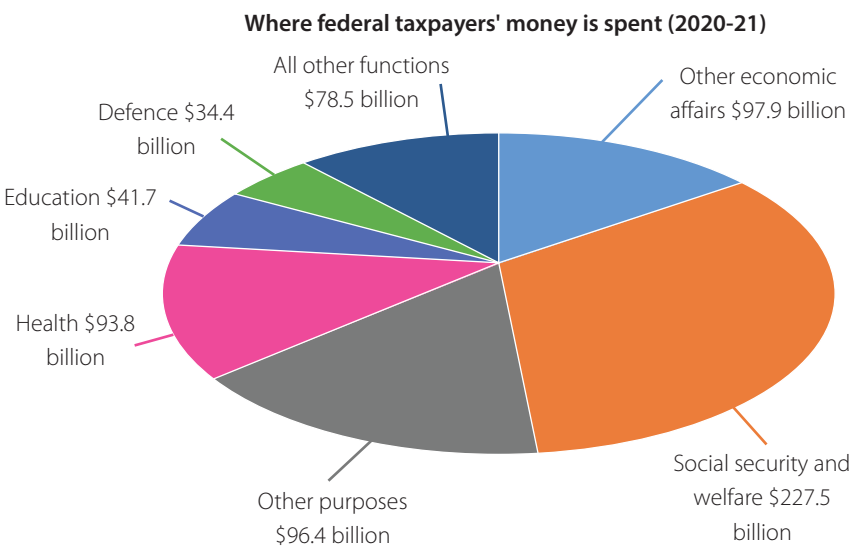
Local council	State government	Federal government

2 How much do you think these services cost? Make a guesstimate.

3 Discuss if you are surprised at how many things are paid for by our taxes?

4 Research on the internet to find the total amount of tax collected in Australia each year.

5 Discuss with the class the fairness of paying for all the things that are listed in the table. Does it matter that you don't personally use every one of these services?



Source: Australian Taxation Office

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Activity 2: Second-hand vehicles

The cost of buying a second-hand Toyota Hilux is listed in the table below. There is a considerable range from lowest to highest price each year.

Year	Price from:	Price to:
2021	$18,100	$74,250
2020	$17,000	$69,850
2019	$15,100	$65,670
2018	$13,300	$56,650
2017	$11,800	$50,930
2016	$10,600	$42,570
2015	$8,800	$40,810
2014	$8,000	$36,850
2013	$7,500	$34,980
2012	$7,200	$30,910
2011	$6,200	$28,710
2010	$5,900	$25,410



1 How does the *range* of prices vary for each year?

2 Explain why there is a range in price. Give an example of what features would be expected for the lowest, mid and highest condition price.

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3 For the 'Price from' column, what is the difference in price from 2010 to 2021?

4 For the 'Price to' column, what is the difference in price from 2010 to 2021?

5 Graph the lowest range prices and highest range prices on the same graph. Use technology.

6 Make a list of all the costs associated with buying a car.

7 Approximately how much would a 2014 second-hand, mid-condition Toyota Hilux cost?

8 What taxes and charges are associated with buying a car. How much are the taxes and charges for a 2014 second-hand, mid-condition Toyota Hilux? How much do they total?

9 If you were to buy a lowest range Hilux from 2014, explain how you might save for this. Would you get a loan? Where could you go to get a car loan?



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8B Tuning in

Epic Fail



It is crucial when making a large purchase, such as a second-hand car, that you check to make sure it is not stolen.

In October 2021, media reports began circulating about a Queensland Police record-keeping error which involved stolen cars being confiscated from new, faultless owners.

In one example, the owner told police they paid $30 000 to a legitimate dealer for a Hyundai Santa Fe and had transferred the registration through the Department of Transport as well as doing all the appropriate checks on the car's background. Reportedly there were dozens of car owners caught up in the situation, which Queensland Police blamed on a data transfer error that allowed stolen cars to be mysteriously re-registered legally on government record systems, between 2016 and 2021.

Car owners were unaware that the cars they purchased were stolen vehicles. Under the law, stolen cars belong to the original owner or to the insurance company. In this situation, these new 'owners' would lose their car. If they had taken a loan on the car, they would still have to pay the loan, even if they had no car!

You may want to look at buyers' rights and responsibilities on the Consumer Affairs Victoria website before you choose to buy.

Discussion questions:

1 What are the risks of buying a used car from a dealership?

2 What are the risks of buying a used car from a private citizen?

3 How could you protect yourself from buying a stolen car?

When making such a big purchase, check out all of your options. Don't let yourself be pressured into deciding on the spot. This is a sales technique. If you feel that you are being manipulated, take your time and get some advice from someone who knows more than you about used cars.

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Personal finances

Taking care of your personal finances is important for the following reasons.

- Reduced stress – money worries can add stress to life which isn't good for our health.
- So that you can have sufficient money for all your essential expenses such as food and clothing.
- Stops us from living paycheck to paycheck.
- Good health maintainance – spending less time on our finances allows us more time to focus on maintaining good health.
- Increased comfort – a strong financial position lets us enjoy the good things in life.



There are many aspects to maintaining financial health.

Ensuring our tax returns are submitted on time each year and keeping an eye on our pay and superannuation, all contribute to good financial practices.

One area that needs extra attention is **debt**. Australian levels of personal debt are amongst the highest in the world. Search online for the **Australian Debt Clock**, and look at the live counters showing what Australians owe.

There are many reasons why Australians borrow money. It may be to study, to purchase equipment needed for a traineeship or to buy a car or a home. We can, however, protect ourselves financially by understanding the processes involved with debt.

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Understanding mathematical calculations related to money

When we undertake mathematical calculations related to money, we need to have a good understanding of a range of mathematical processes. For example, calculating with percentages and rates is critical, and we also need to be able to use formulas to find unknown values, such as when working out interest.

To find a percentage, it can help to think of it in everyday language. As we saw in Chapter 2, easy percentage, calculations can be done 'in your head'. Otherwise, use the **% key** on a smartphone calculator.



Example 1 Percentage of a value

a Find 5% of $200 'in your head'.
b Find 5% of $200 with a smartphone calculator.

THINKING	WORKING
STEP 1	
It's easy to work out 10% in your head.	**a** 10% is one-tenth, so 10% of $200 is $20.
STEP 2	
5% is half of 10%.	Half of $20 is $10,so the answer is $10.

If the question had asked for 20%, *Step 1* would be the same, but at *Step 2*, because 20% is double 10%, the answer would be double $20, which is $40.

STEP 1	
Only one action is required.	**b** Enter 200 then ×5 then % then =. *OR* Press 5% × 200 =. Interpret the answer as $10. Check that your calculator works percentages out the same way.

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Another important algebraic skill for financial mathematics is substituting numbers into a formula.

Word or term used in mathematics	Meaning
Variable	In the formula $I = P \times \frac{R}{100}$ the *I*, *P and R* are called **variables –** they are place holders for numbers which will vary from situation to situation.
Formula	A **formula** is a mathematical sentence. The sentence tells a story and uses variables. In the formula $I = P \times \frac{R}{100}$ the story is that the *annual interest* to be paid (*I*) equals the principal (*P*) multiplied by the % rate (*R*) (divided by 100 to make a decimal value).
Not using the × sign between numbers and pronumerals	Remember that when we use a formula, if two letters (pronumerals) appear next to each other, there is an invisible multiplication sign (×) in between them. So, $I = P \times \frac{R}{100}$ could be written as: $I = \frac{PR}{100}$.

Practice questions

1 Find the following percentages.

a 10% of $100 **b** 8% of $200 **c** 25% of $950

d 12% of $800 **e** 10% of $189.90 **f** 70% of $674

2 Substitute the following numbers into the formula below. Do not solve the formula, just put the numbers in place of the letters. Don't forget to insert a multiplication (×) symbol when you replace *P* or *R*.

$$I = \frac{PR}{100}$$

a $P = 5000$, $R = 10$; *I* remains as the unknown variable

b $P = 50\,000$, $R = 8$; *I* remains as the unknown variable

c $I = 80$, $P = 4000$; *R* remains as the unknown variable

d $I = 193$, $R = 3$; *P* remains as the unknown variable

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8C GST

What is GST?

GST is the **Goods and Services Tax** that was introduced to Australia on 1 July 2000. It was designed to replace a wholesale sales tax on goods, including several inefficient state taxes, and to be paid on services as well as goods.

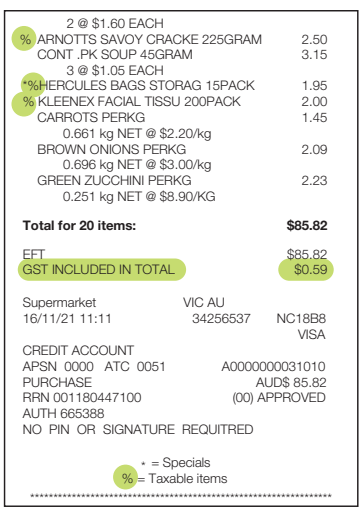
The GST rate is currently 10%. Not all goods and services attract GST. Items that are GST-free (sometimes known as GST exempt) include the following.

- Most basic foods (goods)
- Some education courses (service)
- Some medical, health and care products and services (service)
- Some childcare services (service)
- Some religious and charitable activities (service)
- Cars for disabled people to use, where certain requirements are met (service)
- Water, sewerage and drainage (service)
- Some telecommunications supplies (goods)

Calculating GST

The price of an item must be shown with GST included (unless the item is GST exempt), and the amount of GST must be included on an invoice.

On this supermarket docket, the items that attract GST are indicated (with a % sign), and the total amount of GST is included on a separate line.



2 @ $1.60 EACH
% ARNOTTS SAVOY CRACKE 225GRAM 2.50
CONT .PK SOUP 45GRAM 3.15
3 @ $1.05 EACH
*% HERCULES BAGS STORAG 15PACK 1.95
% KLEENEX FACIAL TISSU 200PACK 2.00
CARROTS PERKG 1.45
0.661 kg NET @ $2.20/kg
BROWN ONIONS PERKG 2.09
0.696 kg NET @ $3.00/kg
GREEN ZUCCHINI PERKG 2.23
0.251 kg NET @ $8.90/KG

Total for 20 items: **$85.82**

EFT $85.82
GST INCLUDED IN TOTAL $0.59

Supermarket VIC AU
16/11/21 11:11 34256537 NC18B8
VISA
CREDIT ACCOUNT
APSN 0000 ATC 0051 A0000000031010
PURCHASE AUD$ 85.82
RRN 001180447100 (00) APPROVED
AUTH 665388
NO PIN OR SIGNATURE REQUITRED

* = Specials
% = Taxable items

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When we buy goods and services, we don't notice the GST because it is already included in the price we pay.

From the point of view of a retailer or service supplier, calculating GST is easy. They work out how much they need to sell the item for to make a profit, then add on 10% for the GST. We pay this price when we buy something from them or when we use their service. The business then pays the 10% GST to the government.



Example 2 Calculating the selling price of a good or service

Tamara is a plumber. She has just completed a job that is worth $460 before she adds the GST. How much will she charge the client?

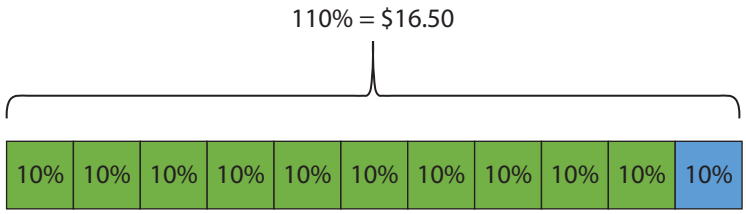
THINKING	WORKING
STEP 1	
Identify the amount that is exclusive of GST.	$460
STEP 2	
Calculate the GST as 10% of this amount. Remember that to calculate a percentage as a decimal, divide by 100. 10% = 10÷100 = 0.1	460 × 0.1 = 46 So the GST is $46. On a smartphone calculator, you can skip Steps 2 and 3.
STEP 3	
Add the GST you have calculated to the original amount.	460 + 46 = 506
STEP 4	
Write the mathematical sentence that shows the calculation.	460 + 460 × 0.1 = 506 On a smartphone: 460 + 10% = 506
STEP 5	
Include the units to make sense of the maths and write the answer in context.	Tamara will charge the client $506, (which includes $46 GST).

Note 1: If Tamara just wants to know the GST amount, she can use her smartphone to calculate the following.
460 × 10% = 46 (or 10% × 460 = 46).
Note 2: The GST adds one-tenth to the bill, so this means the GST amount is **one-eleventh** of the total paid: 506 ÷ 11 = 46.

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Sometimes we need to work out how to calculate the GST amount by working backwards from the total amount paid. Let's look at how this can be viewed using a bar model.

An item was selling for $16.50, including the 10% GST. That is, the price of $16.50 includes the extra the 10% GST – which means it equals 110% of the price without GST included. We can illustrate this by this bar diagram



There are **11** equal portions of 10%.

So, to work out what each 10% equals, we need to divide by 11. And $16.50 ÷11=$1.50. So, the GST included in the price $16.50 is $1.50.

Example 3 Calculating the amount of GST from the total paid

Travis has just paid $2255 for a wide-screen TV. How much GST did he pay?

THINKING	WORKING
STEP 1	
Identify the amount paid in total.	$2255
STEP 2	
Divide this amount by 11.	2255 ÷ 11
STEP 3	
Write the mathematical sentence that shows the calculation.	2255 ÷ 11 = 205
STEP 4	
Include the units to make sense of the maths and write the answer in context.	Travis paid $205 in GST on the wide-screen TV.

This means that the cost of the TV *before* the GST was included is:
2255 – 205 = $2050.

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8C Questions and tasks

Thinking task

1 Take a look at the earlier list of GST-free items.

- **a** Why do you think most food items are GST-free?
- **b** What do you think would happen if the government decided to collect GST on food items?
- **c** What do you think would happen if the government decided to raise the GST to 12%?

Skills questions

2 Classify the following items as goods or as services.

- **a** Bag of potatoes
- **b** Getting a dog washed and clipped
- **c** Having a washing machine installed
- **d** Mobile phone
- **e** Your mobile phone plan

3 Classify the following items as goods or services, and indicate whether they will attract GST or are GST-free.

- **a** Fresh fruit purchased at the market
- **b** Birthday cake purchased from a cake shop
- **c** Having new tyres fitted on your car
- **d** Getting your car serviced
- **e** Frozen pizza purchased from the supermarket
- **f** Meat purchased at the supermarket
- **g** Potato chips purchased from the corner shop
- **h** Your pre-paid mobile phone card
- **i** Take-away food
- **j** Fresh vegetables purchased from the fruit shop

4 Calculate 10% of the following amounts. Write the answer in dollars and cents, rounded to the nearest cent.

a	$423	**b**	$760	**c**	$4573	**d**	$6078	**e**	$10 590
f	$25 000	**g**	$35.75	**h**	$23.50	**i**	$8.25	**j**	$5.03

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5 Calculate the amount of GST included in the following amounts which paid for goods and services that attract GST. Round the answer to the nearest cent.

- **a** $83.58
- **b** $956.40
- **c** $3067.00
- **d** $15 070.00
- **e** $57 499.00

Mathematical literacy

6 Select the correct entry to make the following sentences true.

- **a** You *do/do not* have to pay GST on goods or service that are GST-free.
- **b** In Australia, GST is currently *10% / 12% / 15%*.
- **c** You can calculate how much GST is included in the price you pay, by dividing the price by *10 / 11*.
- **d** If you are a retailer in Australia, you must show the price of your goods *with/without* GST included.
- **e** GST *is/is not* paid to the Australian Taxation Office by the businesses that collect it.

Application tasks

7 For the excerpts from invoices shown below, complete the following tasks.

- **i** Identify if the invoice is for goods or a service.
- **ii** Identify or suggest what the goods or service being purchased is.
- **iii** Identify if the item attracts GST or is GST-free (or a combination).
- **iv** If the item attracts GST, state the amount of GST included in the invoice.

a Water Company invoice

The Water Company
ABN ##################
Tax Invoice/Statement

Date of Issue
20 September 2023
1300 WATER

The Water Company
Bradon Parker
PO Box XYZ
GEELONG, VIC 3220

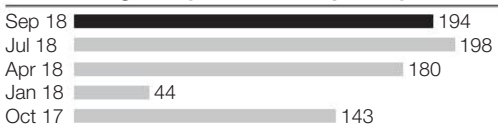
Payment due
22 October 2023
Total amount due
$22.92

Account number
69000001 99999999

You account summary
Service Address: 123 Noname Street

Previous balance	$35.06 DR
Payments/adjustments	$35.06 CR
Your balance	$0.00
New charges	$22.92 DR
Total	$22.92 DR

Your average daily use in litres per day



TARGET YOUR **WATER USE**
Visit our website for tips on how to be more efficient with your water usage.

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b Office supplies shop invoice

BUSINESS PARTNER NO.	INVOICE DATE	INVOICE NO.	PURCH ORDER NO.	TRANSACTION NO.	DISPATCH DATE	CARTONS
99999999	03.08.2020	111133098		125461087	03.08.2020	1

Brandon Parker
13 Anywhere Street
SOMEWHERE VIC 3000

DELIVER TO:
B. Parker
13 Anywhere Street
SOMEWHERE VIC 3000

Contact Name: B. Parker

PAYMENT METHOD:
MASTER CARD
****9999

Page 1 of 1

PRODUCT CODE	DESCRIPTION	QUANTITY ORDERED	QUANTITY SUPPLIED	UNIT PRICE INC. GST	TOTAL AMOUNT INC.GST
% CAP650XLBK	CAN PGI 650 XL BLACK INK	2	2	27.68	55.36

" Indicates item on back order and will be shipped separately
All products purchased through officeworks can be returned at any officework store Australia-wide

TOTAL GST	5.03
TOTAL INVOICE AMOUNT	55.36
AMOUNT OWING	0.00

c Local fruit and vegetable market invoice

FRESH BROCOLLI 3.63
0.91 kg @ $3.99 Per kg
SPIRNG ONIONS 1.29
LONG RED CHILLIES 1.17
0.09 kg @ $12.99 Per kg
JCS CASHEWS SALTED 500g 11.99*
ITEMS 4
SUBTOTAL 18.08
EFTPOS 18.08
G.S.T 1.09
* Indicates Items with GST
RECEIPT NO.2616991
CASHIER : LEONA 10/11/2021 12:07 PM

THANK YOU FOR SHOPPING WITH US
MON-TUES: 8:00AM- 5:00PM
WED- FRI 8:00AM-6:00PM
SAT 7:30AM-4:00PM SUN 7:30AM-4:00PM

Customer Receipt
- - - - - - - - - - - - - - - - -

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d Service station invoice

FuelStop

Welcome to FuelStop

Somewhere VIC 3000
PH: 03 9999 9999
Store ABN:
Fuel ABN: 11 222 333 444

TAX INVOICE

*P:4 PREMIUM 95 35.25L @ 1.759 $/L	$62.00
SALE TOTAL:	**$62.00**
EFTPOS:	$62.00
GST total in sale:	**$5.64**

BANK EFTPOS
BANK CUSTOMER COPY

e Telephone company invoice

ABN 11 222 333 444

TAX INVOICE FOR
BRANDON PARKER
PO BOX 999,
ANYWHERE VIC 3000

BILLING PERIOD
24 September - 23 October

BILL ISSUED
26 October 2021

ACCOUNT NUMBER
9999 99999 9999

BILL NUMBER
168 3353 154

CONTACT US
Help and Information Message us

For help with your bill, visit **phone.com/yourbill**

Experiencing Financial Hardship? If you need

YOUR PHONE BILL

Previous Balance	$0.00
Previous Bill	$65.00
Payments	$65.00 credit
Mobile 0411 126 824 Mobile Plan Medium	$65.00

TOTAL DUE
12 NOV 2021 **$65.00**
Includes GST of $5.91

To avoid a late fee of up to $15.00, please pay by the due date.

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8 Create tax invoices for the following scenarios.

a A wedding photographer provides their clients with packages including a video and photographs taken on the day.

The charges are as follows.

$1800 + GST for a basic package

$2400 + GST for a medium package

$3120 + GST for a top package

Ant and Sha McMarried choose the medium package.



b Ahmed runs the local fruit shop. He displays the prices in his shop inclusive of GST* where applicable. Mrs. Jones comes in and buys the following.

2 kg of tomatoes @ $6.50/kg

1 kg of Pink Lady apples @ 3.90/kg

1 dozen eggs @ $4.35/doz

1 packet of salted peanuts* @ $5.99

c James is a contractor. He charges his clients $65.00/hour + GST. He works for Shannon for 6 hours.

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8D Personal taxation and superannuation

Personal taxation

The financial year

The taxation system is based on the financial year, which in Australia is 1 July to 30 June. For example, the 2023–24 tax year started on 1 July 2023 and finished on 30 June 2024.

At the end of each tax year, we need to lodge a tax return that declares how much income we received during the year, how much tax we might have already paid through the PAYG system (see below) and whether we have any other amounts that are allowable deductions. From this, we may receive a tax refund (because we had paid more tax than we needed to during the year), or we might have to pay more tax (because we didn't pay enough during the year).

Why do we pay tax?

Personal tax is collected by the Australian Taxation Office (ATO) so that the government can provide goods and services for the community, such as education, social services, roads and bridges, national parks, health infrastructure, law and order, welfare and defence.



The federal government uses tax money to fund projects that benefit the community.

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Personal tax is paid on your taxable income. If you have a part-time job and earn a gross wage of more than $350 per week (in the 2023–24 financial year), your employer will have deducted personal tax from your wages and paid it to the ATO. If you earn less than $350 per week, you are below what is known as the tax-free threshold, and tax is not required to be paid.

In 2023–24, the tax-free threshold was $18 200. Note: 18 200 ÷ 52 = 350.

Taxable income and allowable deductions

Your **taxable income** is your gross income (less any allowable deductions). Taxable income can include the following items.

- Wages and salaries, including bonuses and overtime.
- Tips or other gratuities.
- Allowances that your employer pays you to cover things like using your car for work trips, purchasing protective clothing and uniform cleaning.
- Interest from bank accounts.
- Dividends from shares or other investments.
- Commission that a salesperson receives.
- Pensions
- Rent you receive from renting out a property to tenants.



You can claim specialised clothing as an allowable tax deduction if you are required to purchase and wear them by your employer.

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Some income doesn't need to be declared, including the following.

- Pocket money
- Money from selling items that you make as a hobby (unless you intend to turn it into a business)
- Inheritance
- Lottery or prize money
- Scholarships

An allowable deduction is an expense you must pay as part of your job. For example, if you have to purchase a special uniform to wear at work, you could claim the cost of the uniform as a deduction, and the cost of cleaning and maintaining the uniform (provided you keep a record of your costs). You are not, however, able to claim the cost of your travel to and from work, but you can usually claim travel from one workplace to another.

PAYG (Pay As You Go)

When your employer deducts (or withholds) an amount of tax from your wages every pay day, you are part of the **PAYG** system because you are paying tax *while* you earn your income. At the end of the year, your ATO Income Statement details how much you were paid in the year, and how much tax your employer withheld from your income. This system means that, when you lodge your tax return at the end of the financial year, you shouldn't have to pay any more tax (unless you have income that comes from outside your wages).

You can access your Income Statement through your MyGov account if the ATO is linked to your MyGov account.

Tax File Number (TFN)

Your tax file number is your personal reference number in the tax (and superannuation) systems. You should apply to the Australian Taxation Office for a tax file number as soon as you start working for wages. If you do not provide a tax file number, your employer has to withhold 47% of your pay, regardless of the tax you would usually pay.

Your tax file number stays with you for life, even if you move interstate or overseas. You should keep your tax file number secure. There are only a few people or places that can ask for your tax file number, so don't share it with anyone else. These include the following:

- Australian Taxation Office
- Centrelink
- Your bank or financial institution

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- Your employer **after** you start a job
- Your super fund
- Your registered tax agent.

Superannuation ('Super')

Superannuation, often called 'Super', is a way of saving for your future retirement. When you work for an organisation, your employer will pay an amount into a superannuation fund on your behalf, over and above your wage.

There are rules about how much your employer contributes to superannuation on your behalf. The Superannuation Guarantee rate has been increasing over recent years. It was 10% of your wages in 2021-22, and it is legislated to rise by 0.5% each year until it reaches 12% in 2025–26, where it will remain steady, unless the government changes the legislation.



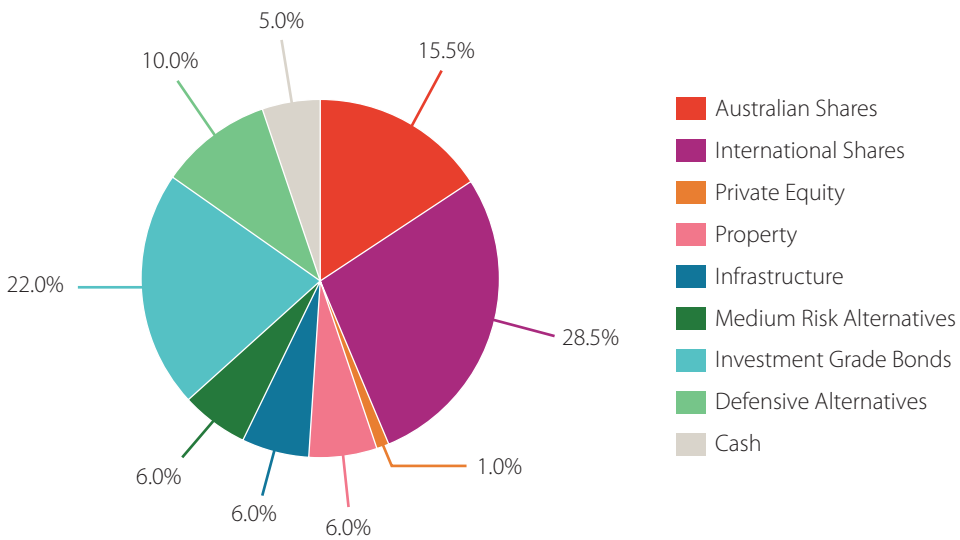
Enjoying life in retirement with an income from superannuation.

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Employers must pay super guarantee on payments they make to an employee under 18 years old if they work for you more than 30 hours in a week, regardless of how much they pay them. Their earnings amount is not relevant.

Financial year	Superannuation Guarantee Percentage
2020–21	9.5%
2021–22	10%
2022–23	10.5%
2023–24	11%
2024–25	11.5%
2025–26	12%

The super that your employer contributes on your behalf into a superannuation fund is joined with everyone else's contributions, and the fund invests this on behalf of its members. More than $3 trillion is held by the super funds. Your super balance grows from the contributions from your employer and through the returns that are made on the investments. The diagram shows a typical mix of asset types in a balanced superannuation fund.



Your superannuation contributions and earnings are kept in the fund until you retire (except under special circumstances). This period is known as the accumulation period, when the amount in your superannuation is normally expected to increase. Once you retire, you 'draw down' from the amount you have accumulated, to receive an income that is usually tax-free.

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Calculating personal tax

The Australian Government sets the tax rates. The 2023–24 tax rates are shown in the following table. The tax rates for the current year can be found on the ATO website. The taxable income levels are called **tax brackets**.

Taxable income	Tax on this income
0 – $18 200	Nil
$18 201 – $45 000	19 cents for each $1 over $18 200
$45 001 – $120 000	$5092 plus 32.5 cents for each $1 over $45 000
$120 001 – $180 000	$29 467 plus 37 cents for each $1 over $120 000
$180 001 and over	$51 667 plus 45 cents for each $1 over $180 000

This table is all you need to calculate tax on any income. Of course, you can use a tax calculator, such as the one provided on the ATO website, but learning to use the table will mean that you will be able to understand **how** tax is calculated.

Example 4 Calculating annual tax

Stavros earns $76 480 per year, working as a bricklayer. How much tax should he pay?

THINKING	WORKING
STEP 1	
Identify the taxable income bracket that Stavros's wages are in, using the tax table.	$45 001 – $120 000
STEP 2	
Calculate how many dollars Stavros earns *over* $45 000.	76 480 – 45 000 = $31 480
STEP 3	
Identify how much tax Stavros will pay for every dollar over $45 000 he earns – read the tax table for the $45 001 – $120 000 tax bracket.	32.5 cents for each $1 over $45 000.

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STEP 4	
Convert the cents into dollars (because all our working is in dollars) by dividing by 100.	32.5 ÷ 100 = 0.325
STEP 5	
Calculate how much tax Stavros will pay for every dollar over $45 000 he earns.	31 480 × 0.325 = $10 231
STEP 6	
Identify the base amount of tax Stavros will pay – read the tax table for the tax bracket.	$5092
STEP 7	
Add the base rate plus the amount of tax to pay for every dollar over $45 000 Stavros will pay.	10 231 + 5092 = $15 323
STEP 8	
Write the mathematical sentence that shows the calculation (remembering how BODMAS works).	(76 480 – 45 000) × 0.325 + 5092 = $15 323
STEP 9	
Include the units to make sense of the maths and write the answer in context.	Stavros will pay **$15 323** per year in tax on his wage of $76 480.

Calculating annual tax from a monthly, fortnightly or weekly wage

Remember that there are:

- 52 weeks in a year
- 26 fortnights in a year
- 12 months in a year
- 365 days in a year.

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Example 5 Calculating annual tax from a weekly wage

Joe earns $223.00 per week working part-time in a surf shop. Calculate the amount of tax he will pay annually if he earns the same amount every week.

THINKING	WORKING
STEP 1	
The tax tables are in annual units, so convert Joe's wage from weekly to yearly, for 52 weeks in a year.	223 × 52 = $11 596
STEP 2	
Identify the tax bracket that Joe's wages are in, using the tax table.	0 – $18 200
STEP 3	
Read the tax table to see how to calculate the tax.	*Nil* tax is payable for amounts up to $18 200.
STEP 4	
Joe owes no tax. Write the answer in context.	Joe will pay no tax annually.

While tax is withheld from your wages, the superannuation amount is **over and above** your wages. You don't receive the super money because it is paid directly into your super fund by your employer.



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Example 6 Calculating superannuation

It is June 2023. Max earns $53 000 per year as a trainee accountant. How much superannuation should Max's employer contribute to Max's super fund for that financial year?

THINKING	WORKING
STEP 1	
This is during the 2022–23 financial year, so check the superannuation guarantee percentage for that year.	From the table above, we can see that the percentage is 10.5%.
STEP 2	
Calculate 10.5% of $53 000 Write the mathematical sentence.	$10.5 \div 100 \times 53\,000 = \$5565$ On a smartphone calculator: $10.5\% \times 53\,000 = \$5565$
STEP 3	
Make sense of the maths by including the units and writing the answer in context.	Max's employer should contribute $5565 in total to Max's super fund in 2022–23.

8D Tasks and questions

Thinking tasks

1 List as many goods as services as you can think of that are provided by different levels of government.

Categorise these goods and services by the level of government that provides them – Local Government (Council or Shire), State Government, or Federal Government.

Now list as many sources of income for the different levels of government that you can think of.

Categorise these sources of income by the level of government that collects them.

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Skills questions

2 Jasmine worked in her casual job for 60 hours in one pay period over the school holidays. She received the following payslip. Use the payslip to answer the questions below.

PAYSLIP

Employee: Jasmine Lee
Employee ID: 603427
Status: Casual
Rate of Pay: $18.65 per hour

Date: 28/02/2023
Pay period: 13/02/2023 – 26/02/2023

	Hours	Rate	Total
Wages for ordinary hours worked	60	$18.75	$1125.00
	Total gross		$1125.00
Taxation			$80.75
	Total		$1044.25
Deductions			$20.50
	Total net		$1023.75
Paid to Bank 063 111 Account 123 456 78			

Summary	This period	Year to date
Total Gross	$1125.00	$5178.00
Taxable Gross	$1125.00	$5178.00
Tax	$80.75	$100.30
Net income	$1044.25	$5077.70
Deductions	$20.50	$25.90
Total	$1023.75	$5051.80

a The pay period is for one:

A week **B** fortnight **C** month **D** year

b Tax is calculated on the:

A gross pay **B** net pay **C** deductions **D** total net pay

c Jasmine's take home pay is:

A $1125.00 **B** $1044.25 **C** $20.50 **D** $1023.75

d The net pay is calculated by:

A gross pay + tax **C** gross pay – tax – deductions

B gross pay – tax **D** hours × rate

e The deductions are subtracted from:

A gross pay **B** before-tax pay **C** after-tax pay **D** net pay

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3 Which financial year do the following dates belong to?

a 31 March 2024 **b** 5 September 2024 **c** 30 June 2023 **d** 1 July 2023

4 Classify the following sources of income as assessable or non-assessable income.

a Jin won $476.00 from a Tattslotto ticket.

b Ravi worked in his family's bakery during the school holidays for wages.

c Ahn great-aunt left them $10 000 in her will.

d Tarkin worked as a waitperson and received $50 in tips.

e Rijit takes photographs as a hobby and sells some of the photos he shoots.

5 Use the 2021–22 tax table given previously to calculate the annual tax on the following annual incomes.

a $47 950 **b** $235 000 **c** $15 000 **d** $23 350

6 Use the 2021–22 tax table given previously to calculate the annual tax on the following incomes. Assume that the person earns the same amount each pay period for the year.

a Jack gross wages are $375 a week as an apprentice carpenter.

b Harley has just started work as a kindergarten assistant. His gross pay is $575 per fortnight.

c Thomas earns $2022.69 gross per fortnight.

7 Imagine it is 2 February 2022. How much superannuation should be contributed by the employer for an employee earning the following.

a $34 256 per year (Give your answer per year.)

b $863.27 per week (Give you answer per week.)

c $1209.43 per fortnight (Give your answer per fortnight.)

d $89 450 per year (Give your answer per month.)

e $89 450 per year (Give your answer per week.)

f $785.15 per week (Give your answer per year.)

8 If Annabelle paid $2022 one year in tax, which tax bracket would her income be in?

9 How much tax would a person earning exactly $120 000 in a year pay? Hint: You can read the amount straight from the table.

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Mathematical literacy

10 Brainstorm different words that are used for

Personal tax	Income	Deductions

Application tasks

11 Jia had the following income in 2021–22.

- $14 476 from her part-time job.
- $120.00 from a term deposit account that her Grandmother gave her.
- $2 000 that her Great-uncle left her.

She also had the following expenses:

- $75.00 to buy a uniform for her job

a Classify Jia's income into assessable and non-assessable income.

b Can Jia claim the $75.00 as an eligible deduction?

c How much is Jia's assessable income?

d Which tax bracket does Jia's income fall into?

e How much tax should Jia pay?

12 It is March 2022. Remy is 17 and works a part-time job in a big retail store. She is paid casual rates of $15.27 per hour from Monday to Saturday, and $21.63 per hour on Sunday. Every week she works the following hours.

Day	Hours worked	Rate	Pay
Friday	3	$15.27	$45.81
Saturday	4		
Sunday	5		
		Total	

a Fill in the rate for Saturday and Sunday and calculate the pay for those days.

b Calculate Remy's pay for the week.

c Calculate Remy's tax for that week.

d Does Remy's employer have to contribute to Remy's superannuation? Why or why not?

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13 An Income Statement from the ATO provides information on a person's earnings from one employer for a financial year. It is an official document that is used when a person (or their tax agent or accountant) prepares their tax return. Glance through it, then look more closely to answer the following questions. Discuss the answers with a classmate.

Australian Government
Australian Taxation Office

Name BRANDON PARKER
TFN 123 456 789

Income statements

Status	Tax ready
Employee number	92A23389FE942A2E652F2F31389B9
Financial year	2020 – 21
Employer	ANY ORGANISATION ANYWHERE
Branch	001
Employer ABN/Branch	84 627 957 637 / 001
BMS/ID	E3213458-53D5-4EC5-849A-C28189C07950
Period	04/09/20 – 30/06/21
Reported date	05/07/2021
Income	
Gross payments individual	$21 759.00
Tax withheld or foreign tax paid	
PAYG withholding – individual	$2683.00
Lump sum amounts	
Lump sum payment A	$0.00
Lump sum payment B	$0.00
Lump sum payment C	$0.00
Lump sum payment D	$0.00
Allowances	
Total	$0.00
Deductions	
Total	$0.00
Employer reported super	
Employer superannuation contribution liability	$2067.12
Ordinary time earnings	$21 759.00

Where you have an entitlement to super contributions, your employer must pay super into your fund at least quarterly. Check your super fund for payments made by your employer.

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a Whose Income Statement is this?

b What is the person's tax file number?

c Which financial year is this statement for?

d What was the person's gross wage for this financial year?

e Calculate the tax, based on the tax table below. Is the tax amount that has been withheld the correct amount of tax for this gross wage?

Taxable income	Tax on this income
0 – $18 200	Nil
$18 201 – $45 000	19 cents for each $1 over $18 200
$45 001 – $120 000	$5092 plus 32.5 cents for each $1 over $45 000
$120 001 – $180 000	$29 467 plus 37 cents for each $1 over $120 000
$180 001 and over	$51 667 plus 45 cents for each $1 over $180 000

f How could this have occurred?

g How much superannuation was contributed by Brandon's employer?

Hint What does the period on the statement refer to? (Even though Brandon was only employed for part of the year, his monthly earnings were taxed based on his annual salary. Brandon might have more than one job, and not claimed the tax-free threshold with this employer.)

h Which number is the superannuation based on?

i Can you tell from any of these numbers what the superannuation percentage was in 2020–21? If so, calculate the percentage.

j Is the percentage you calculated correct, based on the superannuation guarantee percentage table given previously?

k What indicates that this Income Statement is complete and ready to be used when a tax return is lodged?

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8E Interest, loans, time and risk

Interest in financial mathematics is *not* how much you enjoy or are fascinated by something!

Interest is either:

- the money that is *charged* if you borrow money from a bank

or

- the money that you *earn* from saving your money in a bank or financial institution.

Interest and loans

When you borrow money from a friend, you would expect that you would pay them back the same amount that you borowed. Banks and financial institutions, however, are not your friends. When they lend you money, there is a cost involved for them providing you with this money-lending service. That cost or charge is called **interest**.

A **loan** is when you borrow money.

The amount that you borrow is called the **principal**.

The percentage that you pay on top of the principal is called the **interest**.

Interest is calculated by using percentages. A **percentage** of the money that you borrow is added *on top* of the amount you borrow, which you will need to pay back.

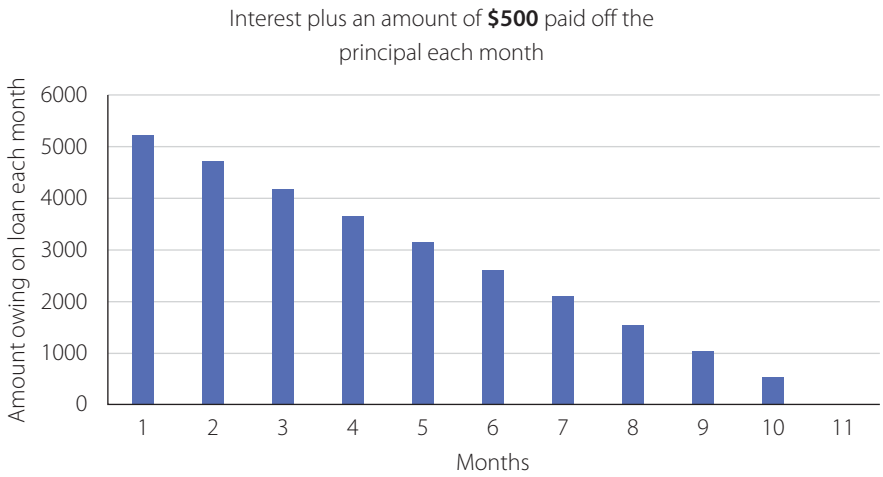
It gets more complicated than that, however. Interest is usually charged at regular intervals (weekly, monthly or yearly) and is payable on the amount that is still owing.

Therefore, if you pay off your loan quickly, with higher repayments each month, you will pay **less** in interest over time.

If you pay off your loan slowly, with lower repayments each month, you will pay **more** in interest over time.

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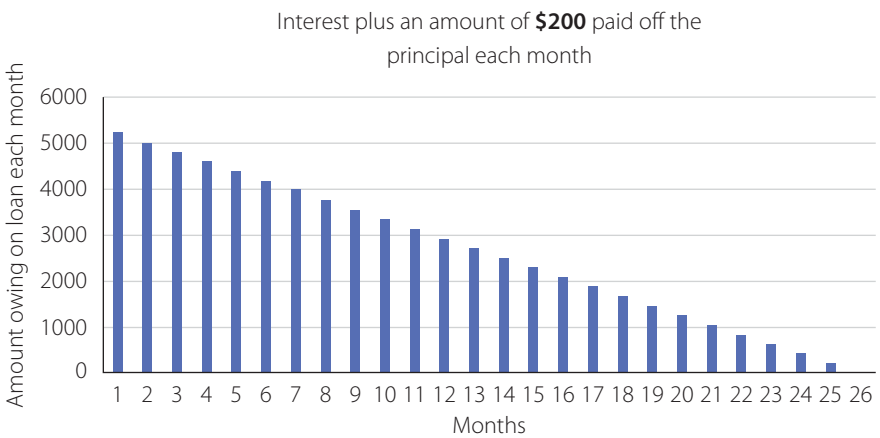
Let's look at an example of a loan of $5000, first with higher repayments each month ($500) and then with lower repayments per month ($200).



This loan is for $5000. The interest plus an amount of $500 towards the principal is repaid each month.

The total cost of this loan is $6375, and it will take 10 months to pay off.

Now let's look at the impact of paying off the loan more slowly.



This loan is also for $5000.

But for this loan, the interest plus an amount of $200 towards the principal is repaid each month.

The total cost of this loan is $8250, and it will take 25 months to pay off.

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The length of a loan is called the **term**. The term of a loan is determined at the start and is agreed to by the customer and the lender. The full amount of money including all interest payments must be made by the end of the loan. If the loan is not repaid, the lender can take legal action to cover their losses, according to the loan agreement.



Interest rates and risk

Interest rates come in the following two forms.

1. **Fixed interest rate** – This is when the percentage rate of interest that you pay is fixed for the length of the loan and doesn't change.
2. **Variable interest rate** – These interest rates are set by the market – it is up to the banks or financial institutions to set the percentage rates of interest for their customers. The interest rate will vary over the length of the loan.

Example of a table comparing interest rates

Mortgage type	Bank 1	Bank 2	Bank 3	Bank 4
1-year fixed	2.09%	1.99%	2.09%	2.04%
2-year fixed	1.94%	1.79%	1.89%	2.04%
3-year fixed	2.14%	1.88%	1.98%	2.04%
4-year fixed	2.19%	1.89	1.98%	2.24%
5-year fixed	2.99%	2.19%	2.24%	2.24%
Variable	2.69%	2.69%	2.69%	2.72%

Choosing a loan has an element of **risk.** If you choose a fixed interest rate for the life of the loan at 4% and the variable interest rate goes down to 2%, then you will pay a lot more money over the term of the loan than if you had chosen the variable interest rate.

Alternatively, if you choose a variable interest rate at 2% at the start of the loan and the interest rate goes up to 8%, you will pay a lot more money than if you had chosen the fixed rate of 4%.

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Types of interest, and how to calculate them

There are two main types of interest that can be applied to a loan.

1. **Simple interest** – This is calculated on the principal amount that is borrowed from the loan.
2. **Compound interest** – This is calculated on the total amount owing each month on a loan. This means, if you do not sufficiently reduce the amount of principal, you will pay interest on the interest!

Simple interest



To calculate the simple interest paid on a loan we use the following formula.

$$I = \frac{PRT}{100}$$

That is:

$$\text{interest} \longrightarrow I = \frac{PRT}{100}$$

P: principal
R: interest rate
T: time (in years)
$\div$ by 100 to convert rate % to a decimal

Think about what this formula is saying about the way interest works.

- If you borrow more money, the value of P is increased, so you pay more interest.
- If the loan rate is higher, the value of R is increased, so you pay more interest.
- If you have the loan for a longer time, the value of T is increased, so you pay more interest.

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Example 7 Calculating simple interest

A loan of $8000 is taken to buy a second-hand car.
The simple interest rate is 8% per annum, and the loan is for 4 years.
How much interest will you pay?
How much will you pay for the loan in total?

THINKING	WORKING
STEP 1	
Write the formula, and then list everything you know.	$I = \frac{PRT}{100}$ $I = ?$ $P = \$8000$, $R = 8\%$, $T = 4$ years
STEP 2	
Substitute the numbers into the formula.	$I = \frac{8000 \times 8 \times 4}{100}$ $I = \$2560$ On a smartphone calculator: $8000 \times 8\% \times 4 = 2560$
STEP 3	
Add the Principal and Interest to find the total amount you will pay for the loan ($\$A$).	$A = P + I$ $P = \$8000$, $I = \$2560$ So $A = 8000 + 2560$ $A = \$10\,560$
STEP 4	
Make sense of the maths by including the units and writing the answer in context.	The interest on the loan is $2560 and the total loan repayments are $10 560.

Note: You have paid $10 560 for a car that is now 4 years older and worth less than the original $8000.
You could easily use a spreadsheet to undertake the above interest calculations.

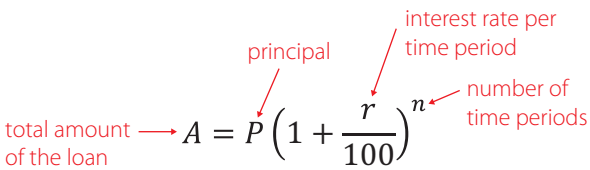
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Compound interest

To calculate the compound interest paid on a loan we use the following formula.

$$A = P\left(1+\frac{r}{100}\right)^n$$

Where:



Example 8 Calculating compound interest

A loan of $10 000 is taken to buy a motorbike.
The compound interest rate is 6% per annum (which means, per year) and the loan is for 5 years.
How much interest will you pay?
How much will you pay in total?

THINKING	WORKING
STEP 1	
Write the formula and then list everything you know.	$A = P\left(1+\frac{r}{100}\right)^n$ $A = ?$ $P = \$10\,000$, $r = 6\%$, $n = 5$ years
STEP 2	
Substitute the numbers into the formula to find the total amount of the loan. (Rotate a smartphone calculator to access the scientific functions for brackets, or use a spreadsheet to do the calculations for you).	$A = 10\,000 \times \left(1+\frac{6}{100}\right)^5$ $A = 10\,000 \times (1.06)^5$ $A = \$13\,382.26$
STEP 3	
Subtract the amount of the Principal to find the Interest you will pay in total over the 5 years.	$A = P + I$ therefore $I = A - P$ $A = \$13\,382.26$, $P = \$10\,000$ $I = 13\,382.26 - 10\,000$ $I = \$3382.26$

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STEP 4

Make sense of the maths by including the units and writing the answer in context.	The interest on the loan is $3382.26 and the total repayments are $13 382.26.

Loan sharks



Be aware! There is a reason why some money lenders are called 'loan sharks'. These loans might be 'pay day' loans or short-term 'get out of trouble' loans. But when you do the maths, the interest paid may be extraordinarily large, compared to the original loan. Instead of getting you out of trouble, they may just delay the trouble and then make it worse!

The internet has some great loan calculators and apps that help you calculate the cost of loans. Understanding how a loan is calculated, however, and the different types of calculations that are used will empower you to make better decisions when it comes to considering loans in the future!

8E Tasks and questions

Thinking task

1 Using the internet, search for loan calculators.

- **a** Find several different loan calculators and note down the organisations behind them.
- **b** Do they all give the same result? How do they present the information? Which calculator do you now think is the best for you and why?
- **c** Choose three loan calculators from your selection to examine. Enter a loan of $400 000 for 25 years at 3% interest.
- **d** Which loan calculator do you think is the best? Give reasons for this decision.

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Skills questions

2 For the short-term **simple interest** loans shown below, calculate the following.

i The interest charged.

ii The total amount of the loan.

a $1000 for 1 year at 12%

b $10 000 for 1 year at 12%

c $2000 for 1 year at 8%

d $2000 for 1 year at 5%

e $2000 for 1 year at 20%

f $4000 for 1 year at 8%

3 For the short-term **simple interest** loans shown below, calculate the following.

i The interest charged.

ii The total amount of the loan.

a $3000 for 4 years at 6% p.a. (p.a. means per annum, which is per year)

b $6000 for 2 years at 5% p.a.

c $2000 for 2 years at 11% p.a.

d $1000 for 2 years at 20% p.a.

e $4500 for 2 years at 8% p.a.

f $9000 for 4 years at 14% p.a.

4 For the **compound interest** loans shown below, calculate the following.

i The total amount of the loan.

ii The total amount of interest charged for the loan.

a Principal of $4000
Interest rate of 4% p.a.
Term of 1 year

b Principal of $6000
Interest rate of 4% p.a.
Term of 1 year

c Principal of $12 000
Interest rate of 5% p.a.
Term of 1 year

d Principal of $20 000
Interest rate of 3% p.a.
Term of 1 year

e Principal of $1000
Interest rate of 4% p.a.
Term of 1 year

f Principal of $5000
Interest rate of 4% p.a.
Term of 1 year

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5 For the **compound interest** loans shown below, calculate the following.

i The total amount of the loan.

ii The total amount of interest charged for the loan.

a Principal of $80 000
Interest rate of 4% p.a.
Term of 3 years

b Principal of $400 000
Interest rate of 4% p.a.
Term of 20 years

c Principal of $500 000
Interest rate of 4% p.a.
Term of 25 years

d Principal of $35 000
Interest rate of 5% p.a.
Term of 25 years

e Principal of $200 000
Interest rate of 6% p.a.
Term of 15 years

f Principal of $800 000
Interest rate of 5% p.a.
Term of 25 years

Mixed practice

6 Find for each of the loans shown below, find the following.

i The total amount of the loan.

ii The total amount of interest charged for the loan.

a A simple interest loan of $500 at 22% for 1 year.

b A compound interest loan with a principal of $300 000 at 3% for 20 years.

c A simple interest loan of $90 000 for 4 years with an interest rate of 3%.

d A compound interest loan of $90 000 for 4 years with an interest rate of 3%.

e A simple interest rate of 30% for a 6-months loan of $2000.

f A compound interest loan of $800 000 for 30 years with an interest rate of 5.5%.

Mathematical literacy

7 Make a presentation explaining how a loan works. Include the following words: *loan, interest, interest rate, term,* and *repayments.* Present your information to the class.

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Application tasks

8 Investigate on the internet at least three loans which allow you to **borrow the principal amount of $10 000 for 2 years**. Make a table to compare the loans.

- **a** What is the type of interest offered? Simple or compound?
- **b** What are the stated interest rates for each loan?
- **c** What is the total cost of each loan (interest plus principal)?
- **d** Was it difficult to find the total cost of each loan (interest plus principal)? Give three reasons why this information may be difficult to find.
- **e** What are the disadvantages of these loans?
- **f** What are the possible long-term consequences of these types of loans?

9 Investigate on the internet at least three loans which allow you to **borrow the principal amount of $500 000 for 25 years.** This type of loan may be for a house or apartment and is called a **mortgage**. Make a table to compare the loans.

For this task, look only at **fixed** interest rates. Fixed rates are sometimes given for a shorter period of time, such as 2 years. Assume that the rate can be extended for the term of the loan.

You may want to use a mortgage calculator from the internet to help with your calculations.

- **a** What are the stated interest rates for each loan?
- **b** What is the total cost of each loan (interest plus principal)?
- **c** How much interest will you pay over the life of the loan, for each loan you are investigating?
- **d** Was it difficult to find the total cost of each loan (interest plus principal)? Give three reasons why this information may be difficult to find.
- **e** What are the disadvantages of these loans?
- **f** What are the possible long-term consequences of these types of loans?
- **g** Which loan is the best deal in your opinion and why?

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8F Instalments

In most cases, loans are paid back in **instalments**. The total cost of the loan (interest plus principal) is divided into equal parts – called instalments – that are paid regularly over the period of the loan. The sum of the instalments adds up to the total cost of the loan.



The size of the instalments is dependent on the length of the loan.

If the loan is for a longer period of time, then each instalment will be a lesser amount.

Likewise, if the loan is shorter in time, then each instalment will be a greater amount.

Interest is usually charged at regular time intervals, however, so the longer the loan, **the more interest you will pay.**

Some things to consider when choosing the length of a loan are as follows.

- Does a longer loan have a higher interest rate?
- With a longer loan, you will be in debt for longer. Is this a problem?
- Is the interest rate fixed for a short period of time? Will interest rates go up over the length of the loan?
- Will the loan be more expensive if it has a longer term?
- What are the **discharge conditions and fees** (these are the fees you need to pay if you choose to pay the loan off sooner – or later)?

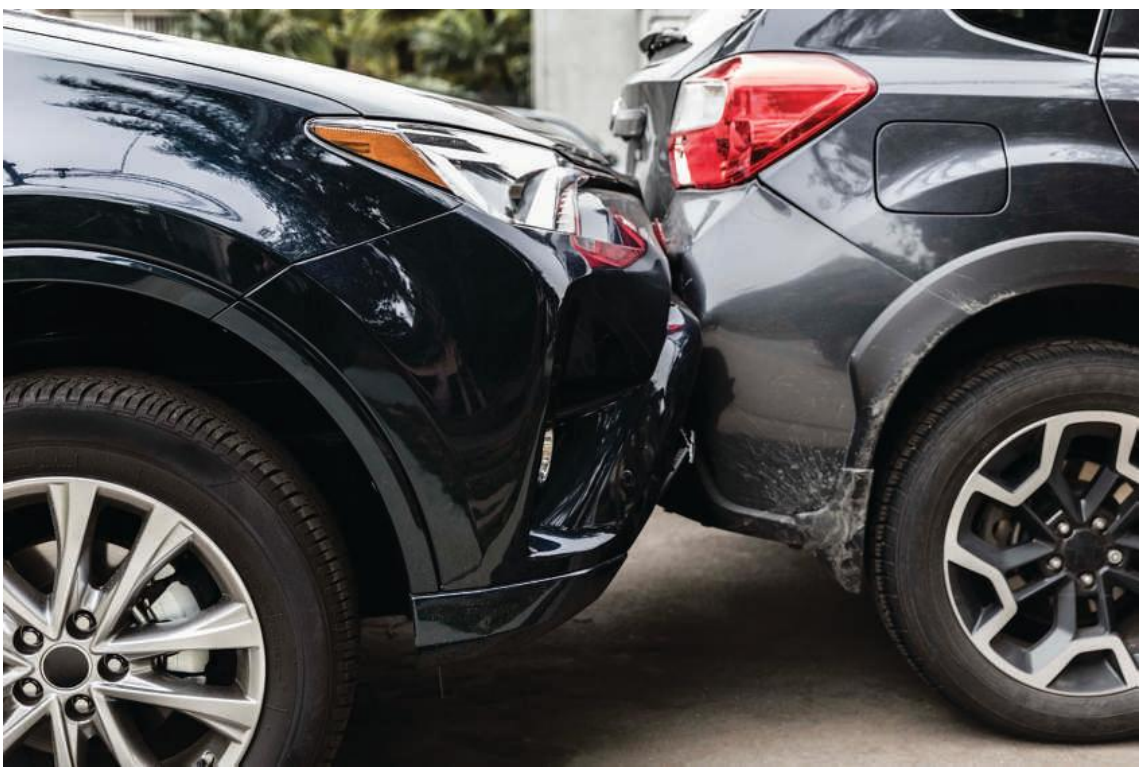
There is **risk** involved with any decision regarding a loan. With an educated and informed opinion, you are better placed to make decisions about which loan is best for you.

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Example 9 Calculating time

Sophie has a small accident in her parents' car. She is only 18 years old so the excess on the insurance is $1600. Sophie borrows this amount, interest free, from her parents. She agrees to pay them back $100 each week.
How many weeks until Sophie has re-paid the loan?

THINKING	WORKING
STEP 1	
Write down what you know mathematically.	Loan = $1600 Instalments = $100 Time period = weekly
STEP 2	
Divide the total amount of the loan by the value of one instalment.	$\frac{1600}{100} = 16$ This is 16 weeks which is roughly 4 months.



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Example 10 Calculating instalments

Tarquin borrows $21 799 on an interest-free loan to purchase tools for work. The terms of Tarquin's loan state that once he finishes the apprenticeship he must repay the loan with monthly instalments within 5 years. As Tarquin completes the apprenticeship, a 20% discount is applied.
How much does Tarquin repay each month?

THINKING	WORKING
STEP 1	
Write down what you know mathematically.	Loan = $21 799 Discount = 20% Term = 5 years = 5 years × 12 months = 60 months
STEP 2	
Think: a 20% discount means that Tarquin pays 80% of the loan. Find 80% of $21 799.	$21\,799 \times \frac{80}{100}$ Tarquin owes = $17 439.20 On a smartphone calculator: 21 799 × 80% = 17 439.20
STEP 3	
Divide the total amount that Tarquin owes by the number of months.	$\frac{17\,439.20}{60} = 290.65$ Tarquin's repayments are $290.65 each month.

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Example 11 Calculating instalments with simple interest

Dep takes out a simple interest loan of $2000 to pay for a holiday. The interest rate is 7% per annum and instalments must be repaid monthly, with the loan discharged within 2 years.
Calculate the following.

a The interest over the term of the loan.
b The total amount of the loan (interest plus principal).
c The monthly instalments.

THINKING	WORKING
STEP 1 Write the simple interest formula, and then list everything you know.	$I = \frac{PRT}{100}$ $I = ?$ $P = \$2000$, $R = 7\%$, $T = 2$ years
STEP 2 Substitute the numbers into the formula.	$I = \frac{2000 \times 7 \times 2}{100}$ $I = \$280$
STEP 3 Add the Principal and Interest to find the total amount to be paid.	$A = P + I$ $P = \$2000$, $I = \$280$ $A = 2000 + 280$ $A = \$2280$
STEP 4 Divide the total amount that Dep owes by the number of months (there are 24 months in 2 years).	$\frac{2280}{24} = 95$ Dep's repayments are $95 each month.
STEP 5 State the answers clearly.	**a** The interest over the term of the loan is $280. **b** The total amount of the loan (interest plus principal) is $2280. **c** The monthly instalments are $95.

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8F Tasks and questions

Thinking task



1 Think about the different ways of paying for a new games console. You really, really want this new console! All your friends have one. It's on sale and normally retails for $650. The trouble is, you only have $130 in savings that you can spare.

Discuss with your class the advantages and disadvantages of the three different payment options listed below. You may want to include additional options.

The new games console sale price is $479.00. (RRP $650.00)

Option 1: Save up until you can afford it.

Option 2: Use a buy now-pay later service at 18% p.a. for the first year, and 45% thereafter.

Option 3: Use a credit card which is interest-free if you pay the amount in full within one month, otherwise it defaults to 24%.

Skills questions

2 How long will it take to repay the following interest-free loans.

- **a** A loan of $1000 with $50 instalments.
- **b** A loan of $750 with $75 instalments.
- **c** A loan of $240 with $30 instalments.
- **d** A loan of $468 with $45 instalments.
- **e** A loan of $388 with $40 instalments.
- **f** A loan of $20 000 with $150 instalments.
- **g** A loan of $20 000 with $50 instalments
- **h** A loan of $20 000 with $250 instalments.

3 Divide the following amounts into instalments. There is no interest for these amounts.

- **a** A principal of $90 paid weekly over 3 weeks.
- **b** A principal of $500 paid weekly over 8 weeks.

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c A principal of $6500 paid monthly over 12 months.

d A principal of $4000 paid monthly over 1 year.

e A principal of $4000 paid monthly over 2 years.

f A principal of $4000 paid monthly over 4 years.

g A principal of $24 000 paid monthly over 6 years.

h A principal of $250 000 paid monthly over 20 years.

i A principal of $500 000 paid monthly over 25 years.

j A principal of $900 000 paid monthly over 25 years.

4 Calculate the following for the simple interest loans shown below.

i The interest over the term of the loan.

ii The total amount of the loan (interest + principal).

iii The **monthly** instalments.

a A loan with a principal of $10 000 at an interest rate of 18% per annum, payable within 4 years.

I = ?

P = $10 000

R = 18%

T = 4 years

b A loan with a principal of $5000 at an interest rate of 14% per annum, payable within 2 years.

I = ?

P = $5000

R = 14%

T = 2 years

c A loan with a principal of $65 000 at an interest rate of 5% per annum, payable within 6 years.

I = ?

P = $65 000

R = 5%

T = 6 years

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d A loan with a principal of $8000 at an interest rate of 14% per annum, payable within 12 years.

I = ?

P = $8000

R = 14%

T = 12 years

e A loan with a principal of $250 000 at an interest rate of 5% per annum, payable within 20 years.

I = ?

P = $250 000

R = 5%

T = 20 years

f A loan with a principal of $6000 at an interest rate of 18% per annum, payable within 3 years.

I = ?

P = $6000

R = 18%

T = 3 years

5 Find the repayments each month for the following traineeship and apprenticeship loans. These loans have a 20% discount if the apprenticeship or traineeship is completed. Apply the 20% discount to each of the following questions. These loans have no interest applied.

a A loan of $18 000 over 10 years.

b A loan of $18 000 over 5 years.

c A loan of $18 000 over 3 years.

d A loan of $21 000 over 10 years.

e A loan of $21 000 over 5 years.

f A loan of $24 000 over 10 years.

g A loan of $24 000 over 5 years.

6 Calculate the following for the simple interest loans shown below.

i The interest over the term of the loan.

ii The total amount of the loan (interest + principal).

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iii The **monthly** instalments.

- **a** A loan of $4000 at 6% for 2 years.
- **b** A loan of $19 000 at 2% for 4 years.
- **c** A loan of $19 000 at 8% for 4 years.
- **d** A loan of $19 000 at 14% for 4 years.
- **e** A loan of $8500 at 5% for 3 years

Mixed practice

7 Answer the following questions about loans and repayments.

- **a** How long will it take to repay a loan of $8000 with $70 instalments.
- **b** Applying a 20% discount, find the monthly repayments for a loan of $19 500 for a term of 6 years.
- **c** What is the monthly instalment on a principal of $22 000 over 6 years?
- **d** How long will it take to repay a loan of $975 with $40 instalments.
- **e** Calculate the instalments for a simple interest loan of $17 000 at 14% over 3 years.
- **f** How long will it take to repay a loan of $2075 with $120 instalments.
- **g** Applying a 20% discount, find the monthly repayments for a loan of $23 000 for a term of 10 years.
- **h** What is the monthly instalment on a principal of $6900 over 2 years?

Mathematical literacy

8 Explain the concept of borrowing to someone, including *interest rates, time, risk* and *instalments*.

Application tasks

9 Read the information in the table below.

Loan amount	Loan term	Interest rate	Monthly repayment	Total interest cost
$10 000	5 years	6.93%	$198	$1861
$10 000	7 years	6.93%	$151	$2649
$10 000	10 years	6.93%	$116	$3890

Date: 24/5/2021. Based on secured personal loans available for a loan of $10 000 and loan term of 5 years. Assuming a P&I loan, repaying monthly. Average interest rate calculations use the midpoint of the rate range.

Source: www.canstar.com.au

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a What is the monthly repayment on the $10 000 loan over 7 years?

b What is the monthly repayment on the $10 000 loan over 10 years?

c What is the total cost of interest on the $10 000 loan over 5 years?

d What is the total cost of interest on the $10 000 loan over 7 years?

e If you pay $3890 in total interest, what is the length of the loan?

f If you pay $198 per month, what is term of the loan?

10 Imagine you buy a studio apartment and take out a mortgage for $250 000. The interest is at a 4% fixed rate. Using a mortgage calculator, complete the following table for a mortgage loan. Mortgage calculators can be found online.



Loan term	Monthly repayment	Monthly interest	Weekly repayment (assume /4)	Yearly repayment	Total repayment over life of loan (Principal + Interest)	Total interest over life of loan (Total – Principal)
15 years						
20 years						
25 years						
30 years						

11 Imagine you buy a unit and take out a mortgage for $450 000. The interest is at a 4% fixed rate. Using a mortgage calculator, complete the following table for a mortgage loan. Mortgage calculators can be found online.

Loan term	Monthly repayment	Monthly interest	Weekly repayment (assume /4)	Yearly repayment	Total repayment over life of loan (Principal + Interest)	Total interest over life of loan (Total – Principal)
15 years						
20 years						
25 years						
30 years						

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12 Imagine you buy a house and take out a mortgage for $650 000. The interest is at a 4% fixed rate. Using a mortgage calculator, complete the following table for a mortgage loan. Mortgage calculators can be found online.

Loan term	Monthly repayment	Monthly interest	Weekly repayment (assume /4)	Yearly repayment	Total repayment over life of loan (Principal + Interest)	Total interest over life of loan (Total – Principal)
15 years						
20 years						
25 years						
30 years						

13 Considering each of the questions above, what weekly, monthly and yearly income would you need to service (pay for) these loans? You might want to factor into your decision the costs of living (such as food and transport) – make sure you still have enough money to live on once the repayments have been deducted.

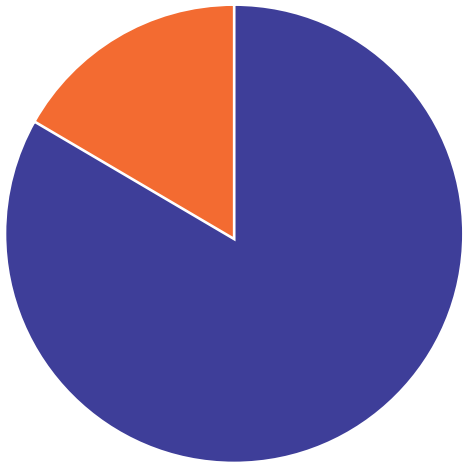


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8G Student loans

Have you considered studying at TAFE or university after you finish Year 12? The Australian Government may help you afford to study by paying the fees for the units you take. When you finish your course, get a job and are earning above a certain income, you start paying back the loan to the government.

The amount you owe the government is usually referred to as your **HECS debt**. HECS stands for the Higher Education Contribution Scheme, and it refers to the payment that the government expects you to make towards the cost of your tertiary education.



In a course with Commonwealth Supported Places (CSP), the Australian Government subsidises the fees for students. The government contributes the blue portion towards each unit and expects the student to contribute the orange portion. A student can choose to pay these fees **up front** *or* **defer** *the payment by taking out a HELP loan.*

To be able to borrow the money from the government, you must be an Australian citizen and enrolled in a course that has Commonwealth Supported Places, which is the official name for the tertiary places that the Australian Government subsidises.

Your tertiary institution will inform you if the course you undertake has commonwealth supported places. If a course does not offer commonwealth supported places, or you are not an Australian citizen, you will be expected to pay the full fees for the course.

Every course has a maximum amount that can be borrowed, and you need to pass at least 50% of your course each year to be eligible to borrow more the following year.

You can find out about the various government funding and loans available when you study through Study Assist (www.studyassist.gov.au).

How a HECS-HELP loan works

Although we usually refer to a HECS debt, the amount owing is officially a Higher Education Loan Program (HELP) debt. You will often see it called a HECS-HELP or VET-HELP loan or debt, particularly if you look at government websites.

These loans are different to loans you might get from a bank or other financial institution in three ways.

- Firstly, there is a limit on how much any individual can receive from HELP. In 2023, this limit was set at $113 028 (although there is a higher limit for some approved courses, e.g., Medicine).

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- Secondly, no interest is charged on a HELP loan. Any debt older than 11 months, however, is **indexed up** on 1 June each year in line with the Consumer Price Index (CPI) so that it maintains its relative value.
- Thirdly, you do not start repaying a HELP loan back until your annual income is above a certain amount, set by the government. In 2023, this compulsory repayment threshold was $51 550.

The Australian Taxation Office is responsible for collecting your HELP loan repayments when you complete your annual tax return. Your employer needs to know if you have a HELP loan so that they can withhold appropriate tax deductions from your salary or wages.

The following table from the ATO website shows the HELP repayment thresholds and rates for 2023–2024:

Repayment income (RI)	Repayment rate
Below $51 550	Nil
$51 550 – $59 518	1.0%
$59 519 – $63 089	2.0%
$63 090 – $66 875	2.5%
$66 876 – $70 888	3.0%
$70 889 – $75 140	3.5%
$75 141 – $79 649	4.0%
$79 650 – $84 429	4.5%
$84 430 – $89 494	5.0%
$89 495 – $94 865	5.5%
$94 866 – $100 557	6.0%
$100 558 – $106 590	6.5%
$106 591 – $112 985	7.0%
$112 986 – $119 764	7.5%
$119 765 – $126 950	8.0%
$126 951 – $134 568	8.5%
$134 569 – $142 642	9.0%
$142 643 – $151 200	9.5%
$151 201 and above	10%

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Example 12 Calculating the amount of a HELP loan to be repaid in a tax year

Jody studied at a Victorian university for three years in a Commonwealth Supported Place and elected to pay for her units with a HELP debt. She graduated 18 months ago with an Accounting degree and found a job as a trainee accountant. When she completed her tax return, her taxable income in 2023–24 was $58 675. Will she have to make a repayment of her HELP debt in 2023–24? If so, how much will this repayment be?

THINKING	WORKING
STEP 1	
Use the table provided on the previous page to check the repayment threshold.	Jody's taxable income is in the range $51 550 – $59 518. The repayment % rate for this range is 1% of the taxable income.
STEP 2	
Apply the percentage repayment rate to Jody's taxable income.	Find 1% of $58 675. On a smartphone calculator: 58 675 × 1% = 586.75
STEP 3	
Round the answer to whole dollars.	587
STEP 4	
Include the units to make sense of the maths and write the answer in context.	Jody needs to make a repayment towards her HELP debt in 2023–24. She will pay $587.



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Example 13 Calculating the amount of a HELP loan to be repaid in a tax year

Thomas graduated with an Environmental Science degree after studying for four years at a Victorian university. He had a HELP loan for his course. Since graduating, he has had short-term casual work projects with periods of no full-time work in between. His employers have deducted HELP repayments from his wages when he has been employed.
During the 2023–24 financial year, Thomas's taxable income was $43 289. Will Thomas have to make a repayment on his HELP loan? If so, how much will it be? If not, what happens to the amount deducted by his employer?

THINKING	WORKING
STEP 1	
Use the table provided on the ATO website to check the repayment threshold.	Thomas's taxable income is below the threshold repayment level of $47 014. Therefore, he will not have to make a repayment on his HELP debt this year. He will receive the amount deducted by his employers back as part of his tax refund.

8G Tasks and questions

Thinking task

1 How does having a HELP debt affect your ability to get a housing loan? A credit card? A car loan? A BNPL (buy now-pay later) provider?

What are the pros and cons of paying off a HELP debt as quickly as possible?

Skills questions

To answer the following questions (2–7), locate the HELP repayment threshold and rate table and the indexation table for the current financial year on the Australian Taxation Office website. If you are unable to access the website, use the tables given previously.

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2 What is the repayment rate of the following taxable incomes?

a $33 999 **b** $105 501 **c** $47 014 **d** $160 235

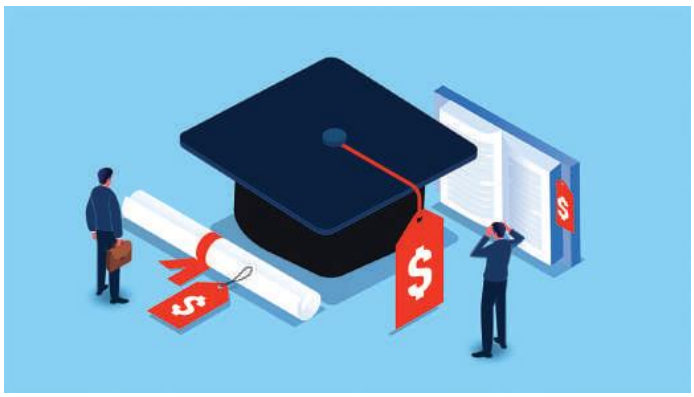
3 State the range of taxable income to which the following repayment rates apply.

a 4.0% **b** 8% **c** 5.5% **d** 20% **e** 0%

4 For the following annual salaries, determine whether a repayment for a HELP debt is required. If so, calculate the amount of the repayment.

a $48 900 **b** $76 350 **c** $148 236

d $23 198 **e** $189 211



Mathematical literacy

5 Brainstorm a list of questions you have about student loans and the HELP debt.

Find as many answers as you can and discuss these. Does what you have found answer the questions fully?

Do you think the HELP debt scheme is a good idea? Why or why not?

How could it be improved?

Application tasks

6 Shayna is an Australian citizen and has a HELP debt with a current balance of $15 234. For the last three years, she hasn't been working as she has taken time off to start a family. When her youngest daughter starts kindergarten, Shayna plans to go to TAFE and study for a Diploma in Early Childhood Education.

What would stop Shayna being able to access a VET Student Loan and increase her HELP debt?

7 Think of a course you are interested in taking at TAFE or university when you finish Year 12. Find out what the fees are for this course and whether you will be able to use HELP to pay these fees.

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8H Credit

Credit is borrowing money (going into debt) and agreeing to pay the money back within a specified time. Penalties, usually in the form of fees or interest charges, apply if the money is not paid back within the specified period.

Credit is different to borrowing money through a loan, which has a fixed repayment structure over a fixed time period. Credit allows for more variation and comes in different forms. How you manage your credit will affect your credit rating. This section will look at credit cards, buy now-pay later (BNPL) services, lay-by and payments by instalments.

Credit cards

A credit card allows you to buy something today, using your credit card, and not have to make the payment until the balance on your credit card is due. The shop keeper or service provider who sells you the goods receives their money immediately, and you then owe that amount to the credit card provider who issued the card. You have to be over 18 to apply for a credit card.



Credit cards and interest

Most credit cards have an interest-free period. If you pay off the amount owing within that period, you will have paid no more for your purchase than if you had paid cash at the time of the purchase. If you do not pay the balance off in full each month, however, you will be charged **interest** on your outstanding balance, meaning that you will have paid more for your purchases than if you paid cash. The interest rate charged on most credit cards is very high, and this can mean that the debt grows quickly. Some credit cards will allow you to take out a cash advance, but the downside of this is that you will start paying interest on the cash advance immediately – there is no interest-free period for cash advances.

Different uses for credit cards

People use credit cards in different ways.

- Some people use them for day-to-day transactions, such as buying their groceries and their petrol, and they usually pay the balance off in full each month.

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- Some people use them for special one-off purchases, such as buying a new computer or paying for an overseas trip and will often make regular payments until the credit card balance is clear, paying some interest.
- Other people keep a credit card for emergencies, such as the washing machine breaking down or the car needing unexpected repairs.

Types of credit cards, and credit card limits

Different types of credit cards are available, and how someone intends to use their credit card could mean that one type of card is better than another type, for them. The different types include:

- **Awards** These credit cards have an annual fee and often have higher interest rates but offer awards such as gift vouchers, based on the amount spent on the card.
- **Low rate** These credit cards have a lower rate but often have a higher annual fee. These cards are usually suited to people who want to minimise the interest paid.
- **Low fee** These credit cards have lower annual or monthly fees but often have higher interest rates. These cards are usually suited to people who do not use the card regularly but who will pay off the balance in full each time.
- **Interest-free** These credit cards usually have a low credit limit and a monthly fee based on a fixed card limit. These cards are usually suited to people who want to have control over their finances and don't want too much complexity.

When you are successful in applying for a credit card, the card provider will set a credit limit which is the total amount that you will be able to charge to the credit card. When people talk about their credit card being 'maxxed out', it means that they have made purchases up to their credit limit and they cannot use the card for more purchases until they have paid off some of the balance on the card (reduced the balance).

The dangers of credit card debt

Many people find paying off their credit card in full each month difficult to do. In fact in 2019, the average credit card debt was estimated to be approximately $3200 per card. But if you don't pay off your credit card balance in full each month, you pay the card provider interest, and this means that you end up paying a lot more for something you bought.

The card provider sets a minimum monthly payment that must be paid if you want to be able to keep using the card. This amount, however, is usually only a small percentage of the total balance.

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In the following example, the person, let's call them Brendan, owes $2823.13, and the minimum payment they have to make is $56.00 (approximately 2% of the total balance).

Your payment summary	
Total amount owing	$2,823.13
Minimum payment	$56.00
Payment due by	14 Dec 2021

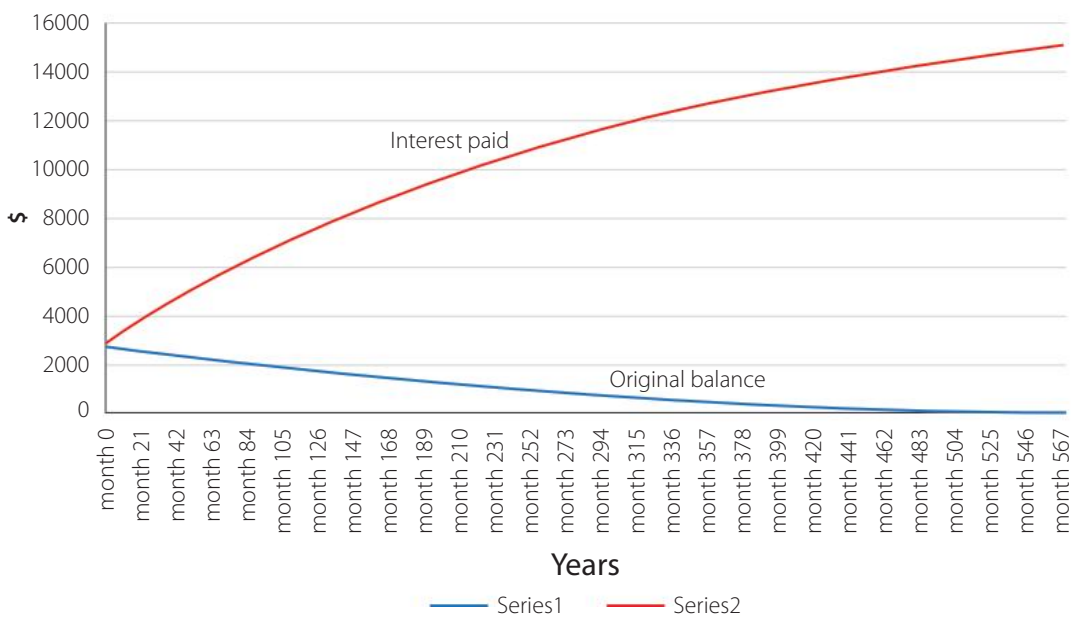
Minimum Repayment Warning: If you make only the minimum payment each month, you will pay more interest and it will take you longer to pay off your balance. For example:

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	43 years, 11 months	$15,527.98
$145.40	2 years	$666.53, a saving of $14,861.45

Extracts from a credit card statement, showing a payment summary and a minimum repayment warning.

The credit card statement informs Brendan that if he only pays the minimum amount each month and doesn't use the credit card to pay for anything else, he will take 43 years and 11 months to pay off the original $2823.13 and will end up paying $15 527.98 in interest. That is more than five times the original amount Brendan owed on his credit card. If Brendan is 20 years old, he would be at least 63 years old by the time he had finished paying this one debt off.

If we look at a graph of this, we can see how much interest is paid. If you were Brendan, think of how many other things you could have done with that money instead of paying interest on a credit card.



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Many banks now offer credit cards that allow someone to consolidate their debts onto the one card (balance transfer). These cards often have a period where no interest is charged, giving that person an opportunity to gain control over their debt, as all the money paid onto that card goes towards reducing the balance on the card, not paying off interest charged.

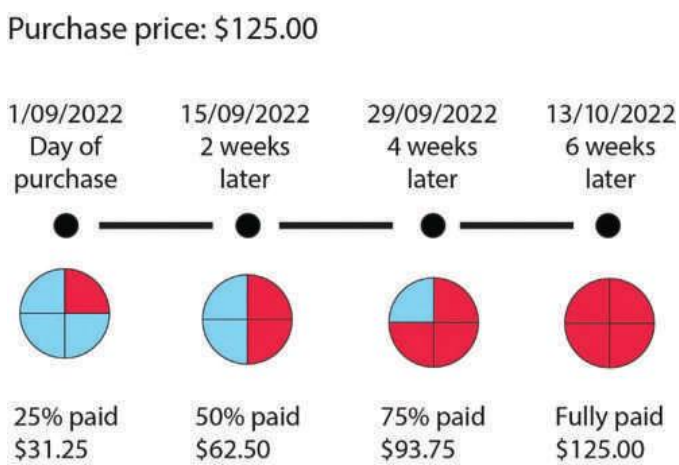
Credit cards are useful if you are careful with how you use them and you choose the right type for your use. Think of them as short-term credit, and pay them off as soon as you can, preferably paying the balance in full each month. A credit card is not something to use to finance big purchases that will need to be paid off, perhaps over several years.

In Australia, the use of credit cards is declining. More people are turning to other forms of credit, like buy now-pay later, because they believe it gives them greater control over their money.

Buy now-pay later (BNPL)

Buy now-pay later (BNPL) is a way of spreading out your payments in instalments over time. The retailer or service provider who sells you the goods receives their money immediately, and you then owe that amount to your BNPL provider, who allows you to spread the repayments over a number of instalments, paid weekly, fortnightly or monthly.

When you apply, are approved and sign up with a BNPL provider, you agree to a fixed repayment schedule for your future purchases, and you nominate your account (bank account, debit card or, in some cases, credit card) from which the repayments will be automatically paid on the due date. You will also be given an account limit. BNPL is managed from an app on your phone.



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BNPL services are usually advertised as 0% interest. This may seem like a better deal than the high interest rates charged on credit cards, but the BNPL providers apply fees such as the following:

- **Late payment fees** These are charged if you make a late payment or miss a payment. Making a late payment, or missing a payment, happens if you don't have enough money in the account that the BNPL is paid from. In dollar value, the late fee is often much higher than the comparative dollar value you would have paid in interest on a credit card.
- **Monthly account keeping fees** Some BNPL service providers charge users a fixed monthly or fortnightly fee to be able to use the service. This fee is usually only charged when you have an outstanding balance with your provider.
- **Establishment fee** Some BNPL service providers charge a fee to set up the account.
- **Payment processing fees** Some BNPL service providers charge this fee on each repayment that you make.



BNPL services can be used to purchase many things. It is important to know your limits and not overcommit.

These fees can quickly add up if you are using the BNPL service for a lot of purchases.

The advantages of using a BNPL service are that it is quick to set up and doesn't require an extensive credit check. Once set up, the service is convenient and easy to use. Allowing you to spread your payments could also be helpful. One disadvantage of using a BNPL service is that the timing of the payments is set by the provider and may not coincide with when you have money in your account. If you make a lot of purchases this way, it is difficult to keep track of how much you still owe in advance, and many people find that they make late payments because they have insufficient funds in the account that their BNPL service is paid from.

A further disadvantage is the fees that are charged if payments are missed. Often, the fees as a proportion of the original purchase price represent a much higher percentage than would have been paid even on a credit card. By only charging fees and not interest, the BNPL providers rely on a loophole in the National Credit Code that means they are not subject to some of the rules governing credit providers charging interest.

Users who pay late or miss payments will also find their credit rating is impacted.

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Lay-by

Lay-by is seen as an old-fashioned method of credit because you don't get the goods until you have fully paid for them. You choose the goods and pay a deposit (usually 10% of the price). The retailer stores the goods and keeps track of your 'ownership' of them. You regularly pay an amount that reduces the balance until you have paid the full amount, and you then receive the goods.



Knitters often lay-by wool to ensure they have the same colour batch for the whole garment.

Lay-by can be useful, however, if you don't need the goods immediately. For example, if you are buying the item for a special occasion, such as a Christmas present, you don't have to keep the present at home and run the risk of it being 'discovered' early. You can take advantage of a sale to lay-by something that you know you will need in the future, but not immediately.

Knitters often put their wool on lay-by. Each batch of wool is a slightly different colour, so to ensure that they are knitting a garment using the same colour batch, they put it on lay-by and pay for a few balls of wool at a time.

The advantage of lay-by is that there is no interest charged on your payments. If you forget or miss several payments, however, the retailer may not hold your goods for you, and you will lose any money you have already paid.

Payment by instalment options – No deposit, no interest

Instalment options may be offered by retailers on more expensive items, such as computers or furniture or washing machines. You purchase the goods and agree to pay the total cost off in equal instalments over a period time, sometimes as long as 5 years (60 months). During this period, and providing you pay the instalments on time, no interest is charged. Although you sign up to the instalment plan at the retailers, the instalment option is usually provided by another financial provider.

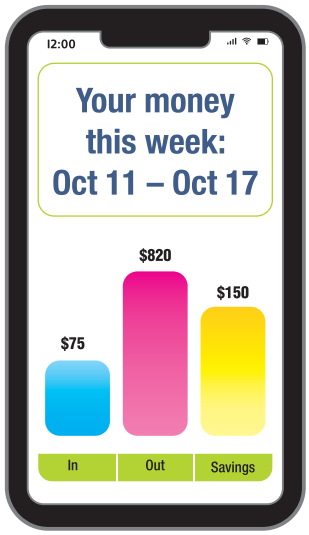
These instalment options are often just a credit card with 0% interest on that initial purchase. It is important to read the 'fine print' of the contract with the instalment provider, as you may find that any other purchases you make with that credit card do attract interest and can't be paid off in instalments.

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8H Tasks and questions

Thinking task

1 You might have seen phone apps that help you 'manage' your money and keep track of your spending with a particular BNPL provider. The following phone screenshot is like some of those apps. What do you notice about the graph?



Use a spreadsheet to create a chart, using the same numbers as in the simulation (or draw it on graph paper, making sure you pay attention to the scale and the numbers being represented).

What do you notice when you compare the graph you just created and the graph in the screenshot?

What message does the app give to the user about their financial position?

Skills questions

2 Using the excerpt from a 2023 calendar below, indicate the dates that payments would be made for each of the BNPL scenarios listed.

May

Su	M	Tu	W	Th	F	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

June

Su	M	Tu	W	Th	F	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

July

Su	M	Tu	W	Th	F	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

August

Su	M	Tu	W	Th	F	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

a 5 weekly payments. The purchase date is 14 June 2023.

b 4 payments every two weeks. The purchase date is 3 June 2023.

c 4 monthly payments. The purchase date is 16 May 2023.

d 4 fortnightly payments. The purchase date is 18 June 2023

e 10 instalments spread fortnightly from 1 May 2023.

3 How much will each payment be in the following BNPL scenarios.

a $96 purchased on a plan for 4 payments every two weeks.

b $125 purchased on a plan for 5 weekly payments.

c $325 purchased on a fortnightly payment plan of 4 instalments.

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d $1250 purchased on a plan of 10 instalments spread fortnightly.

e $12 349 purchased on a plan of 6-monthly instalments.

4 Use the credit card statement summary page shown below to answer the following.

Bank of **Southern Lands**

Your Statement

Awards Credit Card

[redacted]

Page 1 of 3

Statement Period	21 Sep 2021 - 20 Oct 2021
Credit limit	$7,500.00
Available credit	$6,305.62
Your Awards points	**+22,839**

[redacted]

Opening balance at 21 Sep	$6,688.11
New transactions and charges	$1,194.38
Payments/refunds	-$6,688.11
Closing balance at 20 Oct	$1,194.38
Next statement period	21 Oct 2021 - 19 Nov 2021

Your payment summary

Total amount owing	**$1,194.38**
Minimum payment	**$25.00**
Payment due by	**15 Nov 2021**

Your next AutoPay amount of $1,194.38 will be deducted from your account - [redacted] - on 15 Nov 2021.

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	8 years, 11 months	$1,467.86
$61.51	2 years	$282.04, a saving of $1,185.82

Having trouble making repayments?
If you are having difficulty making credit card repayments, please contact us on 1300 XXX XXX. We may be able to assist you. Please note: in the minimum repayment warning calculation, we use the cash advance rate and apply it to the entire balance.

a What type of credit card is it?

A Awards

B Low fee

C Low interest

D Interest free

b How much is owed in total on this credit card?

c When is payment due?

d How many days' notice is given before payment is due?

e How will the payment be made?

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f What is the amount of the minimum payment that can be made?

g How long will it take to pay this debt off if only the minimum payment is made?

h What other conditions are necessary for that length of time to be true?

i How much interest would be paid in that time?

j What is the credit limit of this card?

k How much more can be spent using this card before it is 'maxxed out'?

l Do you think this credit card is owned by someone who pays off their credit card in full each month? What evidence can you find on the statement summary page to support your position?

5 Laki purchases a food processor for $300 as a gift for her mother. The shop offers to lay-by it for her if she agrees to pay a $50 deposit and $50 every fortnight after that until it is paid for.

a How many payments of $50 will Laki have to make?

b After how many fortnights will Laki be able to take the food processor home to give to her mother?

c How many weeks is this?

d If Laki bought the food processor on 28 October, by when would she have paid it off?

e What could happen if Laki forgot to make a payment?

6 The descriptions below are of BNPL offers. Set up a table to compare each of the offers against each of these four criteria:

i The amount needed to set up an account.

ii The repayment schedule.

iii The fee charged for an overdue payment.

iv Any other account-keeping fees charged.

a This account offers the following.

- No establishment fees.
- No minimum purchase.
- Maximum purchase: your pre-approved limit.
- No interest ever.
- Payment over 6 weeks (4 easy payments: now + 2 weeks + 2 weeks + 2 weeks).
- $10 late fee.

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b This account offers the following.

- No establishment fees.
- Choice between 5 fortnightly or 10 fortnightly repayments.
- Monthly fee of $8 for 10 fortnightly repayments.
- Late payment fee of $6 on either account.

c This account offers the following.

- No establishment fees.
- Purchases over $100 are split into 4 equal fortnightly payments – under $100, the full amount is deducted from your account straight away.
- Maximum purchase of $1000.
- No interest charges.
- No annual or monthly fees.
- Late fees of $10 per missed instalment repayment.

d This account offers the following.

- No establishment fees.
- Choice between weekly, fortnightly or monthly payments.
- Available for purchases between $200 and less than $1000.
- $8.00 monthly account fee. (This fee is waived for every month you pay your closing balance in full by the due date.)
- Minimum monthly repayments are required (currently $40 per month).

Mathematical literacy

7 What do the following terms mean.

- Minimum payment (on a credit card)
- Minimum purchase (using a BNPL provider)
- Capped (in relation to fees)
- Credit limit
- Credit rating (also known as a credit score)

Is a higher or lower score for a credit rating better? Why?

What things can impact your credit rating?

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Application tasks

Use the following information for questions 8 and 9.

Rory is a first-year hairdressing apprentice who loves to shop for clothes and makeup. They earn $450 a week after tax and are paid weekly. Rory lives at home with their parents and pays $120 a week for household expenses.

They buy the following items.

Transaction number (Trx #)	Purchase date	Transaction	Amount
1	Jun 12	Gorgeous winter top	$80.00
2	Jun 12	Cute little pair of boots	$138.00
3	Jun 16	'Winter season' skin-cleansing set	$120.00
4	Jun 21	Sensational dress to wear to cousin's wedding	$220.00
5	Jun 22	White shirt for work	$32.00
6	Jun 26	Perfect pair of pants, on special	$60.00
7	Jun 30	Pair of jeans, reduced in EOFY sale	$75.00
8	Jul 4	Shoes that match the dress for cousin's wedding	$120.00

Questions 8 and 9 ask you to compare two different credit schemes: BNPL and a credit card.



8 Rory has signed up to a BNPL service that offers the following and is linked to the account that their wages are paid into.

- 4 fortnightly payments.
- $10 fee for late or missed payments.
- Minimum purchase $30.

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a For each transaction Rory makes, calculate the date and the amount of each instalment.

Trx #	Instalment 1		Instalment 2		Instalment 3		Instalment 4	
	Due date	Amount	Due date	Amount	Due date	Amount	Due date	Amount
1								
2								
3								
4								
5								
6								
7								
8								

b Calculate how much Rory will owe each week until they have paid off these purchases. Use one of the following methods to help with the calculations: a calendar with space to write on each day, a spreadsheet or a table with headings for a number of weeks until they have paid off their purchases.

Show how much Rory owes each week.

c Is Rory able to afford their BNPL commitments each week? Write mathematical sentences to explain and support your answer.

d If Rory's BNPL provider charged a $1 fee for every transaction, how much would Rory pay in transaction fees for these repayments? Does this change your position on whether Rory is able to afford her BNPL commitments each week? Write mathematical sentences to explain and support your answer.

e Rory is contemplating moving out of home and into a share house with two friends. Their share of the rent would be $150/week and they would pay $75/week towards living expenses in the house. Based on the transactions above being typical, would Rory be able to continue a similar spending pattern? Write mathematical sentences to explain and support your answer.

f Setting aside the previous transactions, imagine Rory has just been given approval from their BNPL provider and hasn't made any purchases yet. They see an advertisement for a one-week holiday to Bali for $1400, including flights. Should they book the holiday and pay using BNPL? Write mathematical sentences to explain and support your answer.

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9 Instead of using BNPL, Rory pays for their purchases using a credit card. Their credit card statement covers the period 24 May to 21 June, and is due on 4 July.

- **a** Which transactions will be included in this credit card statement? List the transactions and the amounts.
- **b** What will happen to the transactions made after this credit card statement is issued?
- **c** If Rory had no previous transactions on their credit card, how much would they pay on the due date if they paid the full amount owing on the card? Write a mathematical sentence to explain your answer.
- **d** Would Rory be able to pay this out of one week's pay? What strategies could they adopt to ensure they have enough money to pay the balance off and avoid paying interest?
- **e** What will happen to the transactions made after this credit card statement is issued, but before the payment is due?



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8I Lock-in contracts, subscriptions and joining fees

You must have heard those annoying advertisements that go 'Blah blah blah blah blah blah blah **AND NO LOCK-IN CONTRACTS!!!**'

Particularly in communications, entertainment and fitness, we agree to make payments on a regular basis to keep using that service. Trouble is, even when we stop using the service, the payments often continue. Sometimes this is because we have signed a contract that specifies payments over a particular period (say 12 months), other times it is because we have signed up to an ongoing contract that we have to actively terminate (and even this is often made really difficult). You might have heard of people paying their gym membership fee years after they no longer go to that gym!

Lock-in contracts

A lock-in contract means that you have agreed to pay a certain amount over a given time period, and you can't just opt out at any time. Even if you do try to opt out, you still owe the remaining amount, and you may be charged a fee for terminating the contract early.

Examples of lock-in contracts in the telecommunications world include contracts for mobile phone services.

Paid subscriptions

A paid subscription entitles you to use that service for the period of the subscription. Think Netflix, Stan, Spotify, YouTube Premium, your internet connection or some software services on your computer, such as anti-virus software. Usually a subscription is paid monthly, but some services offer annual subscriptions.



Gym membership is also a subscription. You get to use certain equipment or attend certain classes for payment of a monthly fee.

Joining fees and one-off charges

On many occasions, you will be asked to pay a joining fee or a one-off charge for a piece of equipment. A joining fee typically covers the cost of an initial service, such as an initial consultation when you first join a gym. A one-off charge might be included in an internet subscription to cover the cost of the modem which you need for the subscription to be able to operate properly.

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8I Tasks and questions

Thinking task

1 How many services do you and your family subscribe to?

It is said that subscriptions are the way of the future. What products and services do you think will be subscription-based in the future?

How do subscriptions benefit the consumer? How do subscriptions benefit the provider?

Skills questions



2 Calculate the cost over 12 months of the following mobile phone plans.

- **a** $49 per month
- **b** $89 per month, reducing to $79 per month after the first 12 months
- **c** $99 per month for the first 3 months, then $119 per month after that

3 Calculate the cancellation cost in the following situations.

- **a** Half the monthly fee of $87 for the 3 remaining months of the contract.
- **b** The terms for cancellation are: A flat fee of $250 if cancelled in the first 4 months, reducing to $200 if cancelled between months 5 and 8, then $150 if cancelled after 9 months.

  How much will you pay in cancellation fees if you cancel the contract in the following months.

  - **i** Month 3
  - **ii** Month 8
  - **iii** Month 11
- **c** The terms for cancellation are: Half the monthly fee for the remaining months or part months of the contract.

  How much will you pay in cancellation fees on a 12-month contract for $69 if you cancel the contract at the following times.

  - **i** At the end of month 3.
  - **ii** Part-way through month 5.
  - **iii** 15 days before the end of the contract.

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4 Calculate the cost of the following streaming services over 12 months.

- **a** A monthly charge of $10.50.
- **b** A monthly charge of $14.99 plus an additional sports-pack for $5.50/month taken for 3 months.
- **c** A monthly charge of $18.75 including a 'family friendly' pack of $3.50/month that is discontinued after 5 months.

5 Calculate the cost over 2 years for the following gym memberships.

- **a** $99 joining fee, $68.25/month
- **b** $0 joining fee, $48/fortnight
- **c** $110 joining fee, $15.95/week, paid fortnightly
- **d** Which is the most expensive membership?

Mathematical literacy

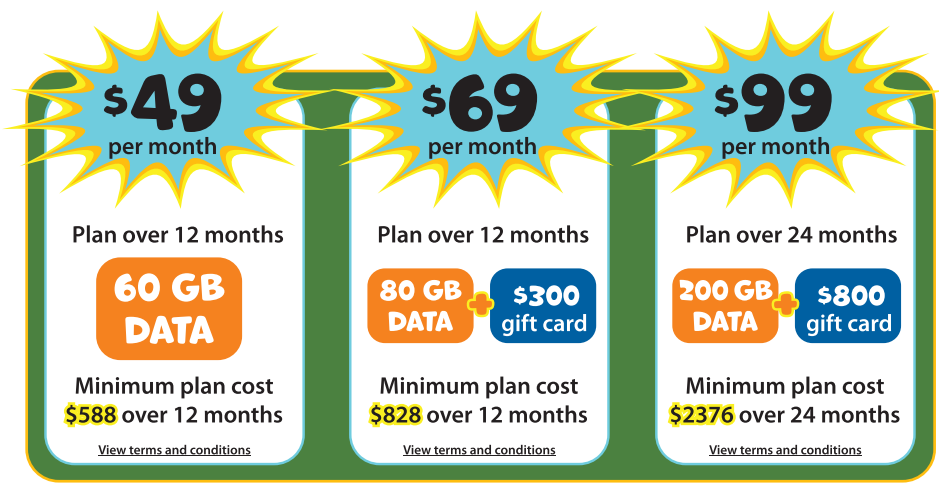
6 Describe what a subscription is using 20 words or less.

Compare your description with others in your class.

Build a general description that uses the ideas in all the descriptions.

Application tasks

7 Complete the questions for the following mobile phone plans.



- **a** Identify whether each of these is a lock-in contract. How do you know?
- **b** How long is each contract?

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8 It pays to read the 'fine print'. For each of the plans shown below, there is an Early Termination Charge (ETC) when the plan is cancelled early.

Plans	$49 Plan	$69 Plan	$99 Plan
Maximum Early Termination Charges (ETC)	$294 plus any Voucher Reimbursement Cancellation Fees (if applicable)	$414 plus any Voucher Reimbursement Cancellation Fees (if applicable)	$1188 plus any Voucher Reimbursement Cancellation Fees (if applicable)

What happens when I cancel my plan early?

You'll need to pay an Early Termination Charge (ETC) equal to 50% of your monthly fee for the months (or part months) remaining in your plan term. The maximum ETC for your plan is set out in the above table. In addition to this, you'll also need to reimburse the phone company for any vouchers you received for entering into your plan. This Voucher Reimbursement Cancellation Fee is pro-rated, equal to the total amount of the base voucher divided by 12 and multiplied by months (or part months) remaining in your plan term. This charge will appear on your bill, the maximum of which is also set out in the table.

a Write the mathematical calculation for the ETC for each plan. Hint: Start with the per-month cost and include the length of the plan in your calculation.

b If you take out the $69 plan for 12 months, then cancel it mid-way through month 9, calculate the following.

- **i** How much will the ETC be?
- **ii** How much will your total costs be?

c On 19 October, you take out a $49 plan, then cancel it on 19 February.

- **i** How much will the ETC be?
- **ii** How much will your total costs be?

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9 Answer the questions below for the following internet subscription offers.

UNLIMITED DATA **Standard Speed**	UNLIMITED DATA **Standard Plus Speed**	UNLIMITED DATA **Premium Speed**
month-to-month	month-to-month	month-to-month
$80 per month	**$10 off for the first 6 months** Then $95 per month	**$10 off for the first 6 months** Then $110 per month
Min cost $296 for new customers who cancel after 1 month. See Core Internet details	Min cost $301 for new customers who cancel after 1 month. See Unlimited Internet details	Min cost $316 for new customers who cancel after 1 month. See Premium Internet details

If you click on each of the details, you get the following information.

Core Internet plan details

Min cost $296 for new customers who cancel after 1 month. If you leave within 24 months, pay out the modem ($9/month for every month remaining in the first 24 months).

Unlimited data plan details

Min cost $301 for new customers who cancel after 1 month. If you leave within 24 months pay out the modem ($9/month for every month remaining in the first 24 months). Offer ends 28 February 2022.

Premium Internet plan details

Min cost $316 for new customers who cancel after 1 month. If you leave within 24 months pay out the modem ($9/month for every month remaining in the first 24 months). Offer ends 28 February 2022.

a Calculate the cost over 12 months for each plan.

b How is the minimum cost for new customers calculated? Hint: Check out the extra details provided.

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10 Choose three streaming subscription services, such as Netflix, Binge or Stan. Research the cost of each of them for a family. This means that you will need to look for multiple streams. Create a table to help you compare the prices.

If you had to choose one of the services, would price be your main criteria?

In your table, indicate which would be your preference. Include the criteria that you considered in addition to price.



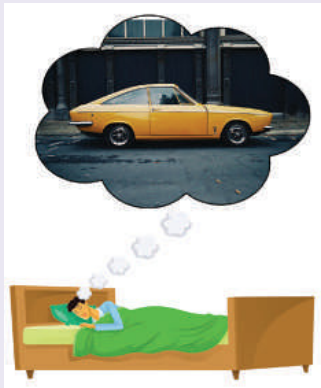
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Investigations

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 Buying your first car



What would your ideal first car be?

What features do you need to consider? Is safety a priority? You may want to check your car's safety rating on the ANCAP website.

Make a list of all the key features that are important to you.

Go online and choose your car. Remember it is good to shop around to find the deal to suit your requirements. Take a screenshot and note the asking price. Remember to include hyperlinks to each site.

Assume that you are a first-year apprentice on a wage of $37 968 per year. You need a car for your work and you have saved $2500.

a Work out how much money you need to borrow to buy your chosen car.

b Look up two bank sites to find out the interest rates they charge for personal loans.

c Write down each bank's application fee and monthly fees.

d A rule of thumb is that you should aim to pay $1000 off the loan each year. This will give you a guide to the length of the personal loan.

e Use an app like the Moneysmart personal loan calculator to work out your monthly repayments and the total cost of each car from either bank. Screenshot these results.

f Change each loan scenario to paying fortnightly instead of monthly. Screenshot these results.

g In each case, write down how much money you will save by paying fortnightly.

h Give two reasons why paying your personal loan fortnightly is better than paying monthly.

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2 Follow that 'Super'

Birthdays are good for you. Statistics show that the people who have the most live the longest.

Anonymous

You probably haven't even decided what you want to do with your life, but this investigation is asking you to fast-forward 50 years and imagine what you want your life to be like after you finish working. (If this is too daunting, don't worry! There are a lot of adults getting near retirement age who can't imagine it either.)



The purpose of having superannuation is so that you have a comfortable income in retirement and can enjoy the things you like doing.

Your task is to create a pamphlet or flyer explaining superannuation to Senior Secondary school students.

a Explain the purpose of superannuation.

b List three good things about superannuation, and three bad things.

c Research how much an employer must put into an employee's superannuation each year.

d Explain why it's a good idea to consolidate your different superannuation funds into one fund.

e Explain at least four things that you should consider when choosing your superannuation fund.

f Briefly explain the four main superannuation funds investment options.

g Use a spreadsheet to compare and demonstrate the difference in the total value of the same superannuation payments made by an employer when the superannuation guarantee moves from 10.5% to 11% to 11.5%. Base this on the same pay per month for a 12 month period.

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Key concepts

- The **GST** or **Goods and Services Tax** is a tax that is added to all non-essential goods and services. The current GST rate is 10%.
- Your **taxable income** is your gross assessable income (less allowable deductions). Tax is calculated on your gross wage, using tax rates set by the Australian Government.
- **Superannuation** is paid by individuals and their employers to save for retirement. In 2021–2022, the minimum contribution that employers must make to eligible employees is 10% of their wages.
- **Interest** is either:
  - the money that is charged if you borrow money from a bank or financial institution; or
  - the money that you earn from saving your money in a bank or financial institution.
- Simple interest $I = \frac{PRT}{100}$

  I = Interest
  P = Principal
  R = Interest Rate (%)
  T = Time (years)
- Total amount of loan $A = P + I$
- Compound interest $A = P\left(1 + \frac{r}{100}\right)^n$

  A = Total amount of the loan
  P = Principal
  r = Interest Rate per time period (%)
  n = Number of time periods
- Most loans are paid back in **instalments**. The amount to be paid (**principal + interest**) is divided up into equal parts – instalments – to be paid regularly over time.
- Students attending university or approved higher education can get a **HECS–HELP** loan to pay for their studies. Once their income is above a certain amount, these loans are repaid as part of their taxes.
- Consumers can access **credit** (borrow money) to make purchases using **credit cards, buy now-pay later (BNPL) services, lay-by** and **payments by instalments.**
- **Subscriptions** are paid to use a service for the period of the subscription.

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Chapter 8 review questions

☐ I can calculate the GST added to goods and services.

1 Classify the following as a good or a service and indicate whether it would attract GST or is GST-free.
- **a** A carton of milk
- **b** A doctor's fee
- **c** Soft drinks

2 Jalin is a builder. He completes three jobs and charges the following.
- **a** $345.00 + GST
- **b** $1120.50 + GST
- **c** $832.90 + GST

Calculate the GST and the final price Jalin will charge for each job.

3 Frida purchased the following items from a supermarket. The items labelled with an * attract GST.

Item	Qty	($) Value
AASHIRWARD EXPORT 10	1	14.50
MAGGI MASALA NOODLES	1	2.99
HALDIRAMS PUNJABI SA	1	10.50
HALDIRAMS KHATTA MEE	1	4.30*
PATTU SEAME WHIE	1	2.20
HALDIRAMS BHUJIA 400	1	4.30*
GREWAL MAKKI ATTA 5K	1	12.30
PRIYA GOLD CHEEZ BIT	1	1.99
HALDIRAMS ALOOK BUJIA	1	2.20*
PATTU URID DHALL WHI	1	6.50
MILLER SUNFLOWER 5L	1	13.50
DAIRY MILK CHOCOLATE	1	0.95*
YOGI MOONG DHALL 5KG	1	15.50
AASHIRWARD EXPORT 10	1	14.50

Calculate the total GST that was paid for these items.

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I can calculate personal tax and superannuation.

4 Athena earnt $124 987 in the 2021–22 financial year.
- **a** Using the 2021–22 tax table, calculate the amount of tax Athena needs to pay for the year.
- **b** Calculate the minimum amount of superannuation Athena's employer is required to pay for the year.

5 Tynan earns $658.50 in the week 23/01/22 – 29/01/22.
- **a** What financial year do these dates belong to?
- **b** Using the 2021–22 tax table, calculate the amount of tax Tynan would pay for the year (assuming he earns the same wage each week).
- **c** Calculate the minimum amount of superannuation Tynan's employer is required to pay for the year.

6 Maxum won $5000 in a lottery. Is he required to pay tax on his winnings? Why?

I can calculate simple and compound interest.

7 Juno borrows $6000 from her mother to pay for her overseas holiday. She agrees to pay it back at an interest rate of 4% per annum over 3 years using compound interest.
- **a** How much interest will Juno pay?
- **b** How much will she pay back altogether?

8 A couple wants to borrow $875 000 to purchase their first home. They investigate the fixed compound interest loans being offered by three banks. The details of these loans are shown in the following table.

	Rate	Time period
a	4.5% per annum	25 years
b	3.8% per annum	30 years
c	4.2% per annum	20 years

Calculate the following.
- **i** The total amount paid on each loan.
- **ii** The interest paid on each loan.

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I can calculate instalments for a loan.

9 An education provider offers interest-free loans to complete their training courses. One course is $18 000 and is to be repaid monthly over 5 years. If the course is completed, a 10% discount is applied.
- **a** What is the total amount that must be repaid if the course is completed?
- **b** Calculate the monthly instalments for repaying the loan.

10 Rashdi takes out a simple interest loan of $3500 to buy equipment for her home gym. The interest rate is 4% per annum, and instalments are monthly for 3 years.
Calculate the following.
- **a** The interest paid over the term of the loan.
- **b** The total amount of the loan.
- **c** The monthly instalments.

I can calculate the repayment amount for a HELP loan.

11 Ardy completed a 5-year Engineering degree at Swinburne University (a Commonwealth Supported Place). He elected to pay for his studies using a HELP debt. Ardy commenced work as a civil engineer and for his first tax return as an engineer, his taxable income in 2021–22 was $52 355.
Will Ardy be required to make a repayment of his HELP debt in 2021–22? If so, how much will this repayment be?

12 Darren completed one semester of study at university and acquired a HELP debt of $2300 in March 2015. He has not added to nor repaid any of the debt. What is the indexed amount of his debt at the start of 2021?

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I understand different methods for providing credit, including credit cards, buy now-pay later (BNPL), lay-by and paying in instalments.

13 Use the credit card statement below to answer the following questions.

019

MR JOHN CITIZEN
10 SAMPLE ST
SUBURBIA, VIC 3000

Statement Period	27 Apr 2018–25 May 2018
Credit limit	$20,000.00
Available credit	$17,536.02
Your Awards points	**+40,913**

Opening balance at 27 Apr	$2,389.42
New transactions and charges	$2,463.98
Payment/refunds	-$2,389.42
Closing balance at 25 May	$2,463.98
Next statement period	26 May 2018–26 Jun 2018

Your payment summary	
Total amount owing	**$2,463.98**
Minimum payment	**$49.00**
Payment due by	**19 Jun 2018**

To minimise interest, pay the total amount owing, or as much as you can, by the payment due date.

Pay at least the minimum by the due date to avoid a late fee and continue using your card.

a What type of credit card is it?
i Awards **ii** Low fee **iii** Low interest **iv** Interest free
b How much is owed in total on this credit card?
c When is payment due?
d What is the amount of the minimum payment that can be made?
e What is the credit limit of this card?
f How much more can be spent using this card before it is 'maxxed out'?

14 Adam purchases a new gaming console on 3 January 2022 for $750. He signs up to a BNPL agreement to pay the amount with the following offer.

- No establishment fees.
- 4 fortnightly payments.
- $10 fee for late or missed payments.

Calculate the date and amount of each instalment.

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☐ I interpret and understand conditions for subscriptions and memberships.

15 Nada joins the local gym and signs a contract for a membership. The terms of the membership are as follows.

- $50 joining fee.
- $25 monthly fee.
- Minimum lock-in contract length of 12 months.
- Early cancellation fee of half the monthly fee for the remainder of the contract.

a Calculate the total cost of the membership over 1 year.
b Calculate the total cost of the membership over 2 years.
c Calculate the total cost of the membership if it is cancelled after 6 months.

☐ I can put these skills together.

16 Manny completed a 4-year Nursing degree at university (a Commonwealth Supported Place) and has commenced working as a graduate Nurse. His income in the financial year 2021–22 was $62 325. He has a HELP debt to pay for his university course. At the end of 2019, this debt was $10 200. He has not repaid nor added to this debt since then.

a Calculate the income tax Manny is required to pay for the 2021–22 year.
b Calculate the minimum superannuation contribution Manny's employer will pay in that year.
c What is the value of the indexed HELP debt in June 2022.
d Calculate the repayment of the HELP debt that Manny will be required to make that year.

Manny has decided to buy a new TV. The TV that he really wants is $3200 + GST. He considers two methods for purchasing the TV:

- A simple interest loan at 7%, paid monthly for 5 years.
- A BNPL agreement of 5 monthly payments and a $50 fee for missed or late payments.

e Calculate the interest Manny would pay with the loan.
f Calculate the amount of each monthly instalment for the simple interest loan.
g Calculate the amount of each instalment for the BNPL agreement.
h What are the pros and cons for each of these repayment methods?

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Key vocabulary

Here is a list of the key maths terms and their meanings used in this chapter.

Term	Meaning
After-tax pay	Pay after tax has been deducted (net pay).
Annual / per annum	Yearly / per year
Assessable income	The amount on which you pay income tax, after allowable deductions from your gross pay.
ATO	Australian Taxation Office
Before-tax pay	Amount earned before tax is deducted (gross pay).
Buy now-pay later (BNPL)	A popular form of consumer credit.
Calendar month	What we know as a 'normal' month, so January, February, March etc.
Compulsory repayment threshold	Applies to the repayment of HECS-HELP and FEE-HELP loans from the Australian Government. If your annual income is higher than the compulsory repayment threshold, you will have to pay back some of your loan. In 2021–22, the compulsory repayment threshold was $51 550.
Consumer price index (CPI)	A percentage amount calculated based on the increase in a 'basket' of goods and services that represent 'typical' spending by Australian families.
Credit card statement	A monthly summary from your bank, showing purchases and payments.
Credit limit	The upper limit of the amount of spending available with a credit card.
FEE-HELP	Refers to the combination of student contributions and student loans provided by the Commonwealth Government for tertiary education, usually in the TAFE sector.
Financial year	Starts on 1 July and finishes on 30 June of the following year – so the 2022–23 financial year starts on 1 July 2022 and finishes on 30 June 2023.
Gratuity	A sum of money given in addition to the 'official' amount owed, for example, tips.

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Term	Meaning
Gross pay	The amount of money earned before any tax or deductions are subtracted.
HECS	The Higher Education Contribution Scheme refers to the Commonwealth Government subsidising places at tertiary institutions, with the expectation that the student also contributes towards their education.
HECS-HELP	Refers to the combination of student contributions and student loans provided by the Commonwealth Government for tertiary education, usually in the university sector.
HELP	The Higher Education Loan Program that enables eligible tertiary students to borrow money from the government to cover their course fees. The HELP debt is repaid once the person is working and receives income above a threshold.
Indexed, Indexation	A percentage amount that is added to an amount owed; it is calculated based on the increase in the goods and services that comprise the consumer price index (CPI). It is an indication of inflation.
Instalment	One of a series of regular payments made when paying off a loan.
Joining fee	An up-front fee when taking out a subscription for a service.
Lay-by	A method of making regular payments for goods until you take possession when the full price has been paid.
Lock-in contract	An agreement to make payments for a service for a specified term, even if you wish to discontinue the service earlier.
Net pay	The amount of money to be paid after taxation has been applied to gross pay.
One-off payment	A single payment that is made only once.
Per annum	Per year / yearly
Subscription	An agreement to make regular payments for using a service.
Take-home pay	Amount of money you receive for your work after all taxes and deductions have been made.

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Term	Meaning
Tax-free threshold	The amount of income below which there is no tax payable.
TFN (Tax file number)	A unique number issued to an individual by the ATO that is used to keep track of their tax and superannuation amounts.
Truncate	To 'drop off' all the decimal numbers without rounding, for example, 15.673 truncates to 15 (whereas by rounding to the nearest whole number, it would be 16).
VET-FEE	The student contribution portion of a course fee for a student in TAFE.

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9 Your money at home – household expenses

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 – managing money in relation to home expenses. Prompt questions might be:

- What activity is depicted in this photo?
- What financial transactions are involved?
- What financial and monetary matters and decisions might be involved?
- What numbers and calculations might need to be used?
- What different tools, technologies or software might be used?
- What research or investigation questions could be undertaken based, on this photo?

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Chapter contents

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9B Tuning in
9C Household utilities bills
9D Other household expenses
9E Getting the best deal – Optimising expenses
9F 21st century communications
9G Inflation and CPI
9H Informed spending choices
9I Recreational spending

Investigations
Chapter review

From the Study Design

In this chapter, you will learn how to:

- read, interpret and perform calculations related to financial services such as with banking, utility bills and GST (Unit 1, Area of Study 3).

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Chapter overview

Introduction

There are many costs associated with living in and running a home. These include household bills such as power, water, insurance, internet and rates or rent. There are other bills too for things like streaming services, transport and sport! By understanding how bills are calculated and presented, you can often get a better deal that might save you money for something important, like a car or holiday.

This chapter examines how to read bills and to compare different products to make the best choice for your situation. We will also look at the big ideas of inflation and the cost of living, and how your spending choices affect your money.

Learning intentions

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

- read, interpret and perform calculations related to charges for services and utilities, such as rent, gas and electricity
- compare products and services from an optimal spending perspective, such as mobile phones, health care, insurance and internet provision
- explain the concept of inflation, the role of CPI in measuring it, and how this affects the cost of living
- calculate inflation as a percentage
- save money by checking the reasonableness of prices against estimates and avoiding scams
- understand gambling from a mathematics perspective, in order to make informed decisions
- apply the problem-solving cycle to complete investigations related to the topics contained within this chapter.

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Spotlight: Tim Russell

An interview with a financial advisor

Tell us about the work you've done and what you do now.

From school I went into banking and I spent 16 years with one of the major banks, including doing financial advising. I realised that there was a whole financial industry away from banking, and so I left and ended up running my own business with a couple of staff, looking after a few hundred clients.

What maths do you use regularly in your job? Could you give some examples?

Let's say you tell me you want to retire at 45. Do you retire and cruise the world on a yacht? Or do you retire and potter around in your garden? What are those options going to cost you? To cruise the world in a super yacht, let's assume it's $200 million to buy the yacht and $20 million a year to live comfortably on it. Then you start playing with the numbers. But if you want to potter around in your garden, maybe you're going to need just $50,000 a year.

If I've got someone who is concerned about how much money they're spending, I use retirement income forecasting. I can see that, if you keep doing what you're doing, you're going to run out of money at roughly this age, based on your investment risk profile and your planned expenditure. I'm going to need you to die at that age or, if that's no good to you, we need to make some changes.

What is the most useful tool or piece of technology that you use regularly in your job?

The Money Smart website has fabulous tools for nearly everything my clients need to do, in terms of budgeting, projecting forward, superannuation, debt loads and more. I like to keep it simple and use those sorts of tools or get my clients to use those tools.

What's your take on the value of learning maths at school?

You need to get a basic understanding. At primary school you need to be able to do your times tables; you will use that all through life and people will be amazed that you still know them. Some other times, you'll need fractions and percentages. If I talk to you about a 2.95% interest rate on your home loan, then that will then have some sort of real meaning to you. It's not just a number.

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9A Starting activities

Activity 1 Who's paying for me?

1 Brainstorm everything that you spend money on. Compare your list with your classmates. What is the same and what is different?

2 Next, find an online budget planner. (Try a website like MoneySmart.)

Look at the different categories in the planner. How many categories of household spending can your spending be allocated to? How many categories are still left?

3 Discuss with your classmates the typical expenses you will need to be responsible for when you are of adult age and still living at home.

4 Discuss with your classmates the typical expenses you will need to be responsible for if you move out of home.

Activity 2 Convince me to budget

1 Do an online search for some of the phrases in the list below. What do these rules and systems have in common?

- 50–20–30 rule
- 60–40 method
- 70–20–10 rule
- Zero-based budget
- Envelope system
- Jar system
- Budgeting apps

2 More important than knowing what these systems do is knowing why you would use them.

Brainstorm reasons why you should budget in the following times.

- Short term – finishing school, university, TAFE or apprenticeship.
- Medium term – your first job and moving out of home.
- Longer term – settling down, buying a house or starting a family.
- Very long term – retirement and old age.

3 Prepare a one-minute stand-up to convince your classmates that budgeting is cool.

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9B Tuning in

Epic Fail

$38 MILLION ELECTRICITY BILL!!! You may be familiar with the concept of bill shock, but could this be the biggest household electricity bill ever received?



A 38-million-dollar electricity bill must be a mistake, right? It pays to be vigilant with your expenses! What could have gone wrong?

(For more information about this story, find the article: *New York man gets a $38 MILLION electricity bill after an error by Con Edison*, published online by the *Daily Mail* in 2019.)

Discussion questions

1 Do you check your phone bill each month?

2 What would you do if you got a phone bill that was very much higher than your usual bill?

3 If the phone company won't listen to you, what government office can help you?

Always check your bills. Make sure that the billing period is correct, and that the amount you are being charged is about right. If your bill is wrong and you do nothing, you can end up in a legal situation – which is not good.

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Managing your money

There is no 'one right way' to manage your personal finances. There are many schools of thought when it comes to looking after your income and expenditure. When you are young, you may manage all your finances yourself, but as you progress through life, you may add a partner or children or extended family into this mix. Co-managing family finances may be a positive if the burden is shared, or may be a negative if there are challenges with different family members' spending habits.

The Victorian Government provides free financial couselling and advice to those in need. You might like to visit the Financial Counselling Victoria website for more information on services for those who require extra help in avoiding or getting out of debt.

Budgeting

Budgeting is a great way to manage your money. Budgeting is keeping track of both your **income** (money in) and **expenditure** (money out).

Using a budget can mean that you don't spend more than you earn. Keeping track of your money using a budget can mean that you do not fall into debt. It can help you save your money so that when you need to spend money, you have some set aside.

A good rule of thumb is: if you can't afford it, then don't buy it.

There are many apps and websites which you can use to help you budget.

Explore some apps now, and find one that you think may be suitable for you to use.



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Goal setting

Making a plan in order to buy something can be a great way to meet a goal. You may want to save for a big holiday and by setting a goal, you can plan for this in your budget. This may involve setting aside a small amount of money each week. Incremental savings can add up to a larger amount in a short time. The best thing about puttting away a small amount of money on a regular basis is that it may not affect your spending on other things.

Practice questions

1 Think about a big-ticket item you would like to buy in the future. This might be your first car, your first solo holiday or a new surfboard or guitar.

- **a** Set a goal. What do you want to buy? When do you want to buy it?
- **b** What is the anticipated cost of your goal?
- **c** What amount of money could you regularly set aside?
- **d** What timeframe would you need to save for this goal?
- **e** How much would you need to save each week?
- **f** If you needed the item sooner, does this change how much you need to save each week? How about if you needed it later?

2 Imagine you have $5000 dollars to spend in 20 minutes. You must spend the exact amount, and you must spend the money in a minimum of eight shops.

Make a list of your purchases and the cost of each.

Keep a running total next to each item you buy.

3 **Prioritising** is choosing one thing over another due to its greater importance. For example, your parents may prioritise your attendance at school over a family holiday.

In life, there will be many times where you must prioritise one thing over another because of the cost.

Think of five times in your life where one thing has been financially sacrificed for another.

4 If you earned $140 each week from your part-time job, how many weeks would it take you to buy a new skateboard or PlayStation?

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9C Household utilities bills



What did you do this morning after you woke up? Did you turn the light on? Go to the toilet? Have a shower? Have breakfast? Clean your teeth?

If you did any of these things, you were making use of the utilities (electricity, gas and water) that are available to make modern living comfortable. Unless you live off-grid and use rainwater tanks and composting toilets, these utilities are provided by organisations who charge each household for their use of the service.

The cost charged includes two amounts. One amount is based on the average amount used daily (the usage charge) which varies per day. The second is a fixed service charge to the property (often called a daily supply charge).

The generation of electricity and gas and the treatment of water all contribute to greenhouse gas emissions and global warming. The utility companies are working towards reducing these emissions. They provide information on their bills to help households contribute to the reduction of emissions also.

We measure electricity in kilowatt hours (kWh), gas in megajoules (MJ) and water in kilolitres (kL).

Example 1 Calculating the cost of electricity

Using the rates given, calculate the cost of 234.32 kWh of electricity used over 30 days.
Usage rate: $0.2389 per kWh
Supply rate: $1.3500 per day.

THINKING	WORKING
STEP 1	
Check that the units are the same, then apply the supply rate to the number of days. The answer is in dollars.	30 days; $1.3500 per day 30 × 1.3500 = 40.50
STEP 2	
Check that the units are the same, then apply the usage rate to the number of kWh. The answer is in dollars.	$0.2389 per kWh; 234.32 kWh 234.32 × 0.2389 = 55.979048

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THINKING	WORKING
STEP 3	
Round the two values to cents and add the supply charge to the usage charge.	40.50 + 55.98 = 96.48
STEP 4	
Include the units to make sense of the maths and write the answer in context.	The cost of 234.32 kWh of electricity used over 30 days is $96.48, made up of a supply charge of $40.50 and a usage charge of $55.98.

Note 1: The rates were given to 4 decimal places, then the final answer is rounded to dollars and cents.
Note 2: Using the terminology from the question when you state the final answer is a good way of checking that the answer seems reasonable.



Example 2 Calculating the cost of electricity for a particular period

Using the information given, calculate the cost of electricity for the period 4 June 2022 to 2 July 2022.

4 June meter reading: 45 326.82 kWh
2 July meter reading: 45 585.46 kWh
Usage rate: $0.2389 per kWh
Supply rate: $1.3500 per day.

THINKING	WORKING
STEP 1	
Determine the number of days in the period.	June 4 to July 2 is 29 days.
STEP 2	
Check that the units are the same, then apply the supply rate to the number of days. The answer is in dollars.	29 days; $1.3500 per day 29 × 1.3500 = 39.15
STEP 3	
Determine the amount of electricity used for the period, by subtracting the earlier meter reading from the later reading.	45 585.46 – 45 326.82 = 258.64 kWh

... continued

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THINKING	WORKING
STEP 4	
Check that the units are the same, then apply the usage rate to the number of kWh. The answer is in dollars.	\$0.2389 per kWh; 258.64 kWh $258.64 \times 0.2389 = 61.789096$
STEP 5	
Round the numbers to cents if necessary and add the supply charge to the usage charge.	$39.15 + 61.79 = 100.94$
STEP 6	
Include the units to make sense of the maths and write the answer in context.	The cost of electricity for the period 4 June 2022 to 2 July 2022 is \$100.94, made up of a supply charge of \$39.15 and a usage charge of \$61.79.

Note: When counting the days, the start date and the end date are both counted. This is to capture usage after the time of day that the meter was read on 4 June, as well as usage before the time of day that the meter was read on 2 July.

9C Tasks and questions

Thinking task

1 Identify the **fixed** portion and the **variable** portion on a utility bill. Which of these does your household have some control over? How could you minimise your household usage of the utility? Who would benefit from minimising the usage? How would they benefit?

Skills questions

2 Do some online research to find out:

- **a** the difference between a retailer and a distributor in the energy market
- **b** the different electricity distributors that cover the state of Victoria
- **c** the different gas distributors that cover the state of Victoria
- **d** what an NMI number is
- **e** what an MIRN is.

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3 The following is an extract from an electricity bill.

Supply Period 01-Nov-2020 to 28-Nov-2020 **(28 days)** Meter Index: 01-Nov = **27326.72**, 28-Nov = **27511.28**

(A): Actual (E): Estimate **Next Meter Read: 23-Feb-2021 ± 2 days**

Meter Reads

Meter Number	Previous Read Date	Current Read Date	Total Read	Multiplier	Total Usage
9999999/001	31-Oct-2020	28-Nov-2020	184.56 kWh (A)	1	184.56 kWh

Electricity Charges for Period 01-Nov-2020 to 28-Nov-2020 **All prices include GST**

Description	Period	Quantity Unit		Rate $	Total	Discount Rate $*	Discount Total*
Peak usage - step 1	01-Nov - 28-Nov	184.56 kWh	x	0.2475	$45.68	0.2302	$42.48
Daily Charges	01-Nov - 28-Nov	28 days	x	1.2100	$33.88	1.1253	$31.50
Total charges (including $7.23 GST)					$79.56		
Total discount: 7%*					**$5.57**		
Total after discount (including $6.73 GST)*							$73.99

*Terms and conditions apply

a Is the reading an actual reading or an estimated reading?

b What period is the supply for?

c How much electricity was consumed in that period?

d What rate is charged for the electricity usage?

e What rate is charged for the daily supply charge?

f When could the next meter reading take place?

4 Using the usage and daily supply charges shown in the bill extract in question 3, calculate the cost to the customer of the following electricity consumption.

a 283.49 kWh used over 28 days

b 645.21 kWh used over 48 days

c Meter readings as follows:

28 February = 38 437.83 kWh 28 March = 38 622.39 kWh

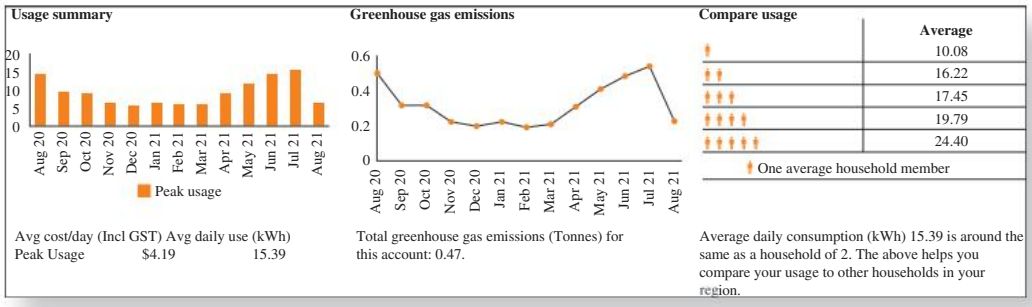
d Meter readings as follows

28 December = 16 215.61 kWh 26 January = 16 400.17 kWh



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5 The following information on a monthly electricity bill is provided to help the customer manage their electricity consumption. Use the information to answer the questions below.



a What time of year is this bill period?

b What observations can you make about the information that is presented? Share your answers with your classmates.

c What conclusions can you draw about the electricity consumption of this household throughout the year?

d What could be a reason for the noticeable drop in the month of August 2021 shown on the Usage Summary Graph and the Greenhouse Gas Emissions graph?

e What is the average daily consumption in kWh?

f We do not know how many people live in this household, but what size household does the bill suggest this average daily consumption is for?

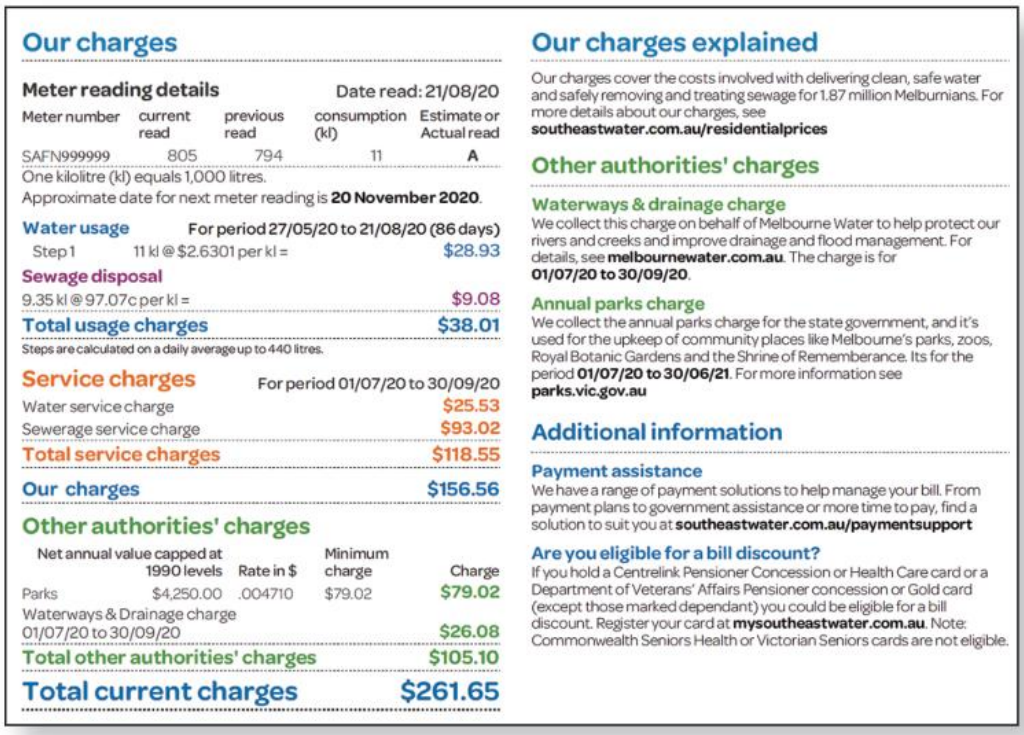
g What could you guess about the average daily consumption of electricity if, in fact, only one person lived in this household?

h What could you guess about the average daily consumption of electricity if, in fact, four people lived in this household?



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6 The following information comes from a water bill. Use the information to answer the questions below.



Our charges

Meter reading details Date read: 21/08/20

Meter number	current read	previous read	consumption (kl)	Estimate or Actual read
SAFN999999	805	794	11	A

One kilolitre (kl) equals 1,000 litres.
Approximate date for next meter reading is **20 November 2020**.

Water usage For period 27/05/20 to 21/08/20 (86 days)
Step 1 11 kl @ $2.6301 per kl = $28.93

Sewage disposal
9.35 kl @ 97.07c per kl = $9.08

Total usage charges $38.01
Steps are calculated on a daily average up to 440 litres.

Service charges For period 01/07/20 to 30/09/20
Water service charge $25.53
Sewerage service charge $93.02
Total service charges $118.55

Our charges $156.56

Other authorities' charges

	Net annual value capped at 1990 levels	Rate in $	Minimum charge	Charge
Parks	$4,250.00	.004710	$79.02	$79.02
Waterways & Drainage charge 01/07/20 to 30/09/20				$26.08

Total other authorities' charges $105.10

Total current charges $261.65

Our charges explained

Our charges cover the costs involved with delivering clean, safe water and safely removing and treating sewage for 1.87 million Melburnians. For more details about our charges, see **southeastwater.com.au/residentialprices**

Other authorities' charges

Waterways & drainage charge
We collect this charge on behalf of Melbourne Water to help protect our rivers and creeks and improve drainage and flood management. For details, see **melbournewater.com.au**. The charge is for **01/07/20 to 30/09/20**.

Annual parks charge
We collect the annual parks charge for the state government, and it's used for the upkeep of community places like Melbourne's parks, zoos, Royal Botanic Gardens and the Shrine of Remembrance. Its for the period **01/07/20 to 30/06/21**. For more information see **parks.vic.gov.au**

Additional information

Payment assistance
We have a range of payment solutions to help manage your bill. From payment plans to government assistance or more time to pay, find a solution to suit you at **southeastwater.com.au/paymentsupport**

Are you eligible for a bill discount?
If you hold a Centrelink Pensioner Concession or Health Care card or a Department of Veterans' Affairs Pensioner concession or Gold card (except those marked dependant) you could be eligible for a bill discount. Register your card at **mysoutheastwater.com.au**. Note: Commonwealth Seniors Health or Victorian Seniors cards are not eligible.

a What are the units used to measure water consumption on this bill?

b How much does one kilolitre (kL) equal in litres?

c How many kilolitres of water were used during the period of this bill? How many litres is this?

d How many kilolitres, on average, does this household consume per day? How many litres is this?

e A household bucket holds 10 litres. How many buckets of water, on average, does this household consume per day?

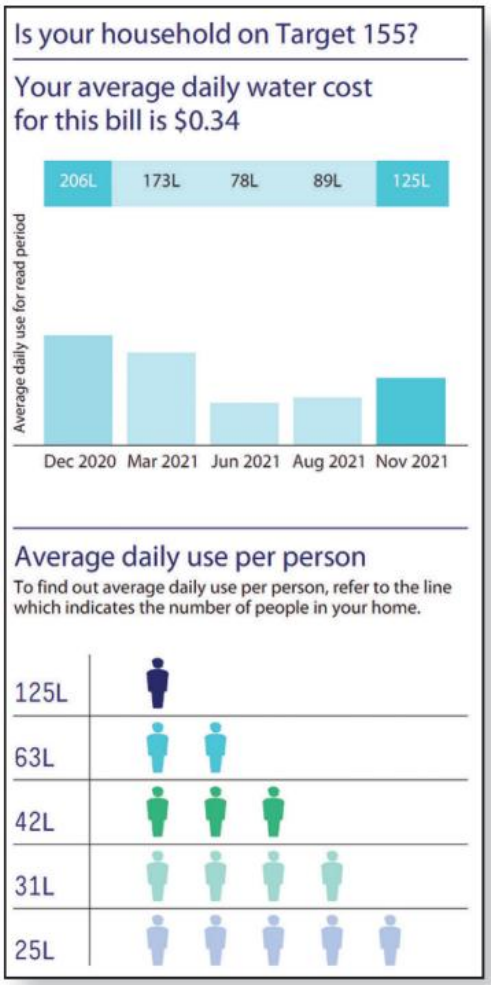
f What two components make up the total usage charges?

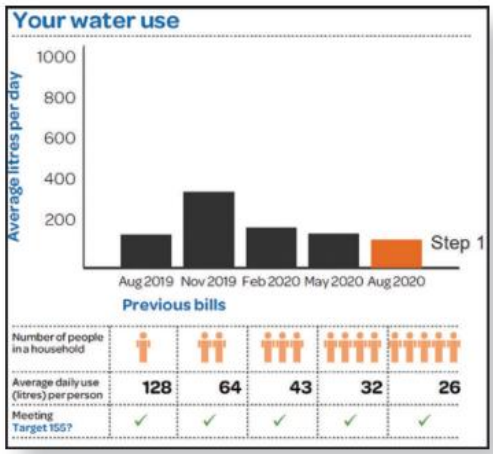
g What are 'Other authorities' charges? Who are these 'other authorities'?

h Who could be eligible for a bill discount?

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7 The following information comes from two different water bills. Use the information to answer the questions below.





a What similarities and differences do you notice between the two bills? Share your answers with your classmates.

b What calculation is performed to find the average daily use per person?

c What is Target 155? You might have to search the internet for more information.

d For the following households, how many more litres of water could each household use per day before they were not meeting Target 155?

- **i** A one-person household?
- **ii** A three-person household?

e Which bill is more effective in indicating whether the household is meeting Target 155? Which features of the bill support your argument?

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Mathematical literacy

8 What is a feed-in tariff in relation to electricity charges? Research how this works and explain the impact of a feed-in tariff on household expenses.

Application tasks

9 Online bills come in a table format. Look at the excerpt below and answer the questions.

15-Sep	Opening account balance	$255.41		
24-Sep	Customer purchase Top Up – Gas	$210	Payment by credit card	$210
5-Oct	Automatic payment by credit card	$255.41		
12-Oct	Customer purchase Top Up – Gas	$120	Payment by credit card	$120
30-Oct	Customer purchase Top Up – Gas	$60	Payment by credit card	$60
15-Nov	Account review for period 13 Sep – 11 Nov	$0	Closing account balance	$0

a What household service could this bill be for?

b How much was paid on 12 October?

c What does the amount of $255.41 represent?

d How was the amount of $60 paid?

e What time period does this bill cover?

10 The following extracts are from two different electricity retailers.

Extract 1

Supply Period 01-Nov-2020 to 28-Nov-2020 **(28 days)** Meter Index: 01-Nov = **27326.72**, 28-Nov = **27511.28**

Meter Reads (A): Actual (E): Estimate **Next Meter Read: 23-Feb-2021 ± 2 days**

Meter Number	Previous Read Date	Current Read Date	Total Read	Multiplier	Total Usage
9999999/001	31-Oct-2020	28-Nov-2020	184.56 kWh (A)	1	184.56 kWh

Electricity Charges for Period 01-Nov-2020 to 28-Nov-2020 All prices include GST

Description	Period	Quantity	Unit		Rate $	Total	Discount Rate $*	Discount Total*
Peak usage - step 1	01-Nov - 28-Nov	184.56	kWh	x	0.2475	$45.68	0.2302	$42.48
Daily Charges	01-Nov - 28-Nov	28	days	x	1.2100	$33.88	1.1253	$31.50
Total charges (including $7.23 GST)						$79.56		
Total discount: 7%*						**$5.57**		
Total after discount (including $6.73 GST)*								$73.99

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Extract 2

Charges	Period	Rate (incl GST)	Quantity	Total
Market Offer				
4313960:001 Off peak period	5 Nov - 5 Dec	18.14 c/kWh	188 kWh	$34.10
4313960:001 Peak period	5 Nov - 5 Dec	32.49 c/kWh	62 kWh	$20.14
Daily Supply Charge (103.94 c/day x 31 days)				$32.22
Property charges for this period			**250 kWh**	**$86.46**
Total charges for this period				**$86.46**

a What differences do you notice between the two bills?

b Which bill had the higher daily supply charge?

c Which customer used the most electricity, on average, per day?

d Which bill has the higher usage charges?

e How much in total did the customer in the second extract pay for their power usage?

f Use the kWh consumed on the second extract and calculate how much this customer would have paid, based on the costs in the first extract.

g Based on your calculation in part **f**, would you advise this customer to switch to the first retailer? Why or why not? Support your decision with the maths.

11 The following extract from an electricity bill shows the different payment methods available. Use the extract to answer the questions below.



a Why do you think the retailer offers different ways to pay?

b What are the advantages and disadvantages of each method. Share your answers with your classmates.

c If this was your household bill, which method would you choose to pay? Provide reasons for your choice.

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d Some electricity retailers offer a 1% discount on the total amount of the bill if it is paid with direct debit. Why do you think they would do that?

e What are the advantages and disadvantages to the consumer of such a discount?

12 The following extract from a water bill shows the details of residential charges. Use the extract to answer the questions below.

BL Details of charges - Residential

Previous Bill

Previous Bill	$238.45

Payments Received

14/9/2023	–$238.45

BALANCE FORWARD $0.00

Usage Charges

Meter Number	Bill Days	Previous Reading	Current Reading	Consumption in Kilolitres	Rate $	Total $
MAFD99999	96	00444	00456	12.00	(meter read date: 30/11/2023)	

Total Water Consumed

Usage Step 1 (27/08/2023 to 30/11/2023	12.00	2.7562	$33.07
Total	**12.00**		**$33.07**

Sewage Disposal	9.09	0.7647	$6.95
Total			$6.95

TOTAL USAGE CHARGES $40.02

Network Charges	Charge Period	Charge $
Water Network Charge	(01/10/2023 to 31/12/2023)	$51.89
Sewerage Network Charge	(01/10/2023 to 21/12/2023)	$55.64

TOTAL NETWORK CHARGES $107.53

Other Charges

Waterways & Drainage Charge (01/10/2023 to 31/12/2023)	$26.39

TOTAL OTHER AUTHORITIES' CHARGES $26.39

FINAL TOTAL, PLEASE PAY THIS AMOUNT $173.94

a What does **balance forward** mean on this extract? Explain why the value of balance forward is $0.00.

b How many kilolitres, on average, does this household consume daily? How many litres is this?

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c Approximately what percentage of the total consumption is the sewage disposal consumption?

d Compare the number of days covered by this water bill with the number of days covered by the electricity bills shown in question 1.

- **i** How many water bills would you expect to get in a year?
- **ii** How many electricity bills would you expect to get in a year?

e Assume these bills (the water bill in this question and the electricity bills in question 1) can fairly represent the water and electricity usage for each period.

- **i** Calculate the annual electricity charges, based on each of the bills shown in Extract 1 in question 10.
- **ii** Calculate the annual water charges based on the bills shown in this question.
- **iii** Based on these calculations, are households spending more on electricity or water on an annual basis?



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9D Other household expenses

The electricity, gas and water utilities that we looked at in the previous section are only some of the regular expenses needed to keep a household running.

Other household expenses can include the following.

- Vehicle registration (charged by the State Government and including cars, motorcycles, trucks, caravans, boats and some trailers).
- Rates (charged by local councils and only charged to house owners or landowners).
- Transport (the cost of getting to work, TAFE or University).
- Communications and the internet (these are covered in section 9F).
- House and contents insurance (payable to private companies for owners, renters or landlords).
- Car insurance (comprehensive or third-party property, fire and theft).
- Private health insurance (there are rules set by the Federal Government that relate to your age when (if) you take out private health insurance, and your level of income).
- Pet insurance
- Home maintenance
- Car maintenance
- Replacement or repair of furniture or whitegoods (like fridges and washing machines) if they become obsolete or break down.



Many of these expenses are discretionary, which means the household has a choice as to whether to spend money on them or not. Some, such as vehicle registration and rates, are non-discretionary, and penalties apply if you do not pay. For example, you can be fined (and may even lose your driver's licence) if you drive an unregistered vehicle. If you do not pay your rates, interest is charged on the amount outstanding.

9D Tasks and questions

Thinking task

1 Often in life unexpected expenses occur when you can least afford them, such as when the washing machine breaks down. Think of ways in which you could be prepared for unexpected expenses.

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Skills questions

2 Go to the Victorian Government (VicRoads) website to find out the following:

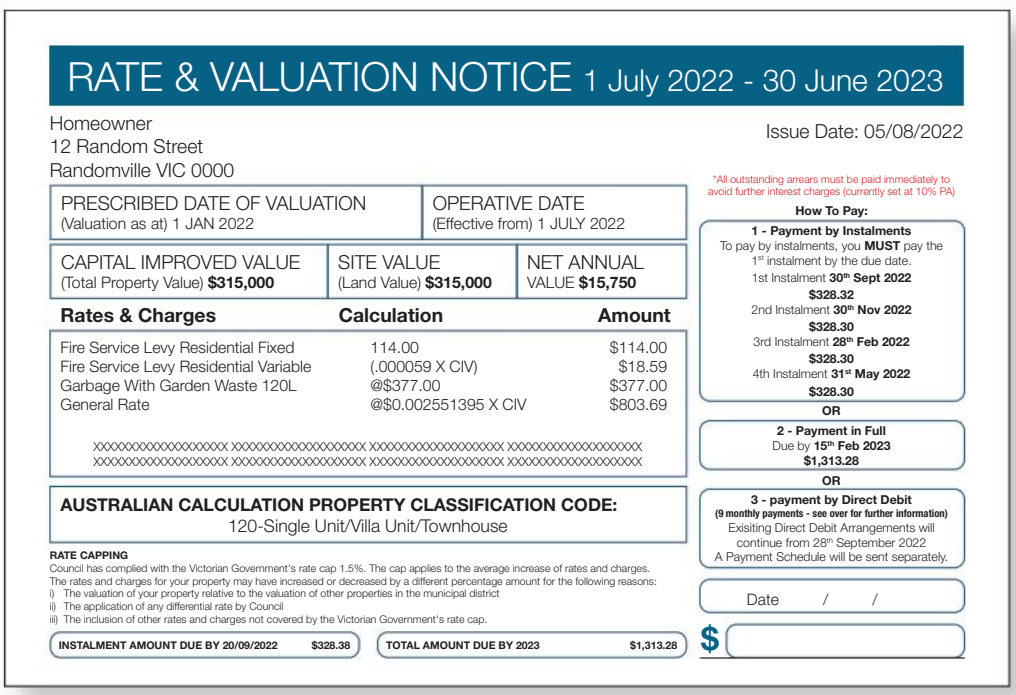
- the current cost to register a car
- the composition of the registration fee.

3 Select another state or territory in Australia and find the registration fees for a car.

- What is the difference in cost between Victoria and the other states/territory?
- Is Victoria more or less expensive than the state/territory you chose?

4 Search online to find out the costs of home insurance, and about how you can reduce your home insurance charges.

5 This is the front page of a rates notice. Use it to answer the following questions.



RATE & VALUATION NOTICE 1 July 2022 - 30 June 2023

Homeowner
12 Random Street
Randomville VIC 0000

Issue Date: 05/08/2022

PRESCRIBED DATE OF VALUATION (Valuation as at) 1 JAN 2022	OPERATIVE DATE (Effective from) 1 JULY 2022

CAPITAL IMPROVED VALUE (Total Property Value) **$315,000**	SITE VALUE (Land Value) **$315,000**	NET ANNUAL VALUE **$15,750**

Rates & Charges	Calculation	Amount
Fire Service Levy Residential Fixed	114.00	$114.00
Fire Service Levy Residential Variable	(.000059 X CIV)	$18.59
Garbage With Garden Waste 120L	@$377.00	$377.00
General Rate	@$0.002551395 X CIV	$803.69

XXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXX

AUSTRALIAN CALCULATION PROPERTY CLASSIFICATION CODE:
120-Single Unit/Villa Unit/Townhouse

RATE CAPPING
Council has complied with the Victorian Government's rate cap 1.5%. The cap applies to the average increase of rates and charges.
The rates and charges for your property may have increased or decreased by a different percentage amount for the following reasons:
i) The valuation of your property relative to the valuation of other properties in the municipal district
ii) The application of any differential rate by Council
iii) The inclusion of other rates and charges not covered by the Victorian Government's rate cap.

INSTALMENT AMOUNT DUE BY 20/09/2022 $328.38

TOTAL AMOUNT DUE BY 2023 $1,313.28

*All outstanding arrears must be paid immediately to avoid further interest charges (currently set at 10% PA)

How To Pay:

1 - Payment by Instalments
To pay by instalments, you **MUST** pay the 1st instalment by the due date.
1st Instalment **30th Sept 2022** **$328.32**
2nd Instalment **30th Nov 2022** **$328.30**
3rd Instalment **28th Feb 2022** **$328.30**
4th Instalment **31st May 2022** **$328.30**

OR

2 - Payment in Full
Due by **15th Feb 2023**
$1,313.28

OR

3 - payment by Direct Debit
(9 monthly payments - see over for further information)
Exisiting Direct Debit Arrangements will continue from 28th September 2022
A Payment Schedule will be sent separately.

Date / /

$

a What period does this notice cover?

b What rates and charges are included in this notice?

c What type of property is this (what is the property classification code)?

d What are the three different payment schedules?

e Why do you think the council would offer different payment schedules?

f What are the arrears mentioned on the notice?

g What interest rate is charged on arrears?

h If these rates were not paid, how much would the interest be for the year?

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6 Search online to find out the costs of car insurance, and about how you can reduce your car insurance charges (make sure you are looking at Australian sites).

- **a** Make a list of the different ways.
- **b** Compare the ways you found with your classmates.
- **c** Order the list from the most achievable for a young person to the least achievable.

Mathematical literacy

7 These are all terms that you might have come across as you searched for details about different types of insurance products. Match the words and phrases on the left with the descriptions on the right.

Agreed value	Spending that you can choose to do or not do.
Comprehensive car insurance	The amount you must pay in the event you make a claim.
Discretionary spending	The amount you pay for an insurance product.
Fire and theft car insurance	Car insurance that covers damage to your car in the event of an accident.
Health insurance extras	An insurance policy that provides new furniture or white goods (for example) in the event of an insurance claim.
Insurance policy excess	A value agreed to by you and your insurance company that will be paid in the event of your car being 'written off'.
New for old replacement	The market value of your car that will be paid in the event of your car being 'written off'.
Premium	The term used by insurance companies to indicate that repairs to a car would exceed the value of the car.
Market value	Private health care can cover you for more than just hospital cover: services such as physiotherapy, dental, chiropractic and podiatry can also be covered.
Third party property car insurance	Car insurance that covers the cost of damage to another person's car or property in the event of you being in an accident.
Written off	Car insurance that covers the cost of your car if it is stolen or burnt.

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Application questions

8 Search private health insurance online and compare three different options.

- **a** Investigate what level of cover is best for you at your stage of life.
- **b** Compare costs to find the best deal.
- **c** Decide whether you will include 'extras' or not. Compare the cost of 'extras' with the cost of paying for the services you might use in a year yourself.
- **d** Present your findings using a spreadsheet and make a recommendation on which is the most suitable insurance option.



9 Compare three quotes for third party fire and theft insurance on a car

- **a** decide on car to insure for i.e. your ideal first car
- **b** find three insurance companies and request a quote based on your ideal car
- **c** use a spreadsheet to present your findings and make a recommendation on which is the most suitable insurance option.

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9E Getting the best deal – Optimising expenses

When we talk about **optimisation** or optimising something, we mean making it as good as we can. When we talk about optimising expenses, we mean paying the lowest price for the service we require.

Single providers and choice of different providers

In the last two sections, we looked at utilities and other household expenses. These can be classified into two categories: **single provider** and **choice of different providers**.

Single provider	Choice of providers
Car registration	Electricity
Rates	Gas
Water	Car insurance
	Private health insurance
	Pet insurance
	Car maintenance
	Household maintenance

The single provider category includes car registration, rates and water. Based on where you live, you have no choice but to use the provider who is allocated to that area and to pay the amount they charge.

- The State Government sets the amount we pay for car registration in Victoria. The total registration cost includes the Transport Accident Commission (TAC) fee, which supports anyone injured in an accident on the roads, and a fee that goes towards road building and maintenance, road safety and traffic management.
- The local government council or shire sets the amount we pay for rates (if we are home owners or landowners). The amount we pay for rates covers waste (rubbish, recycling and garden) collection and the provision of community, sporting and recreation services in that local government area.
- Water corporations, such as South East Water, Barwon Water or Grampians Wimmera Mallee Water, provide water and sewerage services in their designated area.

Where there is a choice there is competition amongst the providers, and the customer can benefit from offers, such as pay-on-time discounts, discounts for direct debit and discounts for receiving your bill by email rather than a paper copy by snail mail. As a consumer, you must be pro-active to optimise your expenses and seek out the best deals for you.

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Comparison websites

Comparison websites offer a chance to compare prices for the services where there is competition between providers. But be careful – comparison websites do not always compare every provider, and providers may pay them to make sure their service is at the top of the list or close to it. Some comparison websites offer 'exclusive' deals that you can only get by using their website to compare and select that provider. The Victorian Government provides a comparison website for electricity and gas providers. The Australian Government provides a comparison website for private health insurance policies.

9E Tasks and questions

Thinking task

1 Is the lowest price *always* the best option for a consumer to take? Why or why not?

Give examples to support your position.

Skills questions

2 Do a quick google search for 'Comparison websites for energy providers'.

a How many sites at the top of the list were 'Ad' sites?

b How many sites were listed (including the 'Ad' sites) *above* the Victorian Government Energy Compare site?

3 Here are two offers that the Victorian Government Energy Compare site has found.

Offer A

Offer rate and details
AEST only

11/12/2021-10/12/2022
11 December - 10 December

	Tariff(inc. GST)
Supply charges	83.60 ¢/day
Flat	
First 608.33 kWh per month	19.03 ¢/kWh
Balance	23.10 ¢/kWh

Current FIT policy
1 January - 31 December

All export	6.70 ¢/kWh

Premium FIT [closed]
1 January - 31 December

All export	60.00 ¢/kWh

Offer B

Offer rate and details
AEST only

All year
1 January - 31 December

	Tariff(inc. GST)
Supply charges	73.70 ¢/day
Flat	
All consumption	19.09 ¢/kWh

Premium FIT [closed]
1 January - 31 December

All export	60.00 ¢/kWh

Current FIT policy
1 January - 31 December

All export	7.10 ¢/kWh

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a Which offer is cheaper for Supply charges?

b Which offer is cheaper for Consumption charges?

c Which has the higher Feed in Tariff (FIT) policy?

d Which of these offers is cheaper overall? (This might be a trick question!)

e What else do you need to know to be able to work out which would be cheaper?

4 Use the offers shown in the previous question to work out which is the optimal (lowest) in each of the following situations. Assume a month of 30 days and calculate the cost for one month. Hint: Setting up a table could help.

a A household that uses 354 kWh per month.

b A household that uses 278 kWh per month.

c A household that uses 798 kWh per month.

5 One of the discount offers includes the following wording:

> **Discounts:**
>
> **Conditional (3%): Percentage of bill amount**
>
> You will receive 2% on-time payment discount off your total consumption and daily charge when you: Pay your bill on or before the due date. You will also receive an extra 1% on-time payment discount when you pay with direct-debit.

You receive bills for the amounts shown below. For each one, calculate the following:

i the on-time payment discount

ii the discount for payment with direct debit

iii the combined discount received

a $123.68

b $1549.34

c $243.00

d $60.62

e There are two different methods that can be used to calculate the total discount. Show these two methods using one example from parts **a**-**d**.

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6 Go to the Australian Government's private health insurance comparison website and conduct a search that compares two of the five most common insurers: Medibank, Bupa, HBF, HCF and NIB.

For this and the subsequent questions, assume you are a single person with no dependants.

a Print out the final summary page from your search.

b Comment on any similarities or differences between the selected insurers.

c Find the meaning of the following with relation to private health insurance policies.

i Excess

ii Co-payment

iii Age-based discount

iv Medicare levy surcharge

v Hospital tier

vi Gap-cover doctors

7 The Medicare Levy Surcharge (MLS) is another initiative of the Australian Government, designed to encourage people with higher taxable income to take out private health insurance, and it is calculated when you complete your tax return. If you have a taxable income over the given threshold and do not have private health insurance, you must pay the levy. The following table shows the thresholds given on the ATO website (in 2022).

MLS income thresholds and rates from 2014–15 to 2022–23

Threshold	Base tier	Tier 1	Tier 2	Tier 3
Single threshold	$93 000 or less	$93 001–$108 000	$108 001–$144 000	$144 001 or more
Family threshold	$186 000 or less	$186 001–$216 000	$216 001–$288 000	$288 001 or more
Medicare levy surcharge	0%	1%	1.25%	1.5%

The family income threshold is increased by $1500 for each MLS-dependent child after the first child.

a Which percentage surcharge would be applied to a single person with a taxable income of $235 000?

b Which percentage surcharge would be applied to a single person with a taxable income of $75 230?

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c Calculate the amount of the levy to be paid on a single taxable income of $93 000.

d Tom is a single person with a taxable income of $125 000. He has no dependent children. What Medicare levy surcharge will be used to calculate Tom's Medicare levy?

e How much will Tom pay?

Mathematical literacy

8 Explain the difference between an age-based discount and the Lifetime Health Cover loading.

Explain why the Australian Government introduced the Lifetime Health Cover loading and the Medicare surcharge levy.

Application tasks

9 If someone was charged the maximum 70% Lifetime Health Cover loading when they first took out their policy, what is the minimum age they could be? Search 'Lifetime Health Cover loading' on the ATO website to help you understand the concept and answer this question.

10 Fast forward in your life to imagine yourself as the following people. Think of the type of health and hospital services they might need at this stage of their lives. Discuss with your classmates to develop a comprehensive list.

a Jantan is 24 years old and has just started full-time work as a bricklayer. He is an active sportsperson and enjoys skateboarding and playing basketball and cricket. This will be Jantan's first private health insurance policy.



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b Kristina and Nic have three teenage children. Marc is 18 and is in first year at university. Jon is in Year 10 and Erika is in Year 8. The family have had ongoing private health cover, so there is no consideration of Lifetime Health Cover loading.

11 Find the optimal private health insurance policy for Jantan and for Kristina and Nic's family (based on your search results in question 10 above). Compare your optimal health policy with the policy found by others in your class. What differences were there in the assumptions that you each made when completing the search?

12 Using the cost of the optimal health insurance policies from the previous question, the MLS income thresholds and the rates table from the ATO given above, and the taxable income given, complete the table.

	Annual taxable income	Annual cost of health insurance policy	% Medicare levy surcharge	Amount of Medicare levy surcharge
Jantan	$59 750			
Kristina and Nic	$363 000			

13 For each of Jantan and Kristina and Nic's family, compare the annual cost of the health insurance policy with the amount of the Medicare levy surcharge. Determine whether they would be better off financially if they take out a private health cover policy.

14 Discuss with your classmates why a person or family would choose to pay for private health insurance, even though it might not at first appear that they would be better off financially.

15 Does this discussion change your mind on the definition of **optimisation**?



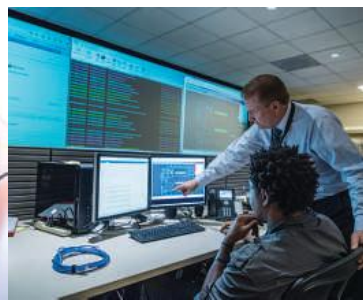
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9F 21st century communications

Can you imagine a life without the internet? What would life be like without social media? How would you communicate with your peers? Find out about news? Hear the latest music?

The infrastructure and labour needed to run your favourite apps is mindboggling!





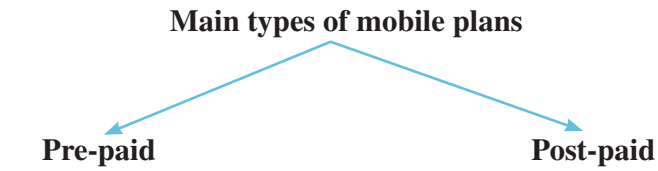
The cost of communications can be high. Companies need to pay for electricity and hardware to store cloud data, maintain networks and pay for radio spectrum and upgrades.

Choosing a communications plan can be daunting. Do you pay for your mobile as a pre-paid, top-up, set amount or flexible plan? Or do you have your mobile in a bundle with your family as part of a home and internet package?

Each company has different plans and pricing, and comparing plans can be confusing. To help you choose, we will look at some common features of plans in Australia.



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- Pay upfront
- Charges may be higher
- No contract
- You choose what to pay
- No nasty surprises with the bill.

- Monthly bill
- Charges may be lower
- May be locked into a contract
- Charges are set, but fees will be even higher if you go over your allocation of calls or data.

In Victoria, the average customer would expect to pay $27 on a post-paid plan and $34 on a pre-paid plan.

It is worth remembering that if you use more data than expected, your monthly post-plan bill can be **much higher**!

9F Tasks and questions

Thinking task

1 Investigate the mobile plan you are currently subscribed to. Is it pre-paid or post-paid? What are the monthly charges? How much data do you get per month? What are the excess charges? What is the actual cost of your plan each month? Compare your plan with others in your class.

Skills questions

2 For each question below, calculate the total cost of each plan over the following time frames.

i A one-year contract.

ii A two-year contract.

a $19 per month.

b $25 per month.

c $50 initial payment for the first month and then $16 per month.

d $300 initial payment for the first month and then $16 per month.

e $15 per month for the first 6 months and then $24 per month.

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f $8 per month for the first 6 months and then $20.99 per month.

g $11.50 per month for the first 3 months and then $22 per month.

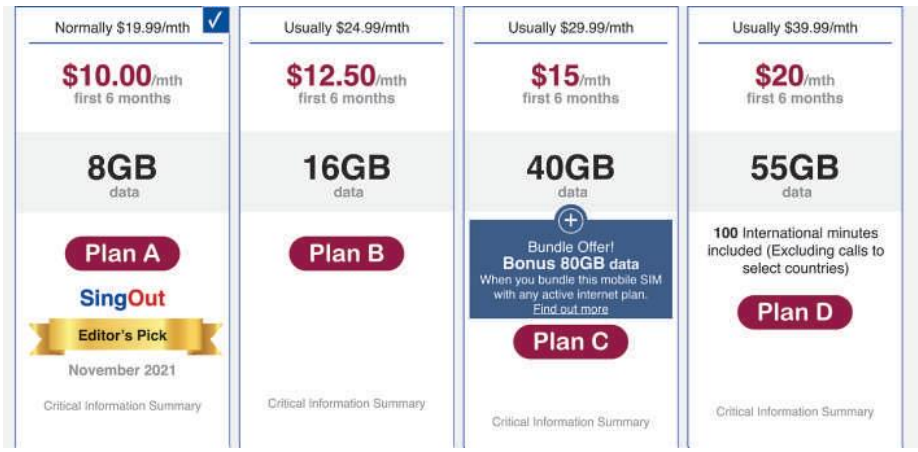
h $14 per month for the first 3 months and then $16.75 per month.

3 Look at the plans below, and calculate the total cost of each plan over the following contracts.

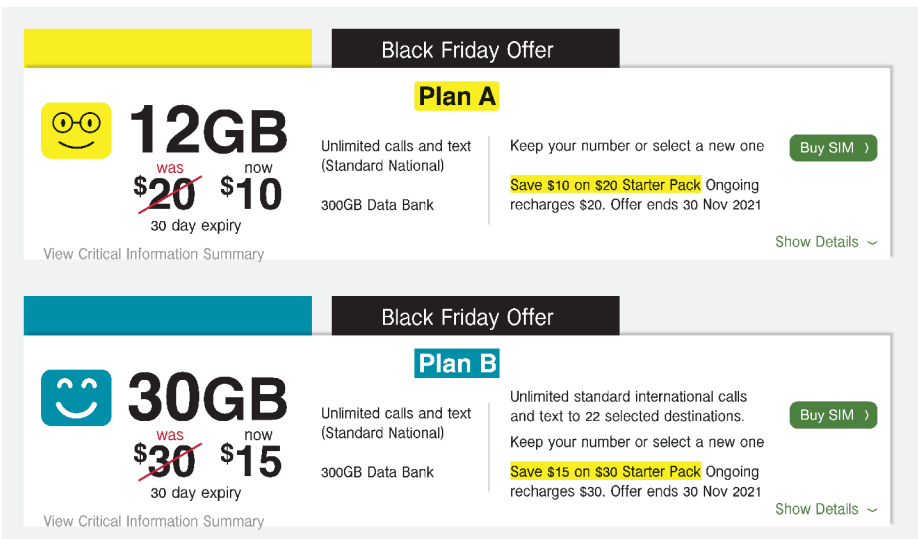
i A one-year contract.

ii A two-year contract.

a

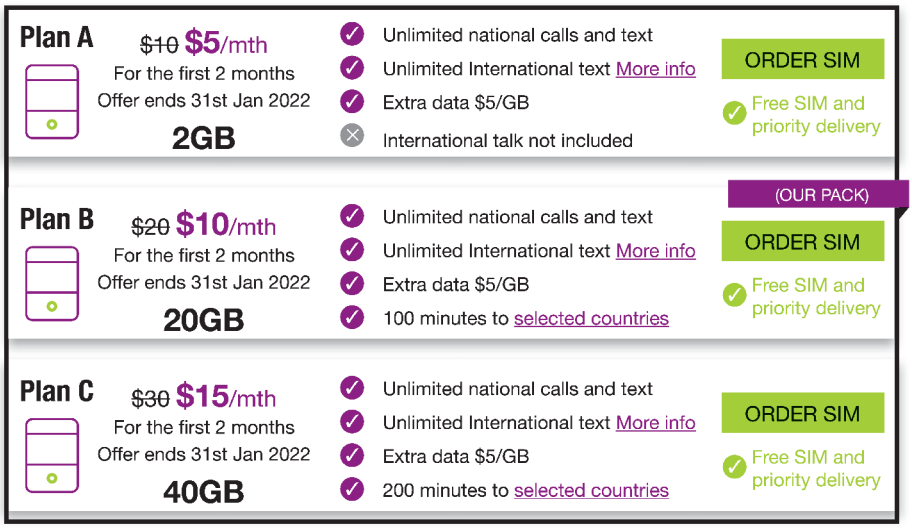


b



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c



4 Calculate the monthly charge for the following plans.

a $20 per month with 1 GB of extra data used at a cost of $10 per extra block of 1 GB.

b $20 per month with 4 GB of extra data used at a cost of $10 per extra block of 1 GB.

c $20 per month with 6.7 GB of extra data used at a cost of $10 per extra block of 1 GB.

d $15 per month with 1 GB of extra data used at a cost of $25 per extra block of 4 GB.

e $15 per month with 3 GB of extra data used at a cost of $25 per extra block of 4 GB.

f $15 per month with 2.9 GB of extra data used at a cost of $25 per extra block of 4 GB.

g $23 per month with 1 GB of extra data used at a cost of $8 per extra block of 4 GB.

h $23 per month with 7 GB of extra data used at a cost of $8 per extra block of 4 GB.

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5 Look at the following charges for international calls on a mobile phone plan.

The Flag Fall is the initial cost.

The Rate/Minute is the cost for each minute.

$A is Australian dollars.

Country	Country Code	Flag Fall	Rate/Minute ($A)
Afghanistan	93	$0.35	$0.32
Antarctica	6721	$0.35	$2.08
Brazil	55	$0.35	$0.09
Cook Islands	682	$0.35	$1.04
Egypt	20	$0.35	$0.14
Fiji	679	$0.35	$0.32
Greece	30	$0.35	$0.07
Grenada	1473	$0.35	$0.33
Indonesia	62	$0.35	$0.12
Kenya	254	$0.35	$0.22
Kiribati	686	$0.35	$0.80
Malaysia	60	$0.35	$0.06

a Calculate the cost of a 1 minute phone call for each country.

b Calculate the cost of a 2 minute phone call for each country.

c Calculate the cost of a 3 minute phone call for each country.

d Calculate the cost of a 30 minute phone call for each country.

e Write a formula in words, showing how you made each calculation.

f Write a formula using letters, showing how you made each calculation.

g Use your formula to find out how much a 45-minute phone call would be to the following places.

i Cook Islands **ii** Greece **iii** Kenya

Mathematical literacy

6 Write definitions for the following words: plans, calls, data.

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Application tasks

7 Look at the following plan and answer the questions.

Plan Details	$10	$20	$30	$40
Mobile data included	2 GB	20 GB	40 GB	80 GB
Included call value	Unlimited			
International Calls	N/A	First 100 mins to 35 selected countries	First 200 mins to 35 selected countries	First 300 mins to 35 selected countries
Minimum monthly charge	$10	$20	$30	$40
Extra data	$20 per GB	$15 per GB	$10 per GB	$5 per GB
Minimum contract term	1 month			

a What is the minimum term (length) of the contract?

b For the $10 plan, how much data is included?

c For the $10 plan, how much will it cost to buy 2 extra GB of data?

d For the $10 plan, what is the total monthly cost including 2 extra GB of data?

e For the $40 plan, how much will it cost to buy 2 extra GB of data?

f For the $40 plan, what is the total monthly cost including 2 extra GB of data?

g Find the cost per month for the following.

- **i** $10 plan with no extra data.
- **ii** $10 plan with 1 GB of extra data.
- **iii** $10 plan with 3 GB of extra data.

h Find the cost per month for the following.

- **i** $20 plan with no extra data.
- **ii** $20 plan with 1 GB of extra data.
- **iii** $20 plan with 3 GB of extra data.

i Find the cost per month for the following.

- **i** $30 plan with no extra data.
- **ii** $30 plan with 1 GB of extra data.
- **iii** $30 plan with 3 GB of extra data.

j Find the cost per month for the following.

- **i** $40 plan with no extra data.
- **ii** $40 plan with 1 GB of extra data.
- **iii** $40 plan with 3 GB of extra data.

k Which do think is the best plan for you, and why?

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8 Consider the following plan.

Phone Choice

Critical Information Summary
Live Plans (12 Months)

These plans are for a post-paid mobile service. This gives you access to a mobile phone number and allows you make and receive calls, send and receive messages and access mobile data all within Australia.

PLAN	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Plan 6
Minimum monthly charge	$17	$22	$28	$33	$38	$45
Total Minimum Cost	$204	$264	$336	$396	$456	$540
Maximum Early Termination Charge	$180	$180	$180	$180	$180	$180
Monthly Call allowance	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
International SMS	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
Standard National SMS and MMS	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
Standard National VIDEO MMS	60 per bill cycle*	60 per bill cycle*	60 per bill cycle*	60 per bill cycle*	60 per bill cycle*	60 per bill cycle*
International Calls	Not included	Not included	Unlimited to 20 selected countries	Unlimited to 20 selected countries	Unlimited to 20 selected countries	Unlimited to 20 selected countries
Limited International Calls-Limited IDD minutes	Not included	Not included	Limited to 20 selected countries (60 minutes)	Limited to 20 selected countries (120 minutes)	Limited to 20 selected countries (180 minutes)	Limited to 20 selected countries (240 minutes)
Monthly Data Allowance	5 GB	14 GB	28 GB	38 GB	48 GB	65 GB
Data Bank Allowance	100 GB	150 GB	200 GB	250 GB	300 GB	350 GB
Fair use policy applies. All for use in Australia only. Calls, SMS and voicemails to standard Australian numbers.						
*Standard VIDEO MMS charges apply once included limit is exceeded.						
Early Termination Charges apply to cancellation during the minimum contract term. Refer to information below regarding Early Termination Charges.						

a Explain what is meant by a **Minimum Monthly Charge**.

b How is the **Total Minimum Cost** calculated?

c Find the total cost for each of Plans 1 to 6 after being in the contract for 6 months.

d You decide to **terminate** (leave) the contract after 6 months. You must pay the early termination charge. What is the cost of 6 months contract plus the termination fee for each of Plans 1 to 6?

e If you use, on average, 20 GB per month, which is the best plan for you?

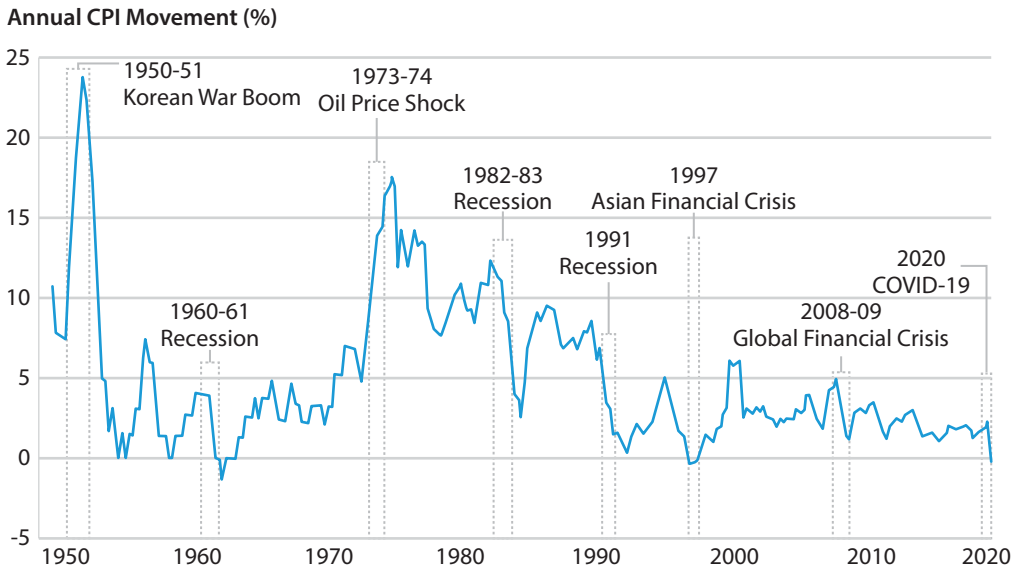
f You make unlimited international calls to family overseas, using 10 GB of data per month. Which is the best plan for you and why?

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9G Inflation and CPI

Inflation is the increase in the price of goods and services that households buy. The **Consumer Price Index (CPI)** measures inflation and is reported every quarter, and an annual CPI percentage (indicating annual inflation) is calculated.

In Australia, we have calculations of inflation going back to 1948. The graph below shows the annual changes in CPI from 1948 to 2020. As you can see, the inflation rate has been up and down over the years.



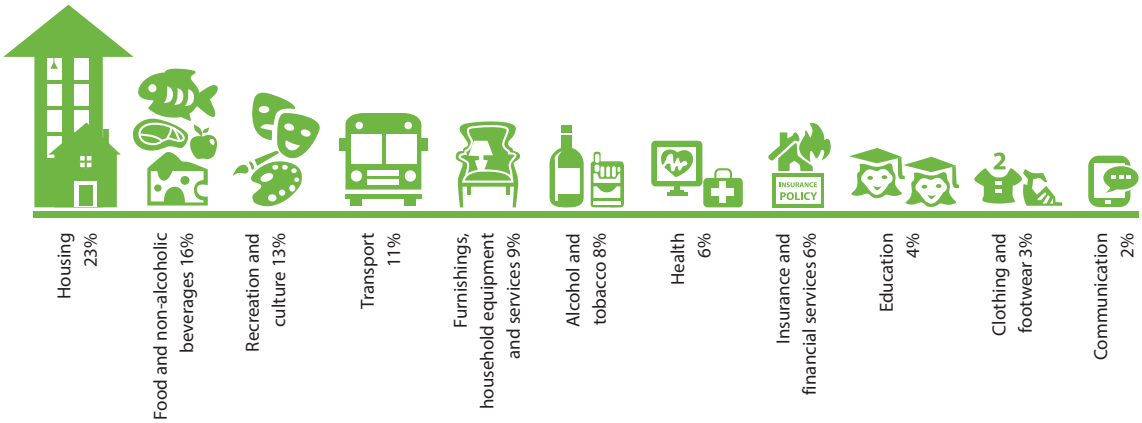
Source: ABS
Annual Consumer Price Index (CPI) movement from 1948 to 2020.

The data used to calculate the CPI is collected by the Australian Bureau of Statistics (ABS). The data represents a 'basket' of 11 categories or groups that households spend money on. The ABS receives much of the data required to calculate the CPI electronically. This data comes from retailers, government authorities, energy providers and real estate agents. The ABS also uses web scraping to obtain online price data.

The basket categories and their weighting are shown below. If households spend more on a particular category, that category will have a higher percentage weight in the CPI.

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Groups in the CPI basket and their weights



You can search for and download the complete list with the weightings for each category from the ABS website.

How the CPI is calculated

There is a formula which is used to calculate inflation as a percentage.

$$\text{Inflation} = \frac{\text{Price}_{\text{Year2}} - \text{Price}_{\text{Year1}}}{\text{Price}_{\text{Year1}}} \times 100$$

Let's assume we are calculating inflation between 2018 (Year 1) and 2019 (Year 2).

Let's look at a basket category containing two typical household expenses – childcare and rent.

In 2018, the average cost per hour of childcare was \$9.50, and in 2019 it was \$9.95.

$$\text{Inflation} = \frac{\text{Price}_{\text{Year2}} - \text{Price}_{\text{Year1}}}{\text{Price}_{\text{Year1}}} \times 100$$

$$\begin{aligned}\text{Inflation for childcare} &= \frac{\$9.95 - \$9.50}{\$9.50} \times 100 \\ &= \frac{\$0.45}{\$9.50} \times 100 \\ &= 4.74\%\end{aligned}$$

Recall that on a smartphone calculator, this calculation is just: 0.45 ÷ 9.5 then press % and =.

In 2018, the median weekly rent was \$420, and in 2019 it was \$425.

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$$\text{Inflation} = \frac{\text{Price}_{\text{Year2}} - \text{Price}_{\text{Year1}}}{\text{Price}_{\text{Year1}}} \times 100$$

$$\begin{aligned}\text{Inflation for rent} &= \frac{\$425 - \$420}{\$420} \times 100 \\ &= \frac{\$5}{\$420} \times 100 \\ &= 1.19\%\end{aligned}$$

Households spend much more on rent than they do on childcare, so in our imaginary basket with just these two items, let's assume rent is weighted at 86% and childcare at 14%.

To calculate the inflation for our basket, we apply the weights to the % change in prices:

$(0.14 \times 4.74) + (0.86 \times 1.19) = 1.69\%$

Therefore, the CPI for our basket is 1.69%. This is summarised in the following table.

	2018	2019	Inflation	Basket weighting	Contribution to CPI
Childcare	$9.50/hr	$9.95/hr	4.74%	14%	0.6636%
Rent	$420/week	$425/week	1.19%	86%	1.0234%
				100%	1.69%

This is the process that the ABS uses to calculate the CPI or inflation figure, but of course, their basket has a lot more items in it, and they collect a lot more data to calculate the average cost of each item each quarter.



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9G Tasks and questions

Thinking task

1 List your personal expenses in the past month in order from those items you spend the most on, to those items you spend the least on. Divide each item according to whether it is a 'need' or a 'want'.

Skills questions

2 Look back at the graph at the start of section 9G, showing the annual movement in CPI from 1948 to 2020. Use the graph to answer the questions below.

- **a** What has been the highest CPI percentage movement during this period?
- **b** What year did this occur?
- **c** How many times has the movement shown deflation (negative inflation)?
- **d** What do these times have in common?
- **e** What has happened to the CPI movement in times of recession?

3 Using the formula for inflation, calculate the annual inflation for each of the following items.

$$\text{Inflation} = \frac{\text{Price}_{\text{Year2}} - \text{Price}_{\text{Year1}}}{\text{Price}_{\text{Year1}}} \times 100$$

- **a** Storage space rental

  2019 average price per month: $340.00

  2020 average price per month: $360.00

- **b** Comprehensive car insurance

  2019 average price per annum: $771.99

  2020 average price per annum: $893.86

- **c** Eggs – 700 grams

  2019 average price per dozen: $4.65

  2020 average price per dozen: $4.76

- **d** Bananas

  2019 average price per kg: $2.94

  2020 average price per kg: $2.64

- **e** Electricity

  2019 average price per kWh: 0.3740

  2020 average price per kWh: 0.2475

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4 Calculate the Year 2 average prices, given the Year 1 average price and the annual inflation rate.

a Annual inflation rate: 3%

Year 1 average price: $100.00

b Annual inflation rate: 2%

Year 1 average price: $600.00

c Annual inflation rate: 4%

Year 1 average price: $36.00

d Annual inflation rate: 3.7%

Year 1 average price: $325.00

e Annual inflation rate: 2.65%

Year 1 average price: $78.60

f Annual inflation rate: 0.2%

Year 1 average price: $100.00

g Annual inflation rate: 0.36%

Year 1 average price: $23.74

5 If we know the inflation rate for a period and the current average price of a good or service (the Year 2 price), we can calculate the average price of that good or service in the previous period (the Year 1 price).

$$\text{Previous period average price (Year 1)} = \frac{\text{Current average price}}{1 + \text{Inflation rate as a decimal}}$$

To make the inflation rate as a decimal, divide by 100.

Use the information given to calculate the average price in the previous period.

a Inflation rate per annum: 3% Current average price: $103.00

b Inflation rate per annum: 4% Current average price: $832.00

c Inflation rate per annum: 2% Current average price: $432.78

d Inflation rate per annum: 2.6% Current average price $215.00

e Inflation rate per annum: 3.4% Current average price $143.20

f Inflation rate per annum: 5.32% Current average price $256.34

g Inflation rate per annum: 0.7% Current average price $153.00

h Inflation rate per annum: 0.83% Current average price $264.32

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Mathematical literacy

6 So far, we have looked at inflation and deflation, and we have worked with the inflation rate. There is, however, a third state that the change in the CPI can take: **stagflation**. Find the definition of stagflation, and make notes on inflation, deflation and stagflation in your own words.

Application tasks

7 Explain what happens to the cost of living for the following households when inflation rises because of an increase in rent. Use some examples to support your explanation. You might need to make some assumptions about the households. If you do, include the assumptions in your explanation.

- **a** A single parent household.
- **b** An aged pensioner couple household.
- **c** A household with five school-aged children where both parents work.



8 Explain what happens to the cost of living for the following households when inflation rises because of an increase in fuel prices and an increase in the cost of food. Use some examples to support your explanation. You might need to make some assumptions about the households. If you do, include the assumptions in your explanation.

- **a** A single parent household.
- **b** An aged pensioner couple household.
- **c** A household with five school-aged children where both parents work.

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9H Informed spending choices

Let's say you've just been to the fruit and veg store. You take a look at the receipt, shown below.



Seedless Valencia Oranges
1.21KG X $3.99 = $4.83
Jazz Apples
0.695KG X $6.99 = $4.86
Honey Dew / Half
1 X $2.99 = $2.99
Bok Choy
2 X $2.29 = $4.58
Red Capsicum Inside
0.86KG X $12.99 = $11.17
Mushroom Button
1.01KG X $14.99 = $15.14
Ginger
0.545KG X $29.99 = $16.34
Baby COS Pack
1 X $3.99 = $3.99
Hass Avocado / Each
1 X $2.99 = $2.99
Kp Mango / Each Inside Kp
1 X $2.99 = $2.99
Broccoli
0.295KG X $6.99 = $2.06
Banana
0.63KG X $2.69 = $1.69
Lebanese Cucumbers / Large Inside
0.27KG X $3.99 = $1.08

Three things stand out to you as being wrong, and you walk back to the store to talk to the store manager. What might these three things be?



$12.99 per kg – Outside vs $8.90 per kg – Inside



Loose – $9.00 per kg



$29.99 per kg

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You speak with the store manager and show him the receipt. The manager apologises and agrees that you've been charged too much, and refunds you the difference.

- First, you were charged for capsicum sold *outside* when you had bought the capsicum from *inside*. Usually in fruit and veg stores, the outside price is less than the higher-quality inside produce. But on this day, the placement was the other way around.
- The wrong cost per kg had been used for the button mushrooms, making them more expensive.
- And finally: half a kg of ginger is an awful lot of ginger! The actual amount you bought was 0.0545kg, not 0.545 kg. The mistake for the ginger was a wrong decimal point entered by the cashier.

The amounts should have been:

Red capsicum – inside 0.86 kg × \$8.90 = \$7.65

Mushroom button 1.01 kg × \$9.00 = \$9.09

Ginger 0.0545 kg × \$29.99 = \$1.63

In total, these items should have cost \$18.37. Yet you paid \$42.65.

By returning to the store, you received a refund of \$24.28!

9H Tasks and questions

Thinking task

1 Can you think of a time when you or someone you know has been ripped off or scammed? Discuss your stories with the class.

Skills questions

2 For each of the items below, complete the following.

i Guess the cost.

ii Calculate the cost.

a 1 kg of Kipfler brushed potatoes at \$2/kg.

b 2 kg of Kipfler brushed potatoes at \$2/kg.

c $\frac{1}{2}$ kg of Kipfler brushed potatoes at \$2/kg.

d 1 kg of red delicious apples at \$4.90/kg.

e $\frac{1}{2}$ kg of red delicious apples at \$4.90/kg.

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f $\frac{1}{4}$ kg of red delicious apples at $4.90/kg.

g 1 kg of truss tomatoes at $7.80/kg.

h $\frac{1}{2}$ kg of truss tomatoes at $7.80/kg.

i 0.25 kg of truss tomatoes at $7.80/kg.

j 0.1 kg of truss tomatoes at $7.80/kg.

3 For the discounts shown below, answer the following questions.

i Estimate what the price should be.

ii Check that the discounts have been correctly applied.

iii If the price is incorrect, state the correct price.

iv If the price was incorrect, what was the difference? Did the customer pay more or less than the correct price?

a Black Friday sale – $30 off. RRP $199, now $179.

b End of season clearance – $40 off. RRP $217, now $187.

c End of season clearance – $15 off. RRP $108, now $95.

d Black Friday sale – $95 off. RRP $460, now $375.

e Stocktake sale – $8 off. RRP $34.99, now $27.99.

f Stocktake sale – $36 off. RRP $265, now $246.

g End of season clearance – $26 off. RRP $85.89, now $61.89.

h Boxing Day clearance – $159 off. RRP $694, now $549.

i Boxing Day clearance – $48 off. RRP $278, now $134.

4 For the discounts shown below, answer the following questions.

i Estimate in your head what the price should be.

ii Check that the discounts have been correctly applied.

iii If the price is incorrect, state the correct price.

iv If the price was incorrect, what was the difference? Did the customer pay more or less than the correct price?

a 10% off. RRP $98, now $90.

b 10% off. RRP $54.50, now $50.

c 10% off. RRP $124, now $112.

d 10% off. RRP $50.50, now $45.50.

Hint Remember, when finding 10%, a quick way is to move the decimal point one space to the left. So, $98.00 becomes $9.80.

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e 10% off. RRP $49.99, now $39.99.

f 10% off. RRP $32, now $29.

g 10% off. RRP $62.98, now $56.71.

h 10% off. RRP $56.95, now $51.95.

5 For the discounts shown below, answer the following question.

i Estimate in your head what the price should be.

ii Check that the discounts have been correctly applied.

iii If the price is incorrect, state the correct price.

iv If the price was incorrect, what was the difference? Did the customer pay more or less than the correct price?

a 50% off. RRP $68, now $38.

b 50% off. RRP $99.99, now $52.00.

c 50% off. RRP $1024, now $560.

d 50% off. RRP $76.50, now $38.25.

e 20% off. RRP $107.98, now $86.40.

f 20% off. RRP $36, now $29.

g 20% off. RRP $582, now $475.60.

h 20% off. RRP $78, now $65.

Hint To guess 50% off, halve the price.
To guess 20% off, work out 10% and double it.

6 You pay for the following in cash! Calculate the change you *should* receive.

a Cost $76.50. You have four $20 notes.

b Cost $37.00. You have two $20 notes.

c Cost $92.89. You have five $20 notes.

d Cost $174.99. You have nine $20 notes.

e Cost $54.50. You have one $50 note and some $2 coins.



f Cost $15.60. You have a $10 note and some $2 coins

g Cost $42.80. You have two $20 notes and a $5 note.

h Cost $152.65. You have four $50 notes.

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Mathematical literacy

7 Find a scam on the internet. Make a poster or digital presentation warning people about the scam. Include the relevant government websites that people can visit for help and advice. Include a screenshot of the scam and warnings telling the reader how to spot the features of the scam.

Warning: Be careful when searching for scams that you do not fall for one yourself!



Application tasks

8 Kai decided to join the local gym: 'Get Big Muscles Quick'. The gym was near Kai's home and seemed like a good deal.

Kai had to choose from one of three packages.

Package A	**SALE!** ✓ First 14 days free ✓ $109 per month ✓ 24 months minimum	All inclusive
Package C	**SALE!** ✓ $14.95 per week ✓ Pay the first month upfront ✓ 24 months minimum	All inclusive
Package C	**REGULAR** ✓ 6-month instalments of $305 ✓ Pay for access card – $45 ✓ 24 months minimum	All inclusive

Kai is overwhelmed and the salesperson is putting the pressure on! The salesperson explains that the offer is only for today. They tell Kai that he will not get a better offer anywhere else, and that the sale is *amazing value!*

a Which package does your 'gut' tell you is the best one for Kai?

b What is the cost over two years of Package A?

c What is the cost over two years of Package B?

d What is the cost over two years of Package C?

e Which is the best deal mathematically?

f What strategies could Kai use to stop himself from being scammed?

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9 A tradie provides a quote for paving the backyard.

Superfast Paving **QUOTE**
Paving since 2021 12/12/2023

Melbourne
Victoria
TO:
Brendan

COMMENTS OR SPECIAL INSTRUCTIONS:
Paving the back area of house

QUANTITY	DESCRIPTION	UNIT PRICE	TOTAL
12	Sandstone pavers 12 m^2	$39.00	$560.00
12	Labour $70 per m^2	$70.00	$1022.00
12	Mortar	$60.00	$720.00
NA	Preparation and rubbish removal	$180	$180
NA	Miscellaneous	TBC	TBC
		SUBTOTAL	$2882.00
		GST	$288.20
		TOTAL DUE	$3270.20

THANK YOU FOR YOUR BUSINESS!

This dodgy quote has several flaws.

a Find the cost of 12 m^2 of pavers.

b Find the cost of labour.

c Find the sub-total cost.

d Find the total cost with GST.

e How much extra did this quote charge?

f What does TBC mean? Should this be on a quote?

g What strategies should you use when examining quotes?

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9I Recreational spending

Spending money on favourite recreational activities can bring satisfaction and trigger happiness in the brain.

Some activities which we consider recreational may also have the potential to harm us. Online gaming and gambling are aspects of recreational spending which we will examine here.

First we will look at the idea of expressing **likelihood** with a percentage. Likelihood is the chance that something will happen.

In Victoria, regulations state that the likelihood or **odds** of winning or losing in gambling must be given in percentages. Commonly, the information given to punters is expressed in dollars $, and bets are measured in $1 units.

Suppose you place a $5 bet. This means for a $1 unit investment (tricky language for how much a person spends on the bet) if you win, you will collect $5 from the bookmaker.

If you lose, you will lose your $1.

How does this work?

Thinking about the maths – if you collect $5, this means you have actually won only $4!

That is, your intial cost of $1 plus a $4 win equals $5:

$1 + $4 win = $5 payout.

That means you have a ratio of:

1 : 4 = 5 parts in total.

Thinking about each number in the ratio as a fraction gives us:

$\frac{1}{5}$ and $\frac{4}{5}$

We can express each of these as a percentage.

$\frac{1}{5} \times 100 = 20\%$ there is a 20% chance of winning.

$\frac{4}{5} \times 100 = 80\%$ there is an 80% chance of losing.

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Example 3 Visually representing ratios

Visually represent a bet of $5.

THINKING	WORKING
STEP 1	
Write the mathematical sentence.	$1 + $4 win = $5 payout.
STEP 2	
Find the ratio.	1 : 4 = 5 parts in total.
STEP 3	
Draw the ratio.	

Example 4 Calculate wins and losses

Brendan places $10 of his money on a $4 bet.
If successful, how much will Brendan win from the bookmaker?
If unsuccessful, how much will Brendan lose?

THINKING	WORKING
STEP 1	
If Brendan wins, he will collect $40.	$40 payout = $40 – $10 bet = $30 win.
STEP 2	
Find the ratio.	1 : 3 = 4 parts in total.
STEP 3	
Brendan is placing 10 units of money. Multiply each side by 10.	$1 \times 10 : 3 \times 10 = 40$ in total. 10 : 30 = 40 parts in total.
STEP 4	
Interpret the maths.	If Brendan wins, he will collect $40. If Brendan loses, he will lose $10.

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Example 5 Finding the chance of winning as a fraction

Brendan places his money on a $3 bet. Calculate the chance of winning and losing as a fraction.

THINKING	WORKING
STEP 1	
Thinking about the maths – If Brendan wins, then he will collect $3 for every dollar he bets.	$1 + $2 win = $3 payout.
STEP 2	
Find the ratio.	1 : 2 = 3 parts in total.
STEP 3	
Write each number as a fraction with the total in the denominator.	$\frac{1}{3}$ and $\frac{2}{3}$
STEP 4	
Interpret the maths.	There is a $\frac{1}{3}$ chance of winning. There is a $\frac{2}{3}$ chance of losing.

Example 6 Finding the chance of winning as a percentage

Brendan places his money on a $6 bet. Calculate the chance of winning and losing as a percentage.

THINKING	WORKING
STEP 1	
Thinking about the maths – If Brendan wins, then he will collect $6 for every $1 that he bets.	$1 + $5 win = $6 payout.
STEP 2	
Find the ratio.	1 : 5 = 6 parts in total.
STEP 3	
Write each number as a fraction with the total in the denominator.	$\frac{1}{6}$ and $\frac{5}{6}$

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STEP 4

Calculate the percentage by multiplying each fraction by 100.

$$\frac{1}{6}\times 100 = 16.66667\% = 17\%$$

$$\frac{5}{6}\times 100 = 83.33334\% = 83\%$$

STEP 5

Interpret the maths.

There is a 17% chance of winning.
There is an 83% chance of losing.

9I Tasks and questions

Thinking task

Recreation is defined as follows in the *Cambridge Dictionary*.

recreation

noun [C or U]

UK / ˌrek.riˈel.ʃ°n/ **US** / ˌrek.riˈel.ʃ°n/ **UK** / ˌri:.kriˈel.ʃ°n/ **US** / ˌri:.kriˈel.ʃ°n/

recreation *noun* [C or U] (ENJOYMENT)

B2 **UK** / ˌrek.riˈel.ʃ°n/ **US** / ˌrek.riˈel.ʃ°n/

(a way of) enjoying yourself when you are not working:

- *His favourite recreations are golf and playing Scrabble.*
- *Emma's only **form of** recreation seems to be shopping.*

Source: https://dictionary.cambridge.org

1 Make a list of all the things that you spend money on recreationally. Put a dollar figure next to each item you have written, indicating how much you spend each week, month and year. Find the total estimated cost of your weekly, monthly and yearly recreational spending.

Item or activity	$ week	$ month	$ year

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Skills questions

2 Using boxes as in Example 3, sketch out the following ratios.

a 1 : 3 **b** 1 : 4 **c** 1 : 2 **d** 1 : 5

e 2 : 3 **f** 2 : 5 **g** 3 : 4 **h** 3 : 5

3 For the bets shown below, calculate the following.

i Potential winnings

ii Potential losses

a \$1 spend on a \$4 bet **b** \$1 spend on a \$5 bet

c \$1 spend on a \$3 bet **d** \$1 spend on a \$6 bet

e \$10 spend on a \$4 bet **f** \$10 spend on a \$5 bet

g \$10 spend on a \$3 bet **h** \$10 spend on a \$6 bet

4 For the bets shown below, calculate fractions for the following.

i The chance of winning.

ii The chance of losing.

a On a \$2 bet **b** On a \$4 bet **c** On a \$5 bet

d On a \$6 bet **e** On an \$8 bet **f** On a \$10 bet

5 For the bets shown below, find the percentage chance of doing the following.

i Winning

ii Losing

a On a \$2 bet **b** On a \$4 bet **c** On a \$5 bet

d On a \$6 bet **e** On an \$8 bet **f** On a \$10 bet

Mixed practice

6 **a** Visually represent a ratio of 1 : 8.

b Calculate the potential winnings and losses from \$1 spent on a \$9 bet.

c Find the fractions that show the chance of winning or losing from a \$9 bet.

d Visually represent a ratio of 2 : 7.

e Find the percentages that show the chance of winning or losing from a \$9 bet.

f Visually represent a ratio of 3 : 8.

g Find the fractions that show the chance of winning or losing from a \$12 bet.

h Find the percentages that show the chance of winning or losing from a \$20 bet.

i Calculate the potential winnings and losses from a \$1 spend on a \$20 bet.

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Mathematical literacy

7 Consider the following activities or scenarios.

i Order the activities from least likely to happen to most likely to happen.

ii Use the internet to find statistics on the likelihood for each actvity.

iii Discuss with your class the order that you chose, and be prepared to give reasons for your choices.

Crashing your parents' car	Dying from parachuting	Winning Tattslotto
Getting bitten by a snake	Falling down a sinkhole	Getting injured from water skiing
Getting bitten by a shark	Getting injured while bungee jumping	Getting an infection in hospital
Getting injured at a trampoline centre	Having a motorbike accident	Winning the jackpot from a $2 scratchie
Winning a Nobel prize	Winning the Royal Melbourne Hospital Home Lottery	Getting eaten by a crocodile

Application tasks

8 For the bets given below, show the following.

i A visual representation of the ratio.

ii The chance of winning or losing as a fraction.

iii The chance of winning or losing as a percentage.

iv The potential amounts that could be won or lost.

a $10 spend on a $2 bet

b $20 spend on a $2 bet

c $50 spend on a $2 bet

d $10 spend on a $4 bet

e $20 spend on a $4 bet

f $50 spend on a $4 bet

g $10 spend on a $8 bet

h $100 spend on a $8 bet

9 Bookmakers are a business, and as such they need to make a profit in order to survive. Investigate how bookmakers make their profit.

a Use the internet to conduct a search on how bookmakers make their money.

b Write down some of the (legal) tricks that they might use.

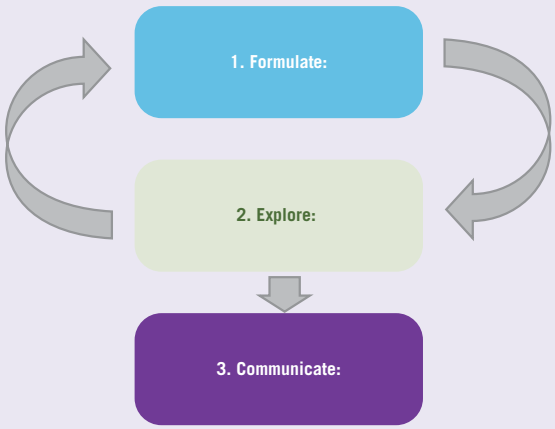
c If the bookmakers must make a profit, where does their money come from?

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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 Looking forward – Income and expenditure in adult life

a Make a list of the stages of life from being a teenager right through to being a grandparent. You might include stages like getting your first job; travelling; getting married.

b Compare your list with those of your classmates, adjusting yours to include any stages that you might have missed.

c Create a table of these life stages and add age groups for each.

d Identify and list the usual expenditures that people of any age have, like food. Add these into your table.

e Identify and list the expenses that are typical for the different life stages, like raising a child. Add these to your table.

f Research the average costs of these expenditures and add these into your table.

g Research the average income for an Australian adult. Add this into your table.

h Use your table to construct a graph showing the expenses of the different life stages of an Australian.

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i Briefly explain which measure of central tendency you have used when deciding on what is typical.

j Present your findings either as a Word document or a spreadsheet.

2 Binge time – Which streaming service?

Your task is to provide a detailed analysis of two streaming services that would suit your family.

a Analyse your family's viewing preferences.

b List the type of content that your family must have, and what type of content would be good if you could afford it.

c For two different streaming services, investigate and list the content types; if any special hardware is required; the costs for joining and then per month; any restrictions like the number of screens that can be used simultaneously; contractual conditions, and anything else that you think is important.

d Provide reasons why you would recommend one of these streaming services over the other for your family, and support your decision using your mathematical calculations and analysis.

e Are there other streaming services? Provide a brief explanation of some of these, including hyperlinks.

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Key concepts

- Household **utilities** include electricity, gas and water.
- There are many other regular household expenses.
  - **Discretionary** expenses are ones you don't strictly need to pay. These might include insurances, and repairing furniture or whitegoods (e.g. fridges, washing machines).
  - In contrast, there are penalties when you do not pay **non-discretionary** expenses such as local council rates and vehicle registration.
- If we can choose our provider, we can try to get the best deal on our utilities and other household expenses using comparison websites.
- There are several factors to consider when choosing a communications plan.
  - Some people may be best-suited to a **pre-paid** mobile plan where you pay upfront, even though the charges may be higher.
  - Others may be best-suited to a **post-paid** mobile plan, which tends to have lower charges. However, your fees will be higher if you use more data or make more calls than you agreed.
- **Inflation** describes an increase in prices over a given period of time.
  - It is measured by the **Consumer Price Index (CPI),** which takes into account eleven categories households spend money on. Different categories receive different weightings.
  - The following formula calculates inflation as a percentage:

$$\text{Inflation} = \frac{\text{Price}_{\text{Year2}} - \text{Price}_{\text{Year1}}}{\text{Price}_{\text{Year1}}} \times 100$$

- The **cost of living** refers to the level of prices for everyday goods and services.
- We can minimise expenses by checking the **reasonableness** of prices against our estimates and avoiding **scams**.
- It is important to make informed decisions about recreational **gambling**.
  - Bets are often measured in $1 units. A $5 bet means that for every $1 you gamble, you will collect $5 (making $4 in profit) if you win. If you lose, you lose every dollar you gambled.

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Chapter 9 review questions

I can identify the elements of a household utility bill.

1 Use the extract from the electricity and gas bill shown below to answer the following questions.

Account: 123456	Invoice: 2414110
Issue date	02-Jan-2022
Due date	18-Jan-2022
Invoice total	$118.92
Amount payable	$118.92

If paid before 18-Jan-2022 you only pay:
$114.69
Includes a pay on time discount of $4.23

Could you save money on another plan?
Great news!
For your electricity service, you are currently on our best energy offer.
Great news!
For your gas service, you are currently on our best energy offer. To see offers from other energy retailers, visit:
https//compare energy vic.go.au or a comparator service provider depending on your meter and tariff structure.

Previous account history		All prices include GST
Opening Balance		$128.53
Payment received 13/12/2021 (thank you)		$88.61 cr
Payment received 13/12/2021 (thank you)		$35.45 cr
Prompt Payment Discount		$4.47 cr
Balance before this invoice		**$0.00**
Electricity charges (details below)	+	$81.79
Gas charges (details below)	+	$37.13
Total amount payable	=	**$118.92**
Prompt Payment Discount	–	$4.23
Total if paid on time	=	**$114.69**

a Identify the amount owing if the bill is paid before 18 January 2022.
b Identify the amount owing if the bill is paid after this date.
c What is the invoice number? Why is the invoice number important?
d Is this customer on the best energy plan for electricity and gas? How do you know?
e Did this customer have an outstanding balance when this invoice was issued? How do you know?

I can read a household utility bill and calculate the usage and supply charges for utilities.

2 Use the extract from the electricity bill shown below to answer the following questions.

Your Electricity Account Usage, NMI ##########
Supply Address ##############################
Supply Period 05-Dec-2021 to 01-Jan-2022 (28 days)

Meter Reads (A): Actual (E): Estimate

Meter Number	Previous Read Date	Current Read Date	Total Read	Multiplier	Total Usage
XXXXXXXXX	04-Dec-2021	01-Jan-2022	174.11 kWh (A)	1	174.11 kWh

Electricity Charges for Periods 05-Dec-2021 to 01-Jan-2022 All prices include GST

Description	Plan Name	Period	Quantity Unit		Rate $	Total	Discount	Net Total*
Daily Charge	GLOSAVE	05-Dec-01-Jan	28 Days	x	1.12200	$31.42	2%	$30.79
Peak Usage - Step 1	GLOSAVE	05-Dec-01-Jan	174.11 KWh	x	0.28930	$50.37	2%	$49.36
Total charges (including $7.44 GST)						**$81.79**		
Total discount						$1.64		
Net Total (including $7.28 GST)*								$80.15

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a How do you know this is an electricity account?
b How many days is the supply period for this account?
c What is the daily charge for the supply of the electricity?
d How much electricity did this customer use during the invoice period?
e What is the rate this customer is charged for the electricity they use?
f What does the total of $80.15 include?

3 Using the rates given on the extract from the electricity bill shown in question 2, calculate the following.
a The daily supply charge for 35 days.
b The daily supply charge for 18 days.
c The usage charge if 154 kWh is used in the invoice period.
d The usage charge if 103.54 kWh is used in the invoice period.
e The total bill for the use of 163.35 kWh of electricity over 26 days.

☐ I can understand the usage summaries provided by utility suppliers that help me monitor my energy or water consumption.

4 The following charts show the water and electricity usage for a two-person household. Use these to answer the questions below.

COMPARE USAGE

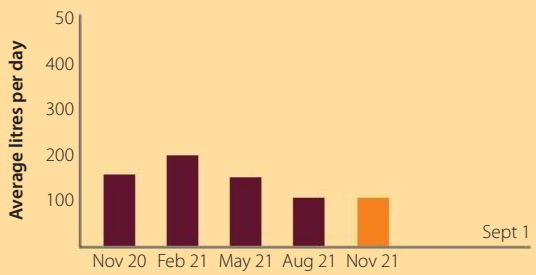
	Average
🧍	7.49
🧍🧍	12.35
🧍🧍🧍	12.70
🧍🧍🧍🧍	14.71
🧍🧍🧍🧍🧍	18.73

🧍 One average household member

Average daily consumption (kWh) 6.22 is around a same as a household of 1. The above helps you compare your usage to other households in your region. Start index of 31063 40 on 04-Dec-2020 and end index 31237.50 on 01-Jan-2022. These are indicative only and may not reflect the actual energy consumption in the billing period.

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Your water use



Previous bills

Number of people in a household	1	2	3	4	5
Average daily use (litres) per person	103	52	34	26	21
Meeting Target 155?	✓	✓	✓	✓	✓

a What is the average water consumption in litres per day for this household?

b What is the average daily electricity consumption in kWh for this household?

c Is this two-person household a high, medium or low user of water and electricity? How do you know?

d If the household used 12.83 kWh of electricity, what household size would they compare to for electricity consumption.

☐ I can explain the different payment methods on a utility bill.

5 Use the extract from an electricity bill shown below to answer the following questions.

The Victorian Default Offer is reasonably priced electricity offer set by Victoria's indepedent regulator. Contact us on 133456 to discuss the suitability of this plan for you.

How to pay

Internet / Phone

Reference Number: ########
Visit www.globirdenergy.com.au/PayOnline or call 1300 456 729 to pay by Credit Card

Direct Debit

Reference Number: ########
Call 13 3456 to set up, or visit: www.globirdenergy.com.au/direct-debit

BPAY **Biller Code: 625921**
Ref: #########

Tel. & Internet Banking - BPAY®
Contact your bank or financial institution to Make this payment from your cheque, savings, debit, credit card or transaction account. More info: www.bpay.com.au

By Mail

Send a cheque payable to GloBird Energy with your customer number on the back to:
PO Box 398, Ringwood, VIC, 3134

In Person

Pay at any Commonwealth Bank Branch
Account Name: GloBird Energy Pty Ltd
BSB: 063 233, Account #: 10418628

Important: Ouote Reference #: #######

POST billpay Pay at any Post Office $0.00 Charge Applies.

####################

*3611################

This bill is based on an estimate of your usage. You can request an adjusted bill based on a self-read. For how to do this visit: www.globirdenergy.com.au/self-read. Under an adjusted bill, the amount or due date may change.

FURTHER PAYMENT METHODS ON FINAL PAGE→

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a How many different ways to pay the bill are shown?
b Which one would be the most convenient for you (or your family) to use? Give reasons for your answer.

☐ I can identify other household expenses required to keep a house running and classify them as discretionary or non-discretionary.

6 Explain the meaning of discretionary and non-discretionary.
7 For the list of expenses shown below, categorise each one as a 'household expense' or 'other'.
a Car insurance (Comprehensive or Third-Party Property, Fire and Theft)
b Car maintenance
c Clothes and shoes
d Communications and the internet
e Eating out or getting takeaway
f Engaging a consultancy firm to prepare a report
g Goods purchased as input into manufacturing and production
h Hiring a training organisation to train your employees
i Home maintenance
j House and/or contents insurance
k Pet insurance
l Private health insurance
m Rates
n Replacement or repair of furniture or whitegoods if they become obsolete or break down
o Transport (the cost of getting to work, TAFE or university)
p Vehicle registration
8 Of those that you categorised as household expenses, indicate whether they are discretionary or non-discretionary.

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☐ I can compare products and services to optimise my spending.

9 The following is a comparison between offers from two gas suppliers.

Offer rate and details AEST only 01 January - 31 December	Tariff(inc. GST)
Supply charges	**82.50 ¢/day**
Flat	
First 27.4 MJ per day	**1.85 ¢/MJ**
Next 21.9 MJ per day	**1.65 ¢/MJ**
Balance	**1.41 ¢/MJ**

Offer rate and details AEST only All year 01 July - 30 June	Tariff(inc. GST)
Supply charges	**65.90 ¢/day**
Flat	
First 27.4 MJ per day	**2.89 ¢/MJ**
Next 21.9 MJ per day	**2.74 ¢/MJ**
Balance	**2.10 ¢/MJ**

a Which offer has the higher supply charge?
b Which offer has the lower gas consumption charge?
c For each offer, what would the total charge be for a household that used 746 MJ of gas over a 28-day period?
d For each offer, what would the total charge be for a household that used 1563.29 MJ of gas over a 29-day period.
e Which offer would you advise a household to choose?

☐ I can calculate taxes and loadings related to rules around health insurance.

10 Lifetime Health Cover (LHC) loading is an initiative of the Australian Government, designed to encourage people to take out and continue to keep private health insurance cover. Once you turn 30, you have until 1 July following your 31st birthday to take out a private health insurance policy if you do not already have one. If you choose to take out a policy after that date, a 2% loading may be added to the cost of your policy for every year over the age of 30 that you have not had private health insurance, up to a maximum of 70%. If you keep the policy continuously for 10 years, the loading will no longer be payable.

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a What percentage loading would people who are the following age pay if they had not taken out a private health insurance policy previously?
  i 34 years old
  ii 50 years old

b If those individuals continued to pay for their policy, what age would they be when the loading is no longer payable.

c A 35-year-old individual who has not held a private health insurance policy is given a quote for $80/month without the loading being applied.
  i What percentage loading will be applied?
  ii Calculate the amount of the loading added to the policy each month.
  iii Calculate the total annual cost of the policy when the loading is included.

11 The Medicare Levy Surcharge (MLS) is another initiative of the Australian Government, designed to encourage people with higher taxable income to take out private health insurance, and it is calculated when you complete your tax return. If you have a taxable income over the given threshold and do not have private health insurance, you must pay the levy. The following table shows the thresholds given on the ATO website (in 2022).

MLS income thresholds and rates from 2014–15 to 2022–23

Threshold	Base tier	Tier 1	Tier 2	Tier 3
Single threshold	$90 000 or less	$90 001–$105 000	$105 001–$140 000	$140 001 or more
Family threshold	$180 000 or less	$180 001–$210 000	$210 001–$280 000	$280 001 or more
Medicare levy surcharge	0%	1%	1.25%	1.5%

The family income threshold is increased by $1500 for each MLS-dependent child after the first child.

a Which percentage surcharge would be applied to a single person with a taxable income of $225 000?

b Which percentage surcharge would be applied to a single person with a taxable income of $68 215?

c Calculate the amount of the levy that would be required to be paid on a single taxable income of $95 000.

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d Adrian is a single person with a taxable income of $132 000. He has no dependent children. What Medicare levy surcharge will be used to calculate Adrian's Medicare levy?

e How much surcharge will Adrian pay?

☐ I can identify features of communications plans.

12 Explain the main differences between a pre-paid and post-paid mobile phone plan.

13 For the plans shown below, calculate the total cost for each plan over the following contract terms.

i A twelve-month contract.

ii A two-year contract.

a $29 per month.

b $200 initial payment for the first month, and then $18 per month.

c $12 per month for the first 6 months, then $36 per month.

d $18 per month for the first 3 months, then $15.85 per month.

☐ I can compare communication plans.

14 At first glance, the following two phones and their accompanying plans seem to be very similar.



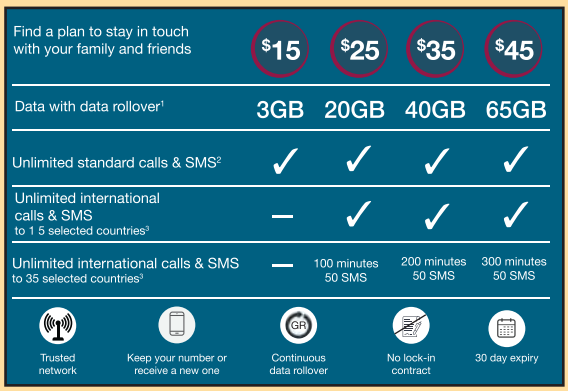
a What is the difference in the cost of the plans?

b What is the difference between the two offers?

c Which one would you advise someone who is looking for a new phone to buy? Give reasons for your answer.

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15 For each of the plans below, answer the following questions.



a How much data is available in each plan?

b Can you use the following criteria to compare these plans? Give reasons for your answer.

i Annual cost

ii Cost per GB

c What is the price of 1 GB of data?

d Based on the price of 1 GB of data, which plan has the lowest cost?

e What reasons could someone have for not choosing the lowest cost plan?

☐ I can explain how the Consumer Price Index (CPI) measure of inflation is calculated.

16 Explain how the 'basket of goods' contributes to the calculation of CPI.

17 Explain what 'weighting' means when referring to the calculation of CPI.

☐ I can calculate inflation, given the formula.

18 The formula used to calculate inflation over any period for any item is given below. For each of the following goods and services, calculate the inflation percentage.

$$\text{Inflation} = \frac{\text{Price}_{\text{Year2}} - \text{Price}_{\text{Year1}}}{\text{Price}_{\text{Year1}}} \times 100$$

a Tomatoes

2017 average price per kg: $1.29

2018 average price per kg: $1.49

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b Household gas
2019 average price per annum: $0.02658/MJ
2020 average price per annum: $0.03558/MJ

c Cost of postage between 1980 and 1990
1980 price: 22c
1990 price: 43c

d Bread
2019 average price per kg: $7.24
2020 average price per kg: $8.63

19 Calculate the Year 2 average prices, given the Year 1 average price and the annual inflation rate.

a Annual inflation rate: 2%
Year 1 average price: $100.00

b Annual inflation rate: 3%
Year 1 average price: $800.00

c Annual inflation rate: 5%
Year 1 average price: $36.50

d Annual inflation rate: 4.2%
Year 1 average price: $12.89

☐ I can estimate and calculate the price of discounted items.

20 For the discounts shown below, answer the following questions.

i Estimate what the price should be.
ii Check that the discounts have been correctly applied.
iii If the price is incorrect, state the correct price.
iv If the price was incorrect, calculate the difference? Did the customer pay more or less than the correct price?

a End of season clearance – $20 off. RRP $189, now $169.
b EOFY clearance – $40 off. RRP $318, now $288.
c Half-yearly clearance – $15 off. RRP $113, now $85.
d 10% off. RRP $110, now $97.
e 10% off. RRP $54.50, now $50.
f 10% off. RRP $228, now $200.
g 20% off. RRP $320, now $282.
h 15% off. RRP $39.99, now $34.00.

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☐ I can visually represent ratios to calculate winnings and losses for recreational spending.

21 Represent the following ratios using boxes.
- **a** 1 : 3
- **b** 1 : 5
- **c** 2 : 5
- **d** 3 : 4

☐ I can calculate potential winnings and losses, and I can represent the chance of winning as a fraction or a percentage.

22 For each of the bets shown below, calculate the following.
- **i** Potential winnings
- **ii** Potential losses
  - **a** $1 spend on a $5 bet
  - **b** $1 spend on a $3 bet
  - **c** $1 spend on an $8 bet
  - **d** $10 spend on a $4 bet
  - **e** $10 spend on a $2 bet

23 For each of the bets shown below, find fractions for the following.
- **i** The chance of winning.
- **ii** The chance of losing.
  - **a** On a $4 bet
  - **b** On a $3 bet
  - **c** On a $20 bet

24 For each of the bets shown below, find the percentage chance of the following.
- **i** The chance of winning.
- **ii** The chance of losing.
  - **a** On a $5 bet
  - **b** On a $6 bet
  - **c** On a $15 bet

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Key vocabulary

Here is a list of the key maths terms and their meanings used in this chapter.

Term	Meaning
Age-based discount	People aged under 30 pay a lower premium as an incentive for them to take up private health cover.
Agreed value	A value agreed to by you and your insurance company that will be paid in the event of your car being **written off**.
Arrears	Amounts unpaid from previous billing periods.
Budget	A summary of income and expenses for an individual, a household, a business or a country.
Comprehensive car insurance	Car insurance that covers damage to your car and any other cars involved in the event of an accident or if the car is stolen.
Consumer Price Index (CPI)	The Australian Bureau of Statistics measures household inflation and includes statistics about price changes for categories of household expenditure. The value is written as a percentage change.
Cost of living	The average amount of money that people in a particular place need in order to afford basic food, housing and clothing.
Deflation	A decrease in the price of goods and services, meaning that the CPI is negative.
Discretionary spending	Spending that you can choose to do or not.
Fire and theft car insurance	Car insurance that covers the cost of your car if it is stolen or burnt.
Health insurance extras	Extras health insurance helps cover the cost of everyday health expenses that are not covered by Medicare, like dental and physio.
Inflation	A measure of how much more expensive a set of goods and services has become over a certain period, usually a year. The value is written as a percentage change.

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Term	Meaning
Insurance policy excess	This is the amount you have to pay if you decide to make a claim on your policy. It means you accept a portion of the risk yourself, so as to reduce the premium.
kL (Kilolitre)	The unit in which water supplied to households is measured.
kWh (Kilowatt hour)	The unit in which electricity supplied to households is measured.
Lifetime health cover (LHC)	Lifetime health cover is a government initiative that encourages you to purchase and maintain private patient hospital cover earlier in life.
Loading	In relation to private health insurance, a loading can be added to the cost of the premium if you defer taking out insurance until after you turn 31.
Medicare	Medicare is Australia's universal healthcare scheme that guarantees all Australians (and some overseas visitors) access to health and hospital care at low or no cost.
Medicare levy surcharge (MLS)	An amount charged when you complete your income tax return if you (or your family) income is above a certain threshold. It is designed to encourage the people who can afford it to take out private health insurance which takes pressure off the public health system.
MIRN	Each gas meter to a household has its own MIRN – Meter Identification Reference Number.
MJ (Megajoule)	The unit in which gas supplied to households is measured.
New for old replacement	The market value of your car that will be paid in the event of your car being **written off**.
NMI	Each electricity connection point to a household has its own NIM – National Meter Identification number.

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Term	Meaning
Optimisation	Making sure that you are getting the 'best' deal for the services you require. Optimising your expenses means that you will be looking to pay the lowest amount for the level of service you require.
Premium	The amount you pay for an insurance product.
Private health insurance	All Australians (and some overseas visitors) are covered by Medicare when they need a doctor or hospitalisation. Private health insurance provides for a higher level of medical service than Medicare. For example, with private health insurance, you do not have to join a waiting list for some operations.
Stagflation	In economics, stagflation is an undesirable situation where unemployment is very high, the economic growth rate is too low and the inflation rate is high.
Third-party property car insurance	Car insurance that covers the cost of damage to another person's car or property in the event of you being in an accident.
Written off	The term used by insurance companies to indicate that repairs to a car would exceed the value of the car.

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10 Shapes and spatial representations in the world around us

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 – shape and design. Prompt questions might be:

- What activity might be depicted in this photo?
- What shapes and designs are involved?
- What measurements and plans or diagrams might be needed?
- What about scales and ratios?
- What about costs and charges?
- What formulae 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?

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Chapter contents

Chapter overview and Spotlight

10A Starting activities
10B Tuning in
10C Dimensions of space and shape
10D Angles
10E Names for the shapes and designs all around you
10F Describing and classifying shapes
10G Plans, views and measurements
10H Plans and scales
10I Drawing plans and diagrams
Investigations
Chapter review

From the Study Design

In this chapter, you will learn how to:

- interpret and describe common shapes and objects using accurate and appropriate geometric and spatial language and conventions
- create and modify simple diagrams, plans, maps or designs using drawing equipment and digital drawing packages
- interpret diagrams, plans, maps and models and evaluate their accuracy

(Unit 2, Area of Study 4).

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Chapter overview

Introduction

Geometric shapes and patterns are used everywhere. No matter where you look, almost everything is made up of geometric shapes. All of the items in our home, and even the packaging our food comes in is influenced by geometry and shapes.

Geometry is used across many industries, particularly design and construction, including fashion, furniture-making, architecture, vehicle design, landscaping, tiling and in planning and designing sports playing fields, to name a few. For example, in fashion design, a fashion designer has to know about different shapes and their symmetry for creating the best design.

In this chapter we will examine a range of simple and compound shapes, and learn to represent, classify, construct and interpret shapes and objects, such as in plans and in the finished products. This chapter will also look at angle properties and dimensional representations and perspectives.

Learning intentions

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

- distinguish between one-, two- and three-dimensional shapes
- describe and measure angles
- sketch three-dimensional objects
- name and classify common two- and three-dimensional shapes
- understand the use of plans and common measurements in industry
- understand and use ratio and scales when drawing two-dimensional plans
- design and create plans and diagrams, both by hand and using technology
- apply the problem-solving cycle to complete investigations related to the topics contained within this chapter.

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Spotlight: Tom Coupe

An interview with a builder/house designer Part 1

Tell us about the work you've done and what you do now.

I used to do residential building work, primarily as a carpenter. I become self-employed, building playgrounds for schools, and now tiny houses. I spend 70 to 80% of my time doing physical work and the rest is design and management.

What maths do you use regularly in your job? Could you give some examples?

Tiny house roofs have to be pitched. It involves lots of geometry and it's not a skill I could do without. I do use my mathematical brain a lot at work daily. I often have to imagine 3-dimensional problems to work out how to design them, to build them. Design work is key to my business, particularly now I'm selling a standardised model for other people to build.

On the quoting side, I've needed to do very accurate estimates and materials schedules in the past. It's very simple and we're talking just basic arithmetic, but that came down to having accurate measurements. As accurate as I can make them.

What is the most useful tool or piece of technology that you use regularly in your job?

I use a CAD program to design my tiny houses, which has a lot of geometry functions in it. I can use that to figure out things like rough drawings, heights, etc. CAD programmes are great for the estimating side.

But a building site is not an appropriate spot for a computer. It'll last about six weeks before it's covered in dust and water. You want something simpler on a building site that you can carry in your pocket, as you might find yourself doing sums on top of a roof. There's a calculator on my phone and I will use that for basic stuff.

What was your attitude towards maths when you were in school?

I was good at it, but I didn't enjoy going to the classes as they weren't overly practical. Geometry was seen as the lowest form of maths you could do at my school, and it was not appreciated. I liked geometry and much preferred to have that type of problem-solving task.

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10A Starting activities

Activity 1: Clothes

Below are some images of dressmakers making clothes using patterns.





Clothing design questions

Work in small groups to discuss what maths skills and knowledge might be needed to design and make clothes.

1 Make a list of the different maths skills and knowledge you would need.

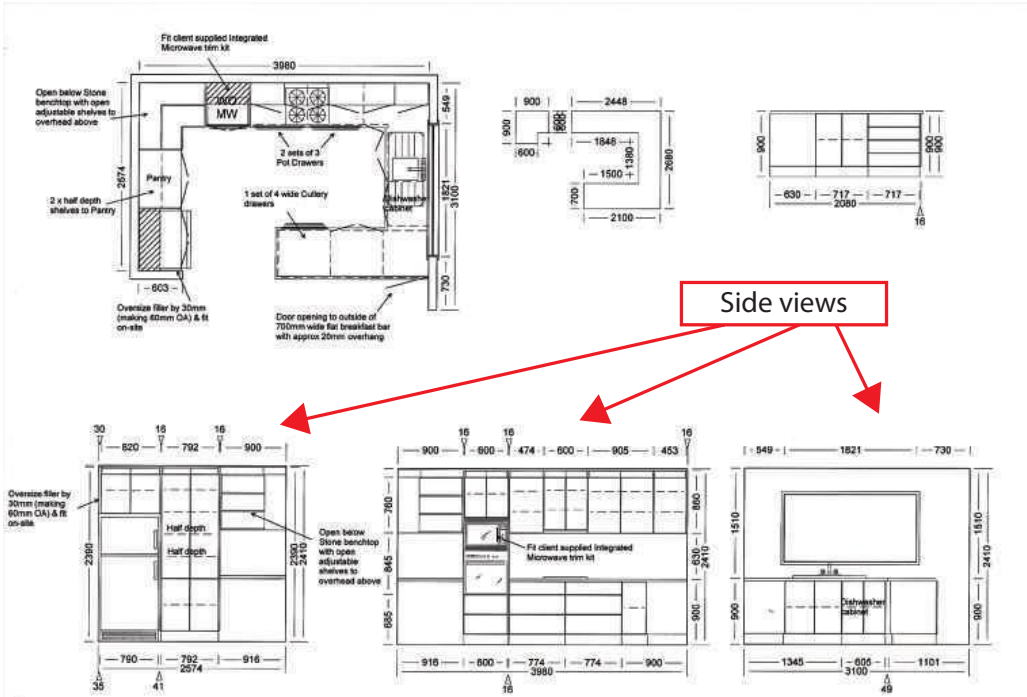
2 How important do you think knowledge of shapes might be to dressmaking?

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3 Do you think the different types of clothing we wear need people with different skills to make it? Think about shoes, for example, as well as other items we might wear?

Activity 2: Building plans and designs

Here is the plan for a new kitchen.



Kitchen design questions

Work in small groups to look at the plans for a kitchen.

1 Make a list of the different maths skills and knowledge you would need to have to make such drawings and plans.

2 Make a list of the different shapes and the key language you need to understand them.

3 What does each part of the plan show you?

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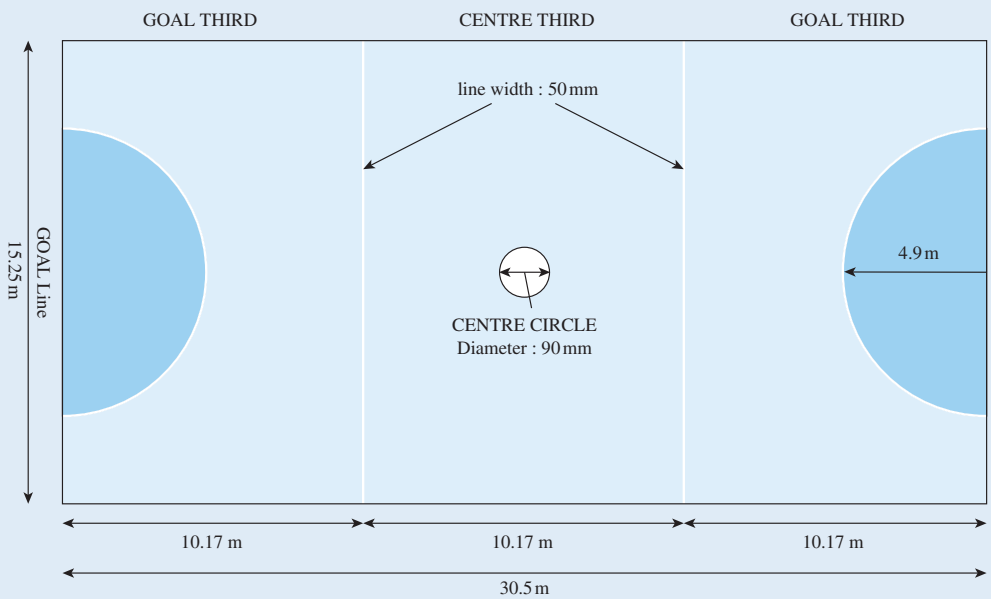
10B Tuning in

In this chapter, we will learn some of the basics of shape and design as we use them in the world around us.

In this section, we will explore how knowledge about shapes and their representations can be useful.

Sport playing fields and dimensions

The design for a netball court requires knowledge of shapes, dimensions and measurements.



What are the design and measurement requirements for a competition level swimming pool?



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Packaging

In designing products and packaging, we need to understand shape, design and measurements. Here are some examples.

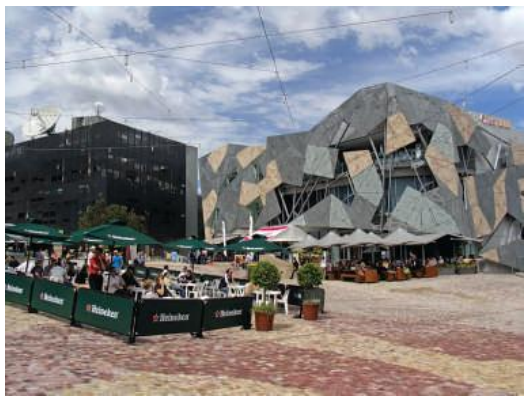




Federation square

An important occupation requiring an in-depth (and creative) understanding and knowledge of shape and design is architecture and designing buildings. One important landmark in Melbourne that shows the use of different shapes is Federation Square.

Think about what skills and knowledge go into designing such a building.



Nature

Nature itself is full of amazing shapes and designs, and these can be investigated. This is dependent on having the knowledge and language to talk about and describe their features and characteristics.





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Epic Fail – Issues with design and planning

If you search for Epic Fails using terms like 'epic construction fails' or 'epic building fails', you will find examples where there have been serious design issues with some of the following: the design, planning or construction of buildings, roads or other objects; or the design of illustrations, logos or advertising materials. Some are related to construction issues, like not allowing for the building to carry as much weight as it needed to or even its position in relation to the sun. The design of the London skyscraper known as the 'Walkie-Talkie' (pictured below) has been responsible for causing the carpets of nearby shops to catch fire, shatter tiles, and even partially melt a car. The concave, reflective glass facade acts like a magnifying glass, concentrating the sun's rays onto a localised area, generating temperatures high enough to cause significant damage.



Below is an example of the designers of a road not taking into consideration an existing house, with the road ultimately having to be built around it – did they do their surveying correctly first to see what was already there?





There are examples of the placement of an ATM only a few centimetres above a path – with no sense of people's heights.

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Discussion questions

- How do design-related Epic Fails highlight the importance of careful planning and attention to detail in construction and design projects?
- What role do mathematics and geometry play in the design and construction of buildings, roads, and other structures? Can you think of any examples where a lack of mathematical understanding led to a design failure?
- How can the principles of problem-solving and critical thinking be applied to prevent design failures in the future? What steps can designers and builders take to ensure that their designs are thoroughly checked and tested before construction begins?

Check and reflect – and connect maths to the real world.

There is a very practical element to designing and drawing plans – make sure you see or visit the site before drawing up any plans! As the problem-solving cycle says, there is a need to check and reflect, and connect the maths world to the real world.

Getting the message

From the examples so far, it is clear that understanding shape and design and how they are represented is important across a wide range of real-world and everyday contexts, from dressmaking, to sport, to packaging for food and building design.

Practice Questions

1 Consider an outdoor sport that you may have played and the field that it was played on.

- **a** What geometric shapes is the field made up of?
- **b** Is the field always one particular size? Or can it vary in size?
- **c** What measurements can this field take?
- **d** Draw a plan of the field including all measurements.

2 Create a piece of art (either a drawing or painting) that has at least 6 different geometric shapes in it.

3 Consider an occupation that requires a knowledge and skill of working with spatial design. What tools are used in this occupation to assist in design and construction.

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10C Dimensions of space and shape

When we are working with or considering issues related to shapes and measurements, we often need to consider how items and objects are constructed and how to describe them. For example, if we consider packaging, we can look at the packages of Toblerone or Pringles that we saw earlier, or a box for packing items into.

In each case we need to know and understand the ways and the related terms and language we use to describe the shapes and objects. One such term is **dimension**. The dimensions of something are the sizes of the different sides of it – usually its length, width, thickness, or height. Things can have one, two or three dimensions.



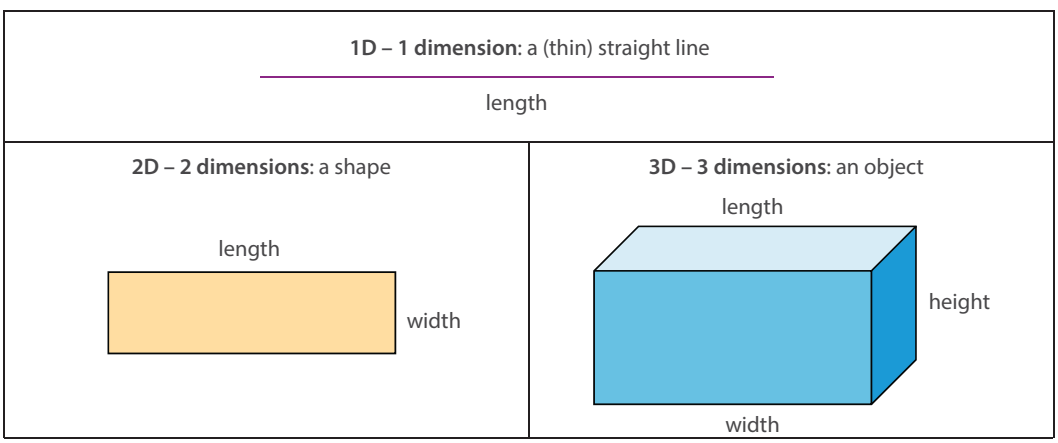
Things with **one dimension (1D)** can only be (thin) straight lines – which just have length (no width, thickness or height).

Things with **two dimensions (2D)** will have both length and width (or height, depth or thickness). They will always be **flat** shapes – they form a **plane**.

Things with **three dimensions (3D)** will have not only length and width but also height (or depth or thickness). They are usually solid objects, like boxes or packages, buildings and so on. The region inside does not have to be filled in – an empty box is still 3D.

We mostly use the word **shape** to refer to 2D things and **object** to refer to 3D things.

Note: One easy way to understand dimensions is to consider that the number of dimensions (1D, 2D or 3D) is the number of measurements you would need to describe something. So, a shape is 2D if you need two measurements to describe it, such as height and width. A straight line is 1D because all you need to measure it is its length.



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10C Tasks and questions

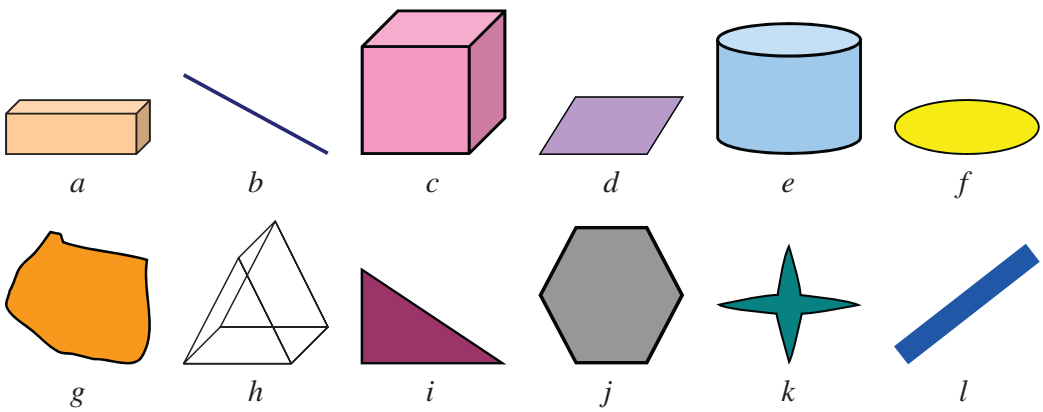
Thinking task

1 Using matchsticks and sticky tape, make as many 2D shapes and 3D objects as you can think of. Can you name any of your shapes or objects?

Skills questions

For the following two questions, rule up a table in your workbook like the one shown below.

2 Here are some different shapes and objects – some are 1D, some are 2D and some are 3D.



Write the letter of each item into the correct column in your table.

1D – 1 dimension	2D – 2 dimensions	3D – 3 dimensions

3 Can you think of some real-life shapes or objects that have different dimensions? Write the name of each item into the correct column in your table.

Literacy task

4 What do you know about the fourth dimension? Investigate the way people talk about four dimensions (4D). Does the fourth dimension exist?

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Application tasks

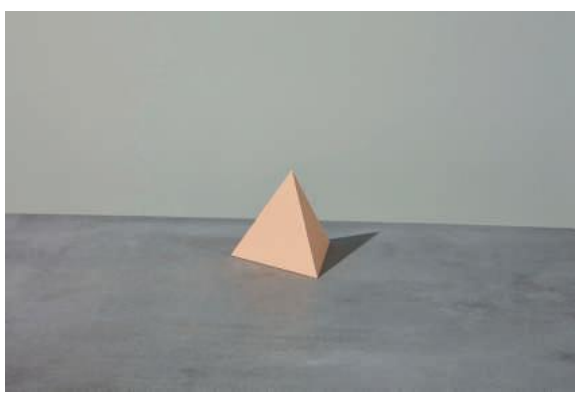
5 Kids playgrounds are made of multiple geometric shapes. Look at the playground below and answer the following questions.



- **a** Make a list of all the 2D shapes that are used in the playground.
- **b** Make a list of all the 3D objects that are used in the playground.
- **c** Create a model of the playground using plasticine or a similar material.
- **d** Design a free-standing swing for the playground. What shapes and objects do you need? Sketch out your design, labelling each shape and object.

6 Create 2D templates (nets) for the following 3D objects. Remember to add tabs so that you can fold your 2D shape into a 3D object.

- **a** Cube
- **b** Triangular prism
- **c** Cylinder
- **d** Rectangular prism
- **e** Triangular pyramid
- **f** Cone

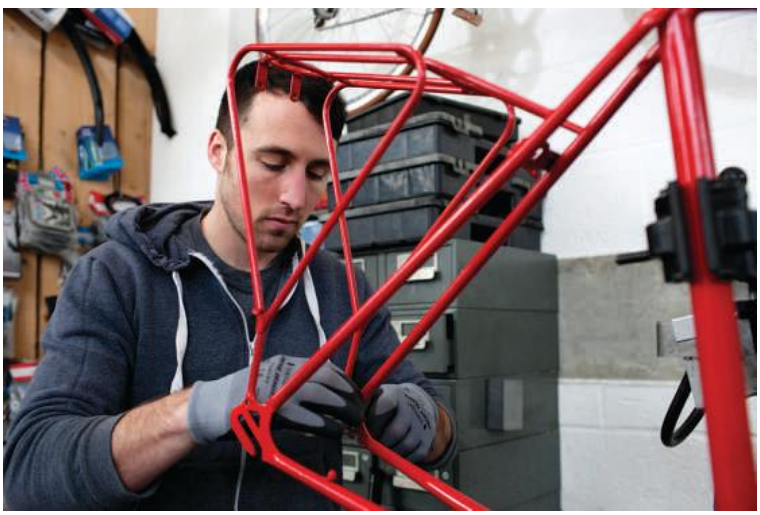


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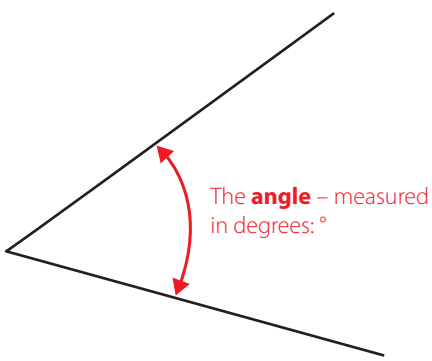
10D Angles

Another important mathematical aspect related to shapes is helping to describe items and objects. For example, we saw earlier that Federation Square in Melbourne is a complex design based on different shapes. An understanding of angles was required in order to describe, design and build it.

We use angles in many aspects of our lives. We use them when we drive, when we play sport (think of passing and shooting in basketball, football, hockey; or in athletics when jumping or throwing). Carpenters use them to construct doors, chairs, tables, etc. Fashion designers will use them when designing clothes, as will architects when designing buildings. We even use them when we read an analogue clock. Angles are also important in the design and use of bikes.



When we describe shapes and designs, we sometimes need to refer to the angles which straight lines make with each other. As a quick refresher, an angle is the amount of turn between two lines around their common point..



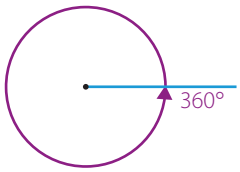
We measure angles in **degrees**. Degrees are abbreviated to °.

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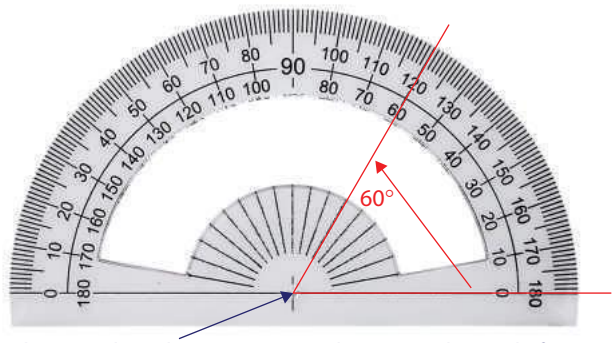
Measuring degrees

As we saw above, we measure angles in **degrees**.

There are 360° in a full rotation.



When you use a protractor to measure angles, the centre of the base of the protractor (usually a small hole in the protractor) needs to be *over* the place you are measuring the angle from. Shown below is how to measure the angle between two lines. This is easiest if you align one of the lines along the base of the protractor.



Where to place the protractor and measure the angle from.

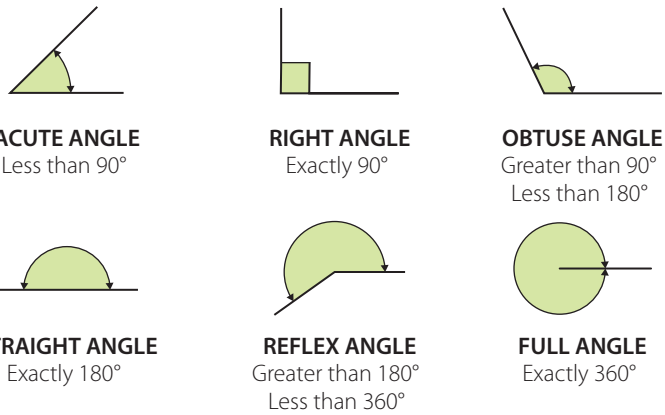
Using a digital protractor and angle apps

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, Protractor Smart, Protractor+ and Angle Meter 360.

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Some common angles

Here are several common types of angles with their names and features.



ACUTE ANGLE
Less than 90°

RIGHT ANGLE
Exactly 90°

OBTUSE ANGLE
Greater than 90°
Less than 180°

STRAIGHT ANGLE
Exactly 180°

REFLEX ANGLE
Greater than 180°
Less than 360°

FULL ANGLE
Exactly 360°

10D Tasks and questions

Thinking task

In small groups, discuss what you know and understand about the word **degrees**. Think about these questions:

1 How do we use the word degrees outside the maths classroom – is this different to how we use the word in mathematics? How are they different? Are they related? Where do we use degrees as an angle measurement in life or at work?

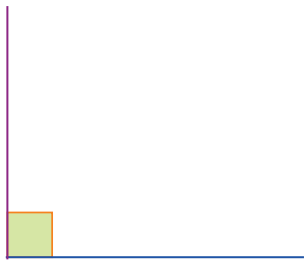


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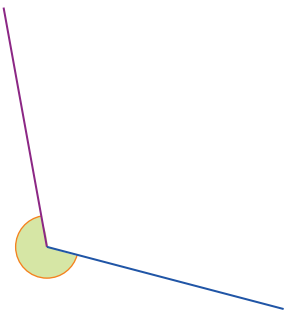
Skills questions

2 Using either a hand-held or digital protractor, measure the following angles.

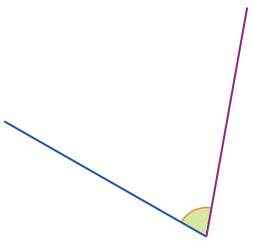
a



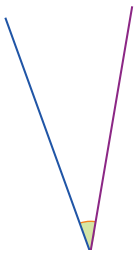
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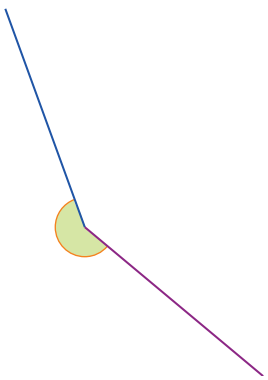
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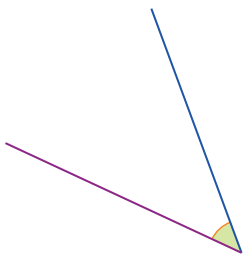
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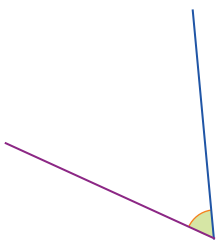
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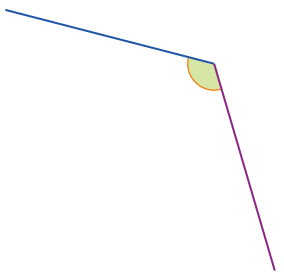
f



g



h



3 Draw the following angles using two lines to show the angle.

a 180° **b** 245° **c** 60°

d 120° **e** 45° **f** 90°

4 For both questions above, state the type of angle – acute, obtuse or reflex.

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Mathematical literacy

5 Angles of 90° are also known as right angles.

Use the internet to research methods for finding a right angle used throughout history and those used today in modern industry.

Present your findings as a poster or use multimedia. Include pictures of the analogue and digital tools that are used to measure right angles.

Application tasks

6 Use a protractor to measure the angles shown in red in each example below. State whether the angles are acute, obtuse or reflex.

a Bike frame angle



b Farm gate: two angles



c Stained-glass window: two angles

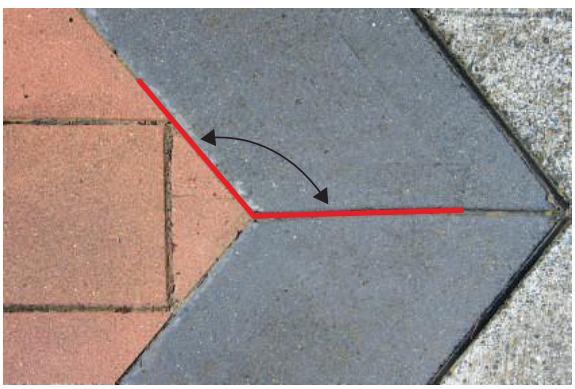


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d Angle of ladder opening



e Angle of paver



f Angle of beach hut roof



7 Use the internet to find at least six examples of angles *other than* 90°, 180° or 360°.

Use a protractor or digital device to measure the angles that you find.

State whether the angles are acute, obtuse or reflex.

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10E Names for the shapes and designs all around you

When we look at the world around us, there are shapes and designs of all sorts. Here are some more real-world examples used in signs.

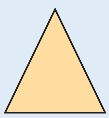
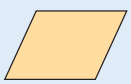
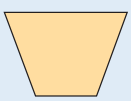
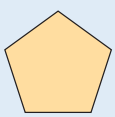
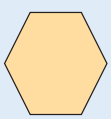
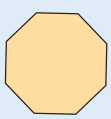


Shapes are used in many different places and in different ways. This section looks at the words and language we use when describing different shapes and objects.

Common shapes and their names

2D shapes

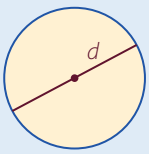
Here are the common names for some 2D shapes you might meet.

Shape	Name	Shape	Name
	Circle		Triangle
	Square		Rectangle
	Parallelogram		Diamond or Rhombus
	Trapezium		Pentagon
	Hexagon		Octagon

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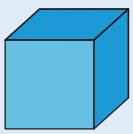
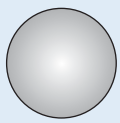
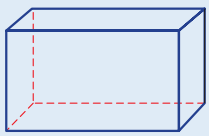
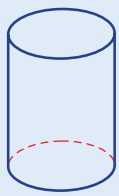
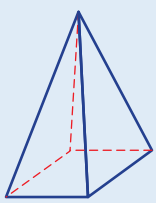
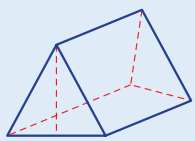
Key features of circles

The key names of the features of a circle are the *radius* and the *diameter*.

	The radius, r, is the distance from the centre to the outside edge of a circle. It is half of the circle's diameter.
	The diameter, d, is the distance from one point on a circle through the centre to another point on the opposite side of the circle.

3D objects

Here are the common names for some 3D objects you might meet.

Shape	Name	Shape	Name
	Cube		Sphere
	Rectangular prism		Cylinder
	Pyramid		Triangular prism
	Cone		

Pyramid objects have a base shape and triangular sides meeting at a point.

Prisms have two identical base shapes and rectangular sides.

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10E Tasks and questions

Thinking task

1 Looking at the images of different shapes introduced so far in this chapter, what are some of the words you have used to describe them?

- **a** Work in small groups or with a partner to develop a list of these key maths words or terms relating to shapes that you know or have used?
- **b** Are you surprised by how many different words you know?
- **c** Can you organise your words into different lists?
  - **i** By the number of dimensions they have?
  - **ii** By whether they have straight or curved sides or a combination?

Skills questions

2 Answer these questions about the 2D shapes shown earlier.

- **a** How many sides does a triangle have?
- **b** How many sides do rectangles and squares have?
- **c** How many sides do diamonds, trapeziums and parallelograms have?
- **d** How many sides does a pentagon have?
- **e** How many sides does a hexagon have?
- **f** How many sides does an octagon have?

3 What is the collective name for all the different four-sided shapes?

4 Sketch the following objects.

- **a** square-based pyramid
- **b** triangular-based pyramid
- **c** pentagonal-based pyramid
- **d** triangular prism
- **e** square-based prism
- **f** rectangular-based prism
- **g** hexagonal-based prism
- **h** cylinder

5 Use a drawing app or a free drawing tool on the internet to do the following.

- **a** Draw two different pyramids.
- **b** Draw two different prisms.
- **c** Name your objects.

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Mathematical literacy

6 Check that you know the meaning of the words below. For any that you don't know, find the meaning and then write it down in your own words.

angle	horizontal	ray
boundary	isosceles	regular
curve	line	rhombus
diagonal	parallel	right angle
edge	perpendicular	solid
ellipse	point	surface
equilateral	prism	vertex
face	quadrilateral	vertical

7 Using words from the above list, complete the following expressions or statements.

a A _____ shape has all sides equal and all angles equal.

b A solid object with two identical ends and flat sides is called a _____.

c The _____ is the border around the outside of a shape which defines the space or area.

d A _____ of a shape or object is a point where two or more line segments meet at a corner.

e The direction from top to bottom is called _____.

f Something that is similar to a line but is not straight is called a _____.

g The outside layer of an object which has area, but no thickness is called the _____.

h When you directly join any two corners of a shape which are not already joined by an edge, you create a _____.

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Application task

8 Name the different shapes and objects you can identify in the pictures.

a Soft drink can



b Nut and bolt



c Federation square



d House



9 Using the internet, find examples in real life of the following shapes.

i Give two examples for each shape.

ii Give the name of each shape.

a triangle

b quadrilateral

c pentagon

d hexagon

e octagon

f greater than eight-sided shape

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10F Describing and classifying shapes

One of the everyday tasks people need to do is describe and compare things – and we do this using their different characteristics.

This emphasises how important it is to understand the words and language we use in mathematics – what we call **mathematical literacy**.

10F Tasks and questions

Thinking task

1 Work in pairs or small groups to think about the different occupations that need an understanding of shape and design and how they are represented in 2D plans and 3D constructions.

Some examples mentioned earlier included fashion designers, dressmakers, engineers, artists, architects, builders and carpenters. What other occupations can you think of where shape and design would make up a key component of their required knowledge and skills?

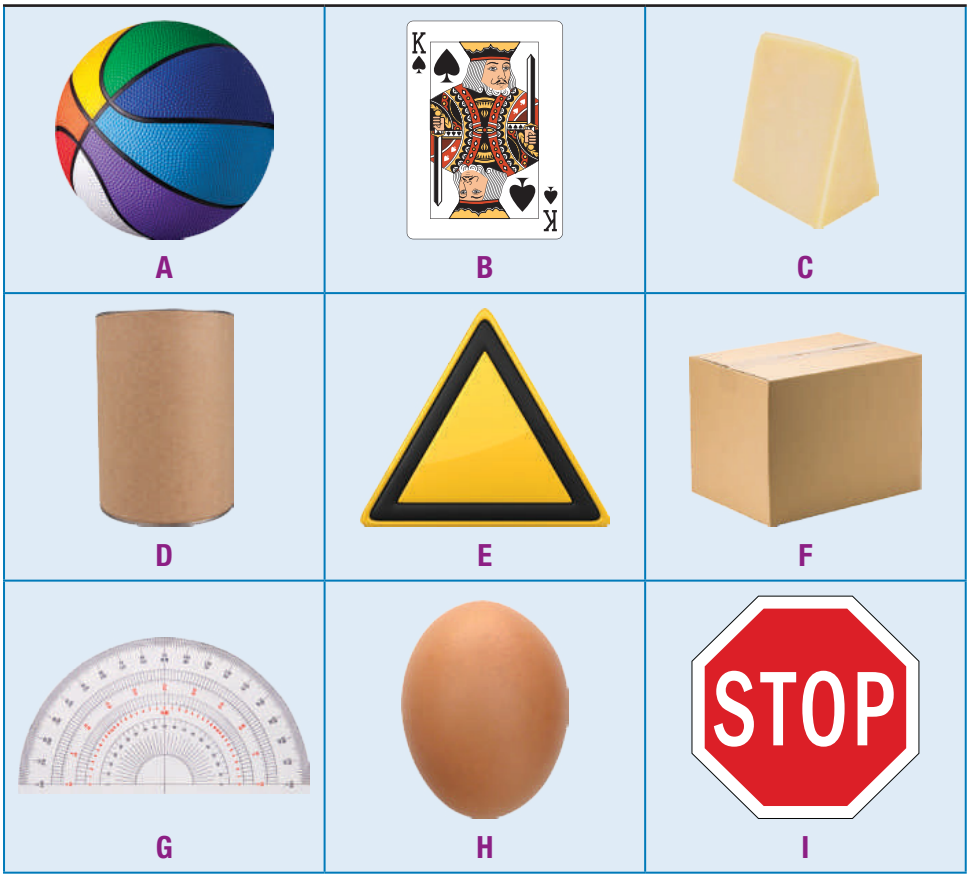
Together, make a list of the occupations and write down the different ways they would use their knowledge about shape and design.

Skills questions

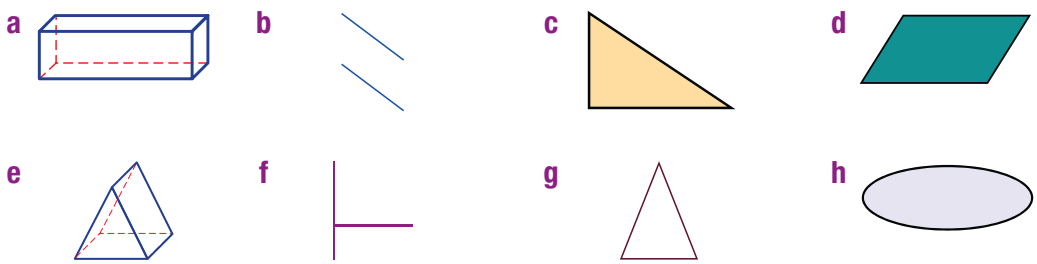
2 Classify each of the objects or shapes opposite by the following characteristics. Which ones:

- **a** have **all** their external boundaries as straight lines?
- **b** are two dimensional?
- **c** are quadrilaterals?
- **d** have only one curved face?
- **e** are regular figures?

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3 Match each of the shapes below to the following descriptions.



A Ellipse

B Isosceles triangle

C Parallel lines

D Parallelogram

E Perpendicular lines

F Rectangular prism

G Right-angled triangle

H Triangular prism

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Mathematical Literacy

4 Accurately describe each of the following, using the language and terminology of shape. (Hint: You may want to look back at section 10E.)



a Aboriginal flag



b Kuwaiti flag



c Give way sign



d Flammable liquids danger sign



e Stop sign



f Safety marker



g Paving



h Athletics track

Application tasks

5 A quadrilateral is the name given to a shape with four sides. Some examples are shown below.

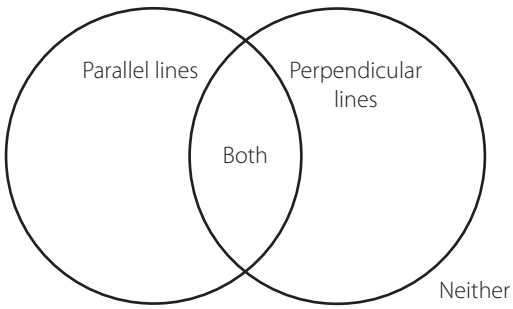


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a Draw as many different quadrilaterals that you can think of.

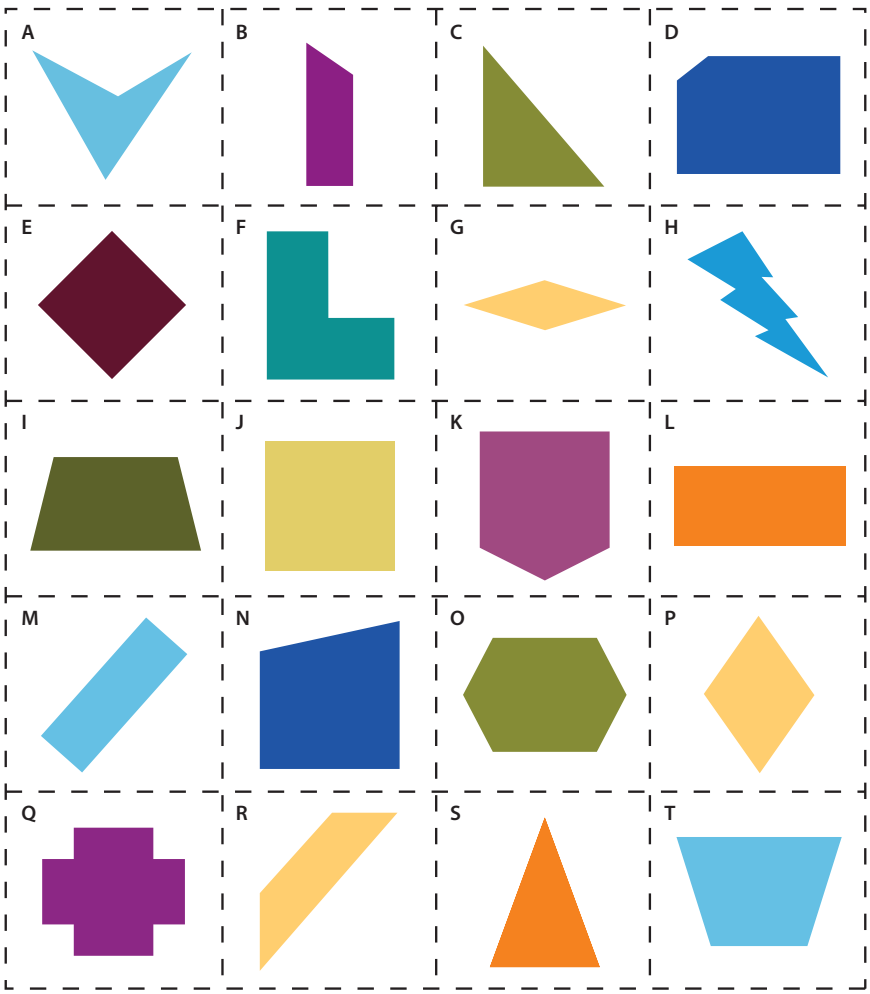
b Can you give specific names to any of your shapes?

c Make a Venn diagram to sort your shapes into categories determined by whether they have parallel or perpendicular lines.



d Can you think of another way to classify your shapes?

6 Consider the following shapes.



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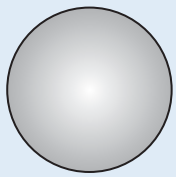
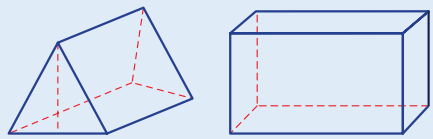
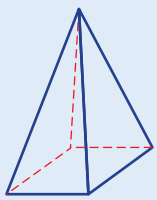
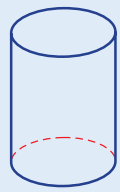
a Classify the shapes into groups with similar properties.

b Represent the classifications you have made using a Venn diagram.

c Add one more shape into each grouping.

d Give reasons for each of your groupings.

7 Create a table with the following headings.

Sphere	Prisms
	
Pyramids	**Cylinders**
	

Find as many real-life examples of these shapes as you can. Use the internet.



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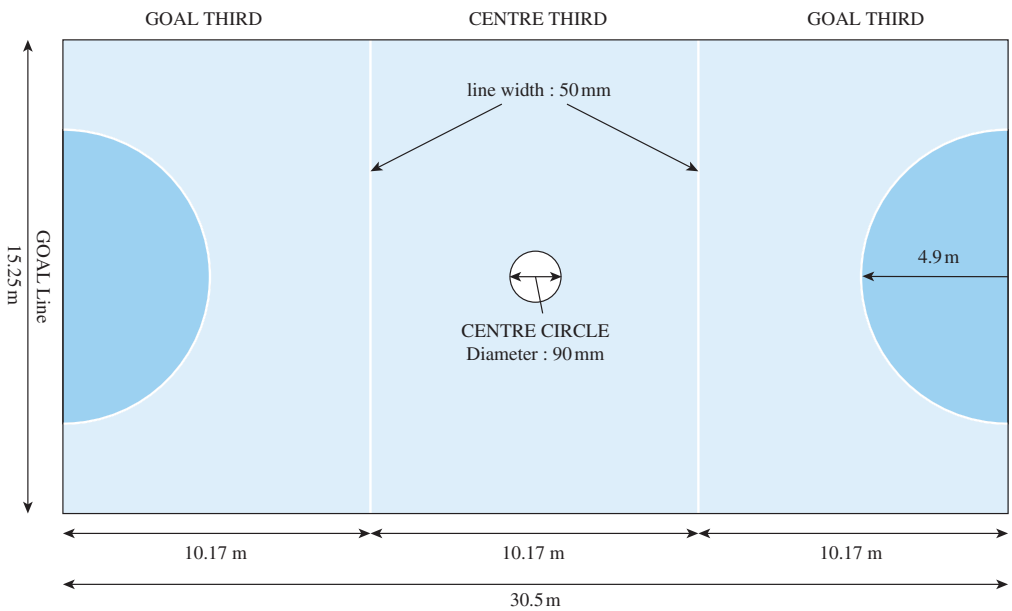
10G Plans, views and measurements



In order to make things, no matter what they might be, you need plans or diagrams to follow. For example, in dressmaking, patterns with drawings and detailed instructions are used, and for building a house or making furniture, detailed plans are required.

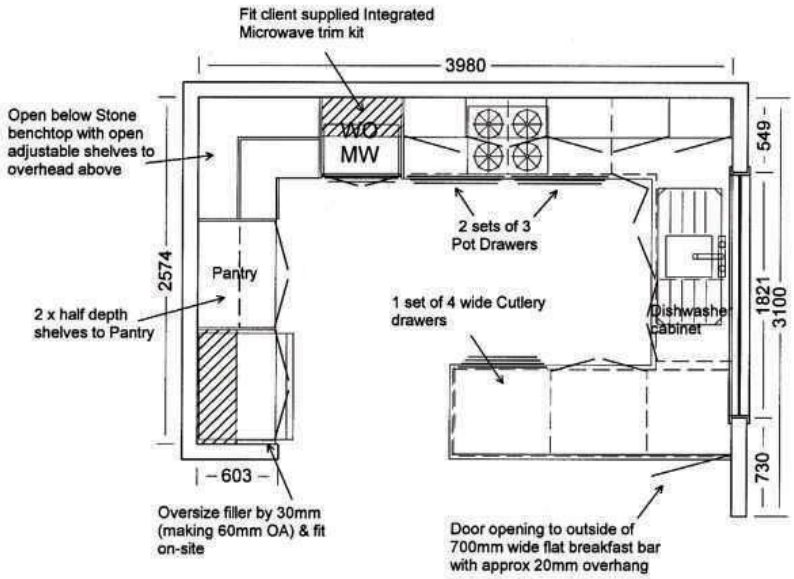
Plans are sets of drawings or two-dimensional diagrams which describe an item, and which provide the design specifications for people who want to build the item. Plans can be drawn or printed on paper, but nowadays they can take the form of digital files. Plans need to be accurate and must provide details about the design, shapes and measurements to use.

Here is an example of a netball court plan with its dimensions and measurements.



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We have a way of marking dimensions and their measurements on drawings, diagrams and plans. We often use arrows, sometimes with small perpendicular lines as well, to show the lengths or dimensions as in the kitchen plan below.



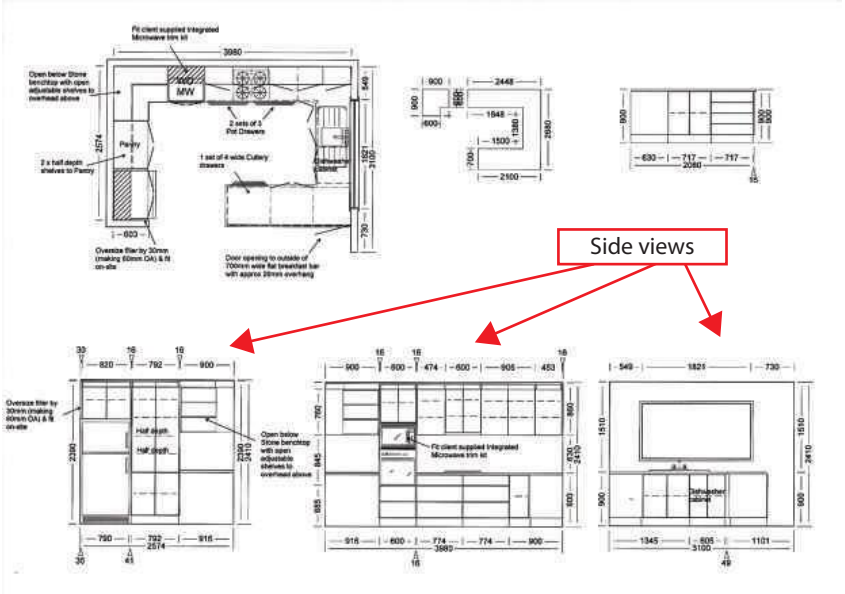
Different views of a plan

Because most plans represent three-dimensional objects on a two-dimensional document, the use of different views or what are sometimes called **projections** are needed. Each projection is achieved by assuming different viewing points from which to see the item or object. The common way to do this is to use different views:

- **Top view** – a view from above, looking down, which is often called a birds-eye view.
- **Front view** or **side view**, or sometimes called **elevation** if the projections are for a building. These are views drawn as if someone was looking straight at the vertical sides of the object – this would be a wall or side of the building if for a house or room.

The above kitchen and netball plans are Top view projections. In the more complete plan for the kitchen, which is shown below, you can see a set of different views for the kitchen design. You can see a Top view and a number of different Side views which show the design of the kitchen looking horizontally at the opposite walls.

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Measurements and units

In architecture, surveying, building and construction, it is normal to use metres (m) and millimetres (mm) as shown in the plans above and the picture below from a timber yard.



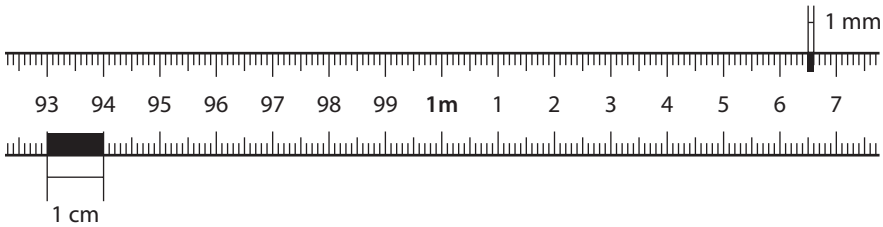
In this image, the planks of wood are 190 mm wide by 19 mm thick. The lengths are shown on the left as 2.3 m etc. The price is $26 per linear metre (LM), so a 2.3 m length costs:

$2.3 \times 26 = \$59.80$.

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In other areas, however, such as clothes making, knitting or sewing, measurements are often taken in centimetres (cm).

Do you remember the relative size of centimetres and millimetres? Here is part of a tape measure showing cm and mm as a reminder.



It is important to remember your metric prefixes and how to convert from one unit to another. There are as follows.

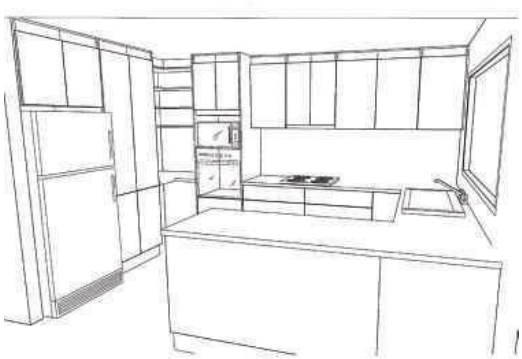
- 1000 m in 1 km
- 100 cm in 1 m
- 1000 mm in 1 m
- 10 mm in 1 cm.

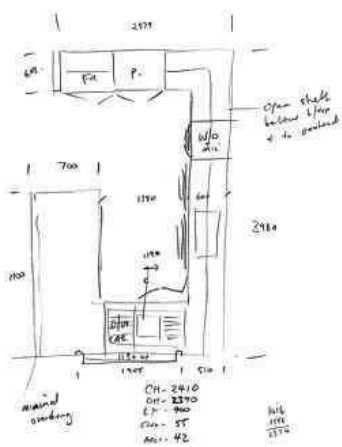
These units and measurements are used frequently in the creation of plans and in using and interpreting plans when assembling and making items or objects.

On the job

One of the tasks that is often needed prior to creating plans is to develop drafts of your ideas or make rough sketches. This can happen in different ways.

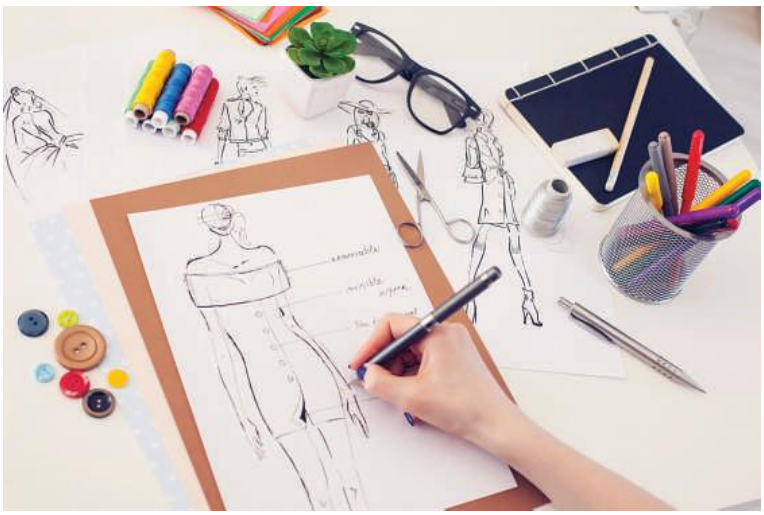
For example, if you are having a room renovated, usually the architect or drafter would visit and take photos, make sketches and take the measurements of the existing room. Here is an example for the kitchen renovation plans shown earlier.





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If starting from scratch, you would make sketches and draft designs, depending on what it is you are making. This would involve your knowledge of shape and design alongside knowing how to measure and use scales.



10G Tasks and questions

Thinking task

1 Many types of industries use different measurements. Some of these measurements are historical. For example, horses are measured in **hands**, where one hand is 4 inches.



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Some measurements are cultural. For example, in Thailand, some farmers still refer to the old units, where 4000 cm is equal to one sen, and one *rai* is equal to one square *sen*.

Use the knowledge in your classroom and on the internet to explore the different types of measurements that are still in use around the world.

Skills questions

2 Use your ruler to measure the length of the following lines. Express your answers in both mm and cm (to the nearest millimetre).

a _____

b _____

c _____

3 Use your ruler to draw straight lines on a sheet of A4 paper with the following lengths.

a 75 mm **b** 18.7 cm **c** 3.2 cm **d** 132 mm

Mathematical literacy

4 Make a list of the different types of plans you can find that are used in industry.



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Application task

5 Find an example of a plan, pattern or diagram that uses drawings and measurements for making an item. It could be a plan for a building or for making furniture, toys, jewellery, clothes or crafts.

You could ask at home, ask your friends or research on the internet.

Once you have found the plan, write a summary about it and comment on the following features.

- Describe the item being made or constructed.
- What shapes are used in the plan?
- What measurements and units are used?
- What tools or equipment would be needed?

Include copies or photos of the plan in your summary.

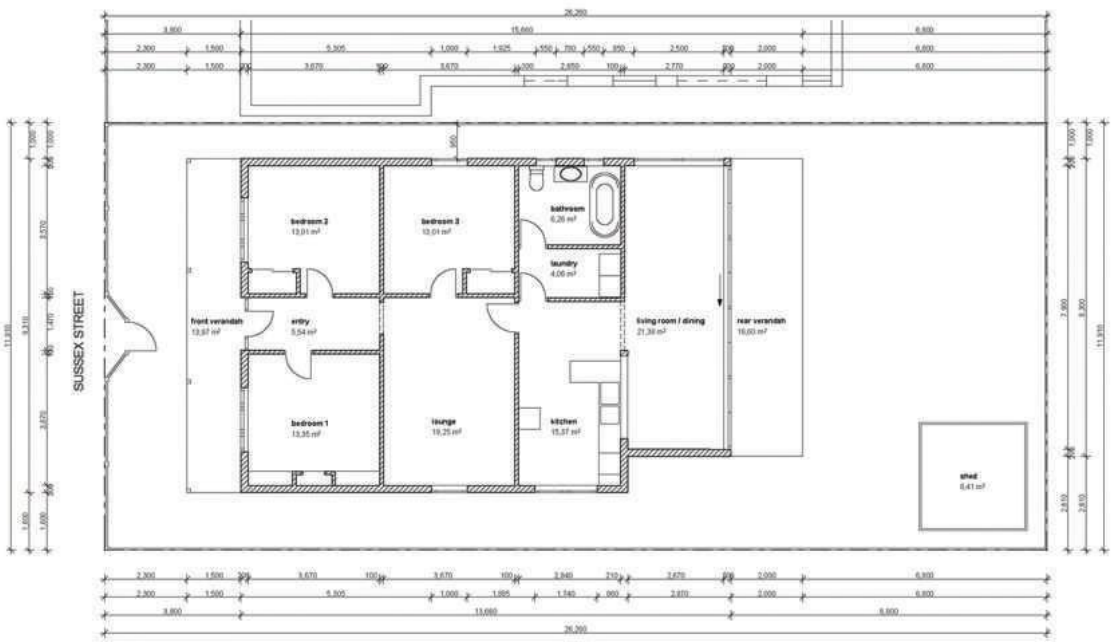


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10H Plans and scales

In most cases, plans cannot be drawn at the actual size of the item being made, except if it is quite small. For example, all the plans shown above for things such as the netball court or the kitchen need to be much smaller than the real thing.

When we draw a plan and represent a real object accurately, we need to reduce (or enlarge) the actual measurements by the same amount or factor to keep them in the right proportion. This factor is called the **scale** and is shown as a **ratio**. (Remember ratios in Chapters 2 and 3?) The scale is the ratio of the length on a plan to the length of the real thing. On this house plan, you can see the scale shown below.



Existing Layout 1:100

The scale is shown as the length on the plan, then a colon (:), followed by the matching length on the real thing. For example: you can see from the text on the lower left that this plan has a scale of **1 : 100**, so anything drawn with the size of '1' on the plan would have a size of '100' in the real world. A measurement of 50 mm on the plan would be 50 × 100 = 5000 mm or 5 m in the actual house.

This means that in this house plan, the lengths shown on the plan are one one-hundredth the actual length of the building (100 times smaller).

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Using different scales

If something you are drawing is quite small, it is possible to draw a life-sized drawing. This means the scale is 1 cm = 1 cm and the ratio is 1 : 1. This is considered a large scale, even though the numbers used are small.

If you draw a plan in the ratio of 1 : 2, this means 1 cm on the plan would be 2 cm on the real object, therefore, the lengths on the plan will be half $\left(\frac{1}{2}\right)$ of the real thing. Items like furniture or cars require scales from about 1 : 5 up to 1 : 20.

This compares to plans where the items being drawn are large, like a house or a netball court, or very large, like a tall building. In these cases, the scales could be 1 : 20 up to 1 : 200, depending on the detail needed. Plans for such buildings are printed on large sheets of paper, as in this photo, so that more detail can be used on the plan.



Another area where scales are used is on maps. Here, the scale or ratio used must allow for a small length on the map to scale up to a very large distance. Some local maps might have a scale of 1 : 1000, whereas for a larger area like the state of Victoria, you would need a very small scale of 1 : 20 000 or even 1 : 1 000 000. These are considered very small scales.

Different units used in scales

Sometimes, however, especially with maps, they may have a scale like 1 cm = 1 km, which is not a true ratio. The values in the ratio should be measured in the same unit, as in the example of the ratio 1 : 100 in the house plan above. A scale of 1 cm = 1 km means that each cm on the map represents 1 real km on the ground, or a building plan might have 1 cm = 1 m, which means that each cm on the plan represents 1 m

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on the building. To make this scale into a ratio, you need to convert the two different units into the same unit. This is more easily done by changing the larger unit into the smaller unit. So, 1 cm = 1 m converts to a ratio of 1 : 100.

We will look at the different uses of scales in maps in the next chapter.

Example 1 Writing the scale factor for a given ratio

Writing the ratio 1 : 10 as a scale factor.

THINKING	WORKING
STEP 1	
Consider the scale factor.	1 : 10
STEP 2	
Think:	$1 \times 10 = 10$ Therefore, the scale factor is 10.

Example 2 Writing the scale factor as a fraction

Write the ratio 4 : 10 as a fraction.

THINKING	WORKING
STEP 1	
Consider the scale factor.	4 : 10
STEP 2	
Write the scale factor as a fraction.	$\frac{4}{10}$
STEP 3	
Cancel the fraction down to find the smallest fraction.	$\frac{4}{10} = \frac{2}{5}$

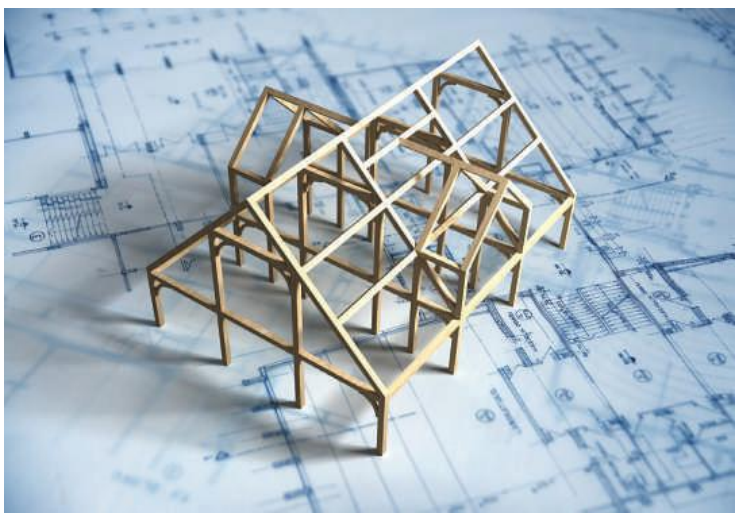
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10H Tasks and questions

Thinking task

1 Build a simple scale model of an object in the classroom, such as a chair or table. You may want to use materials such as icypole sticks, blu-tack or sticky tape.

Once you've finished, answer the following questions.



a What is the purpose of a scale model?

b Does your scale model accurately reflect the real object?

c Considering the size of the real-life object compared to your model, estimate how many times bigger the real object is?

d Measure the height of the real object.

e Measure the height of your scale object.

f How many times bigger is the real object?

Skills questions

2 Give the scale factor for each of the following ratios. For example, the ratio 1 : 10 has a scale factor of 10.

a 1 : 100 **b** 1 : 20 **c** 1 : 4 000

d 1 : 2 **e** 2 : 50 **f** 10 : 15

3 Give the following scale factors as fractions.

a 1 : 2 **b** 2 : 6 **c** 2 : 50

d 3 : 60 **e** 5 : 2000 **f** 4 : 252

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4 By sketching triangles, show the following scale factors. Use a ruler to sketch your triangles.

a 1 : 2 **b** 1 : 3 **c** 1 : 4 **d** 1 : 5

Mathematical literacy

5 Give definitions for the words **model** and **scale**.

Application task

6 Work out the answers to each of the following questions.

a If you drew a plan of something with a scale of 1 : 10 (which means 1 cm would represent 10 cm on the real object), what fraction is the drawing of the real thing?

b A drawing of an object is in the ratio of 1 : 50. What fraction of the real thing is the drawing?

c A plan of an item has a scale of 1 : 250. How many times bigger is the real item compared to the length on the plan?

7 Work out the answers to each of the following questions.

a A plan of an object has a scale of 1 : 250. How long would the actual length be if it was 45 mm on the plan?

b A plan of an object has a scale of 1 : 10. How long would the length on the plan be if the actual length was 750 millimetres (mm)?

c A plan of an object has a scale of 1 : 1000. How long would the length on the plan be if the actual length was 9.555 m?

d The length on the plan of an item is 225 mm. What would the actual length of the item be if the plan had a scale of 1 : 5?

8 For each of the situations below, decide which scale you think would be the most appropriate to use for the plans. Select from one of the following four scales.

A 1 : 10 **B** 1 : 50 **C** 1 : 1000 **D** 1 : 10 000

a A plan for a new sports playing field including a soccer field and tennis courts.

b A plan for a new family room.

c A plan of a new bridge that is going to be almost 2 kilometres long.

d A plan for making a pool table.

e A plan for making a large wall-hanging out of scrap material.

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10I Drawing plans and diagrams

A key skill is being able to design and draw plans and diagrams. Part of this, as we have seen, is the ability to measure. To do this, you also need to understand how to draw shapes and objects using different tools and digital technologies.

Below is information about the different tools you might need to use.

Tools and technology

Drawing by hand

For drawing plans by hand, you will need access to the following tools or equipment.



Measuring tools

There are a range of tools you can use for measuring lengths when making things or when drawing plans. Surveyors and builders use other forms of equipment and technology.

Here is a list of the most common measurement tools.

- Rulers (or a **straight edge rule** as it is called by engineers and builders).
- Tape measures
- Measuring tape reel – which can measure distances up to 40 or 50 metres.

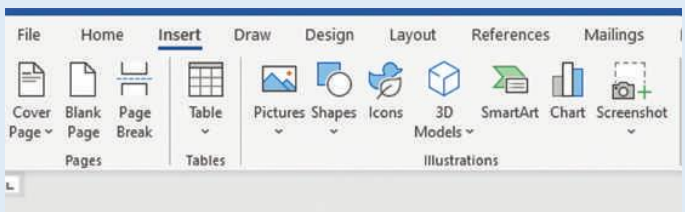
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- Measuring wheel – this is also known as surveyor's wheel or a distance calculation wheel. It is rolled from the starting point to the end point and the numbers on the counter are read to give the measurement of the distance covered by the wheel.
- Laser tape measure – this digital device is an accurate alternative to a traditional measuring tape. It uses optics and laser physics to give precise measurements.
- Mobile phone apps – you can now use measuring apps on your mobile phones to measure distances. Even the best measuring apps, however, are not as accurate as your traditional measuring tape, but they will give you a very good estimate of a distance or length that you need to measure.

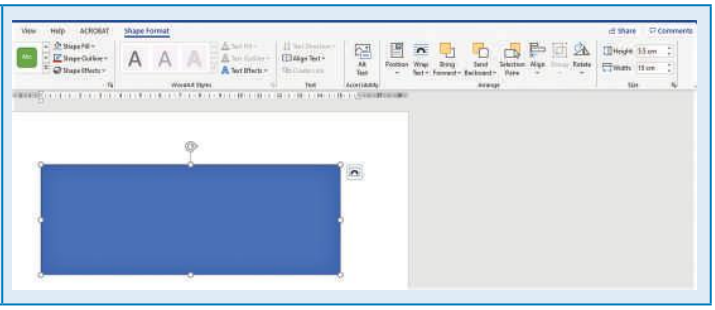
Using Software

There are many options to help you design and draw plans **digitally** – from common software apps that enable you to do this through to sophisticated programs which are specifically designed for drawing and designing.

Word processing software such as Word has quite good drawing tools that can be used. Here are some screenshots to show you examples of what is available.

Use the **Insert** tab to insert different shapes.	
When you click on the drop-down menu for shapes, you can select a wide range of shapes to insert. These include both 2D and 3D shapes.	

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Use the **Picture Format** tab to change and specify the dimensions and colours and much more.	

Common presentation software, such as PowerPoint, also have this capability with similar tools available. One advantage of a program like PowerPoint is that you can **export** your drawings or designs as images – either as .png or .jpeg files.

Specialised design software to help draw plans and diagrams is called computer-aided design (CAD) software. These can be used in various industries to create 2D technical drawings, mock-ups of conceptual designs and 3D models of physical objects. They are used by architects, engineers and draftspersons for creating designs and plans for use. The digital representations of physical objects that are produced by CAD software are used in the creation of actual objects in the real world.

A number of free apps for computers and tablets are available for drawing plans. These can be downloaded for use, or your school may already have some available. Use ones you or your teachers are familiar with. Some examples include *Sketch Up, Draft it* and *QCAD* (CAD software for drawing in 2D).

Notes

1. You could use one of these digital programs to create some of your drawings or plans for this chapter. Ask your teacher for help if you have not used these tools before.
2. The printer you use may not be accurate, so print off a copy of your drawing and use a ruler to check that the dimensions are accurate and adjust if necessary.

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10I Tasks and questions

Thinking task

1 Explore some drawing apps that you find on the internet. See how many 2D shapes and 3D objects you can draw using an app. What are the advantages of drawing with an app?

Skills questions

2 Draw by hand each of the following shapes.

- **a** A rectangle with a length of 12.5 cm and a width of 6.2 cm.
- **b** A circle with a diameter of 65 mm.
- **c** A right-angled triangle with a base length of 5 cm and a vertical height of 7.5 cm.

3 Use some software of your choosing to draw each of the following shapes. (Remember to print off copies of any drawings and use a ruler to check that the dimensions are accurate).

- **a** A circle with a radius of 3.5 cm.
- **b** A square a side width of 54 mm.
- **c** A parallelogram with a base width of 9.7 cm and a vertical height of 4.3 cm.

Mathematical literacy

4 Make a list of at least ten drawing apps, AI and software that could be used for drawing plans. You must be able to try the app with a free sample. State one advantage and one disadvantage for each.



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Application task

5 Plan of a jewellery box

Here is a photo of a jewellery box. Its shape is a rectangular prism.



The measurements of the dimensions for each view of the box are as follows.

Top view: 270 mm × 160 mm

Front view: 270 mm × 90 mm

Side view: 160 mm × 90 mm

a **Hand draw** a 2D scale plan of the outside of the jewellery box, showing the three views for each of the different side perspectives. Use a scale of 1 : 2. The three drawings should fit on one A4 page.

b **Use technology** to draw the same plan and print off a digital copy. Use the software of your choice.

If you have difficulty doing this task, please ask your teacher to help you.

6 Plan of a room

Find a room that is relatively simple and not an odd shape – rectangular is best. For example, your bedroom at home.

a Draw a 2D scale plan of the room that does the following.

- Shows the Top view.
- Includes the main larger pieces of furniture, like the bed, wardrobe or desk.
- Uses a suitable and simple scale, such as 1 : 10 or 1 : 20 depending on the size of the room, so that it fits on an A4 page.

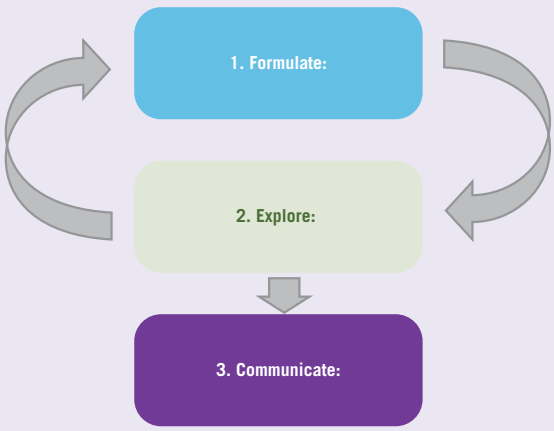
Note: You will need to use a tape measure for the dimensions of the room and the main furniture.

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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 A school flag

Design, draw and describe a flag for your school. Your flag should meet the following specifications.

- Your flag should be rectangular in shape.
- Specify the ratio for the proportion of its width to length (see below). It should be somewhere from 1 : 1 to 1 : 2. Your illustration should meet those specifications.
- Your flag should have at least three different geometric shapes and at least three different colours.
- Your flag should not match any existing flags – Australian or global.

You will need to undertake the following tasks.

a Make a hand-drawn design of your flag so that it fits on an A4 piece of paper.

b Describe the shapes and colours on your flag, and explain any reasons you had for selecting them.

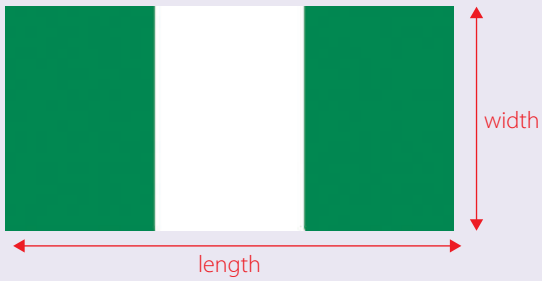
c Specify the ratio of the external dimensions.

d Specify the size or proportions of any interior shapes used on your flag.

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e Make a final drawing of your flag either by hand or using an app or software program to design it.

f Take a photo or screenshot of your flag to share with your classmates.



A note about the proportions of flags

We call the dimensions of a flag the width and length as per this illustration for the Nigerian flag.

Flags have their sides in different proportions. If you look at national flags from around the world, you can see that almost all of them have a rectangular shape. The ratio of **width : length** ranges between a square with the same height and width, which is a ratio of 1 : 1, up to one where the length is double the width, which is a ratio of 1 : 2.

The most common ratios are 2 : 3 and 1 : 2. The Nigerian flag above is 1 : 2, as is the Australian flag.

Here is an example of a flag that is in the ratio of 2 : 3. It is the Italian flag.



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2 Design a sports court

Your task is to create a sketch and then an accurate Top view scale drawing of a sports court.

a Using a sports court at school or in the community, measure all dimensions and marked lines. Include a photo of the original court in your report.

b Record these in a rough sketch.

c Knowing that your accurate drawing must fit onto an A4 page, decide on the scale you will use.

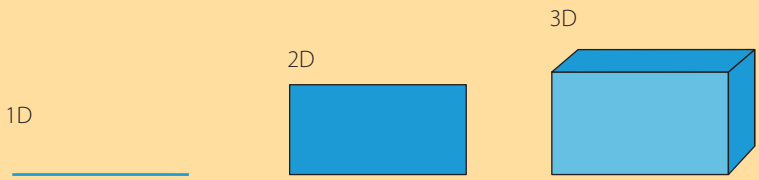
d Create your accurate Top view drawing of the sports court, including all measurements, lines and the scale.

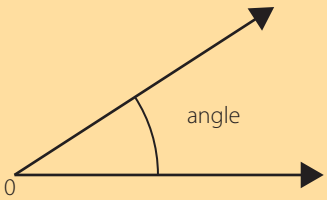


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Key concepts

In everyday life, we deal with **one**-, **two**- and **three**-dimensional shapes and objects.





- **Angles** are formed between two lines originating from the same point.
- We measure angles in **degrees** (°), using a protractor.
- There are 360° in a full revolution.

Names of common 2D shapes

Shape	Name	Shape	Name	Shape	Name	Shape	Name
	Circle		Triangle		Square		Rectangle
	Parallelogram		Diamond or Rhombus		Trapezium		Pentagon
	Hexagon		Octagon				

Names of common 3D objects

Shape	Name	Shape	Name	Shape	Name	Shape	Name
	Cube		Sphere		Rectangular prism		Cylinder
	Pyramid		Triangular prism		Cone		

- **Plans**, **views** and **measurements** are required to be able to create things.
  - To create a plan, we often reduce the measurements of the real object by a **scale** factor. The scale is represented on a plan as a **ratio**.
  - We can draw these using measuring tools like rulers, or software.

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Chapter 10 review questions

☐ I can identify dimensions in space.

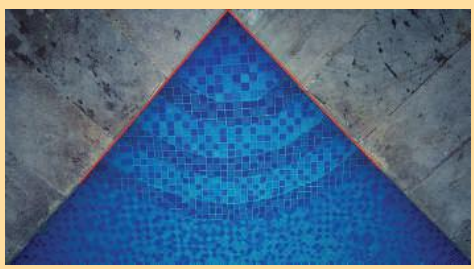
1 Draw something that is one-dimensional.
2 Draw 3 two-dimensional shapes.
3 Draw 3 three-dimensional objects.

☐ I can measure angles in degrees.

4 Draw the following angles using a protractor or a digital angle measure.
a 270° **b** 200° **c** 70°
d 30° **e** 350° **f** 80°

5 Measure the angles in the following.

a



b



c



☐ I can sketch 3D objects.

6 Sketch the following objects.
a Square-based pyramid with base length of 4 cm.
b Cube with side length of 5 cm.
c Cylinder with a diameter of 3 cm and a length of 8 cm.

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7 Using the internet, find two real-life examples for each of the following objects. Include the picture you find or sketch it out.

- **a** Cone
- **b** Sphere
- **c** Square-based pyramid
- **d** Pentagonal-based prism
- **e** Rectangular-based prism

☐ I can describe shapes and objects using different geometric terminology and language.

8 For each of the following images, write a sentence or sentences to describe the shapes or objects shown. Use geometric terms and language, such as whether they are two-dimensional or three-dimensional, and aspects related to their shape, sides, faces or angles.

a



b



c



d



e



f



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☐ I can find the scale factor.

9 State the scale factor in each of the following.

a 1 : 10
b 1 : 5
c 2 : 25
d 3 : 18
e 1 : 10 000

10 Give the following scale factors as fractions.

a 1 : 3
b 2 : 7
c 1 : 50
d 4 : 80
e 5 : 6000

11 By sketching triangles, show the following scale factors. Use a ruler to sketch your triangles.

a 2 : 3
b 1 : 5

☐ I can make scale drawings.

12 Make a scale drawing of yourself.

a Measure your height.
b Measure your arm span.
c Decide on a scale for your drawing.
d State your scale factor.
e Using a ruler, sketch yourself with height and arm span in the correct scale.

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Key vocabulary

Here is a list of the key maths terms and their meanings used in this chapter.

Term	Meaning
Acute angle	An angle less than 90°.
Angle	The amount of turn (usually measured in degrees) between two lines around their common point.
Boundary	A line or border around the outside of a shape. It defines the space or area.
Circle	A 2D shape made by drawing a curve that is always the same distance (called the radius) from a centre.
Computer-aided design (CAD) software	This software can be used in various industries to create 2D technical drawings, mock-ups of conceptual designs and 3D models of physical objects.
Cone	A solid 3D object that has a circular base joined to a point at the top by a curved side.
Cube	A box-shaped solid object that has six identical square faces.
Curve	A smoothly flowing line (no sharp changes) with no straight parts.
Cylinder	A solid object with two identical flat ends that are circular and one curved side. It has the same circular cross-section from one end to the other.
Diagonal	A line segment that goes from one corner of a shape or object to another, but the corners are not next to one another – so not an edge.
Diameter	The distance from one point on a circle through the centre to another point on the opposite side of the circle.
Diamond	A flat shape with 4 straight sides that are all equal length, but the angles are not right angles. The opposite sides are parallel and opposite angles are equal. It is a type of parallelogram. The formal mathematical name is rhombus.

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Term	Meaning
Dimensions	The dimensions of something are the sizes of its different sides – usually its length, width, thickness or height.
Edge	A line segment on the boundary of a shape, joining one corner point (vertex) to another.
Ellipse	An ellipse usually looks like a squashed or elongated circle (in fact a circle is a special kind of ellipse).
Equilateral	Having all sides of equal length.
Face	The individual flat surface of a solid 3D object.
Hexagon	A 6-sided polygon (a flat shape with straight sides).
Horizontal	Horizontal means parallel to the horizon.
Isosceles triangle	A triangle with two equal sides where the angles opposite the equal sides are also equal.
Line	A line has no thickness and only has one dimension. It can be straight or curved.
Obtuse angle	An obtuse angle is more than 90° but less than 180°.
Octagon	An 8-sided polygon (a flat shape with straight sides).
One dimension (1D)	Things with only one dimension (1D) can only be a (thin) straight line – then it only has a length (no width, thickness or height).
Parallel	Parallel means two or more lines are running in the same direction, so they never meet.
Parallelogram	A flat shape with 4 straight sides, where opposite sides are parallel and equal in length, and the opposite angles are equal.
Pentagon	A 5-sided polygon (a flat shape with straight sides).
Perpendicular	Perpendicular means meeting at right angles (at 90° to each other).

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Term	Meaning
Plane	A plane is another word for things with two dimensions (2D) that have both a length and a width (or height, depth or thickness). Things with only two dimensions will always be flat.
Point	In geometry, a point is an exact location represented by a small dot. It has no size or dimensions, only position.
Polygon	A 2D plane shape with straight sides.
Prism	A solid object with two identical ends and flat rectangular sides. The shape of the ends give the prism its name, such as a triangular prism.
Proportion or ratio	Ratio or proportion talks about comparisons between two or more quantities or values – it shows the relative sizes of two or more values.
Pyramid	A solid object where all the sides are triangles which meet at a point at the top and where the base is a polygon (a flat shape with straight sides).
Quadrilateral	A flat shape with four straight sides.
Radius	The radius, r, is the distance from the centre to the outside edge of a circle. It is half of the circle's diameter.
Ratio or Proportion	Ratio or proportion talks about comparisons between two or more quantities or values – it shows the relative sizes of two or more values.
Ray	A part of a line with a start point but no end point – it goes in one direction shown by an arrow.
Rectangle	A 4-sided flat shape with straight sides where all interior angles are right angles (90°). The opposite sides are parallel and of equal length.
Rectangular prism	A solid 3D object which has six faces that are all rectangles. It has the same cross-section along a length, which makes it a prism.

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Term	Meaning
Reflex angle	An angle that is more than 180° but less than 360°.
Regular shape	A regular shape has all sides equal and all angles equal.
Rhombus	A flat shape with 4 straight sides that are all equal length, but the angles are not right angles. The opposite sides are parallel and opposite angles are equal. It is a type of parallelogram.
Right angle	An angle which is equal to 90°, one quarter of a full revolution.
Scale	The ratio of the length in a drawing (or model) to the length on the real thing.
Solid	An object with three dimensions, usually width, depth and height.
Sphere	A 3D object shaped like a round ball. It only has one curved surface with no corners or edges. Every point on the surface is the same distance from the centre.
Square	A flat shape with 4 straight sides, where all sides have equal length, and every interior angle is a right angle (90°).
Straight angle	An angle that is exactly 180°. It looks like a straight line.
Surface	The outside layer of an object that has area but no thickness. It is a 2D boundary that can be flat or curved.
Three dimensions (3D)	Things with three dimensions (3D) will have not only a length and a width but also a height, depth or thickness. Things with three dimensions are usually solid objects, like packets, boxes, packages or buildings.
Trapezium	A flat shape with 4 straight sides with one pair of parallel opposite sides.
Triangle	A 3-sided flat shape with straight sides.

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Term	Meaning
Triangular prism	A solid 3D object which has three faces that are all triangles. It has the same triangular cross-section along a length, which makes it a prism.
Two dimensions (2D)	Things with two dimensions (2D) will have both a length and a width (or height, depth or thickness). Things with only two dimensions will always be flat – this is often called a **plane** as well.
Vertex	A point where two or more line segments meet to form a corner.
Vertical	Vertical means at right angles or perpendicular to the horizon.

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11 Measuring up – Measurement skills and tools

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 – measurement. Prompt questions might be:

- What activity might be depicted in this photo?
- What measurements and calculations would this person need to undertake?
- What types of numbers might need to be used?
- What about preparation and planning?
- What about costs and charges?
- What about times and schedules?
- What formulae 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?

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11D Measurement practice
11E Measuring time
11F A special number – π
11G Area
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11I Volume
Investigations
Chapter review

From the Study Design

In this chapter, you will learn how to:

- calculate and interpret length, area, surface area, volume, capacity and duration for a range of personal, societal or workplace measurement problems with use of estimation, rounding and approximation strategies
- identify and use common metric and other relevant measurements
- convert between a range of standard metric units.
- estimate and measure different quantities using appropriate measurement tools

(Unit 1, Area of Study 4).

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Chapter overview

Introduction

Everywhere in our visual and physical world we meet different types of measurements. These include informal and standard measurements requiring different measurement tools and formulae and an understanding of dimensions and units. This content area helps us to interpret the measurements involved in scales, plans, models, diagrams, travel distances, speeds and times.

We use measurement at home and in the community when we play sport, shop, garden, undertake hobbies like knitting and clothes making, take medicine, paint a structure, run a car and more. We use measurement at work, especially work as a mechanic, hairdresser, builder, carpenter, electrician, chef, nurse, cafe owner, printer, local manufacturer, aged care worker, health worker or horticulturist.

Learning intentions

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

- identify and use common metric and other relevant measurements, and convert between a range of standard metric units
- perform measurements of quantities, and calculations involving measurements
- demonstrate an understanding of time measurements and calculations
- calculate perimeter, including the circumference of a circle
- calculate area
- calculate total surface area (TSA)
- calculate the capacity and volume of three-dimensional objects
- apply the problem-solving cycle to complete investigations related to the topics contained within this chapter.

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Spotlight: Tom Coupe

An interview with a builder/house designer Part 2

Tell us about some of the other work you've been doing as a builder and designer.

With the work I do on tiny houses, I've been working on a revolutionary kind of fire protection technique for houses. A focus for our business has been product development, which can then be taken on by other people.

What maths do you use regularly in your job? Could you give some examples?

All of bush fire protection is done on numbers. It's looking at temperatures. Calculations use basic arithmetic but we often just have to go off estimates using tests. I've done a lot of burn tests. These require accurate timing and equipment. For instance, I need the regulators to be spot-on and be replicable so the test can be repeated. It's very low-level mathematics, but time frames are a large part of it. We're trying to identify particular moments, such as reaching melting temperature, and trying to identify exactly when that happens and to take a note of that time. We're not looking for the exact point in time but the order in which events happen. We're looking for a preference, an order, a hierarchy of events. From that we can look to prioritise different materials and theorise where the weakest point on the house might be.

What is the most useful tool or piece of technology that you use regularly in your job?

The basis of a lot of experiment measurement is to record video. I then make very simple notes. The kind of thing you'll find probably more in a science class at the beginning of high school. There's nothing much more elaborate than that going on. The tests are only a small part of the job, but they are probably the more exciting part.

What do you think was the most useful thing that you learnt in school?

When I was at school I did a computing subject, and in that subject we used spreadsheets, and the skills were completely transferable. That was actually the most useful class that I had at school, although it was also the most boring. I still think about those classes and remember what I did. It was a good foot up.

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11A Starting activities

Activity 1: A cubic metre

Cubic metres are convenient for measuring large volumes, such as on building sites.



Can you visualise a one-metre cube?

- The length, width and height are each 1 metre.
- The volume is 1 cubic metre (1 m^3).

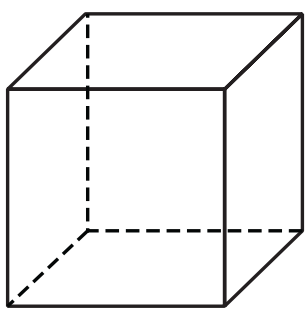
How many dimensions does a cube have?

Close your eyes and visualise the space a one-metre cube would take.

Stretch out your arms and demonstrate how big you think it is.

Ask a partner to measure your outstretched arms to find out how accurate you are with your estimation.

Using materials such as bamboo and masking tape, estimate and construct a one-metre cube shape.



How will you join the pieces? Do you need to **brace** your shape for stability?

1 Compare the size of your construction with your peers. Is it similar or dissimilar?

2 Using a measuring device, measure your construction. How close were you?

Close your eyes again and re-visualise a one-metre cube.

Re-construct your cubic shape using a measuring device. Check your measurements as you go.

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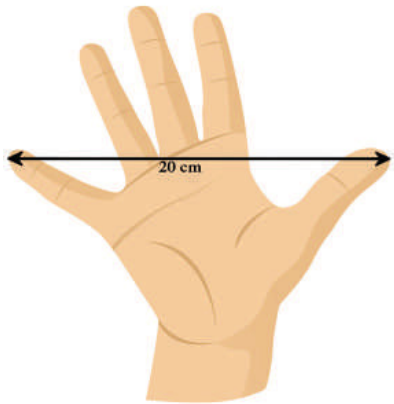
3 Has your perception of a cubic metre changed?

4 Give an example of where you might use cubic metres in real life.

Extension task

What are some other dimensions for a rectangular prism (box) that has a volume of 1 cubic metre?

Activity 2: Body measurements



1 Use a ruler to measure the following:

- **a** your index finger (it will be close to 8–10 cm)
- **b** the width from your thumb to your pinky finger with your hand outstretched, as in the diagram (it will be close to 20 cm)
- **c** your pace or step length (it will be close to 70–75 cm).

2 Draw up a table like the one shown below. Using your hand or other body parts, estimate the lengths of the following objects. State the unit of measurement that you use for each.

Object	Estimated length	Unit of measurement	Actual measurement
20 cent coin			
Pencil			
Small car			
4WD vehicle			
Swimming pool			
Computer keyboard			
Refrigerator (height)			

4 Once you have completed your estimations and noted the units, measure the objects using a device and fill out the third column in the table.

- **a** How close was your guess for each object?
- **b** Did you have the correct units of measurement?
- **c** Has your perception of length changed?

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11B Tuning in

Epic Fail

On a building site, measuring **precisely** is essential. Imprecise measurements could have unfortunate consequences. Here are photos of two buildings where there are significant issues.





Discussion questions

1. What are at least two examples of epic fails that can you see in the pictures?
2. What are at least two things that the builder should have checked?
3. There is a saying: Measure twice, cut once. Where would you apply this in your real life?

Make sure you see all of the project before you begin. Read the plans and check the units of measurement. Use software to put your changes into the big picture of the project. And most importantly, ask yourself if what you are doing is reasonable and realistic. Had the builder taken these fundamental steps, these epic fails would not have happened.

The metric system

The metric system of measurement is used in Australia and in most parts of the world. The basic units of length, mass and time are the metre (m), the kilogram (kg) and the second (s), respectively. The first two of these units are based on multiples of 10. Both for historical and scientific reasons we do not measure time in a decimal system. A sexagesimal (base 60) system is used for time.

Because we do not generally want to measure very large or very small distances in metres (for example we would not want to measure the distance from Melbourne to Brisbane in metres), we need names for both larger and smaller units.

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We do this by the use of prefixes and mathematically by multiplying or dividing by powers of 10. The metric prefixes we use are:

- *kilo*, which denotes 1000
- *centi*, which denotes $\frac{1}{100}$
- *milli*, which denotes $\frac{1}{1000}$.

Measuring tools and devices



Different industries have specific measuring tools and devices that are suited to the tasks.

For example, a builder uses tape measures and laser tools to measure the lengths of objects or spaces.

Medical practitioners may use thermometers to measure a person's temperature, scales to measure weight, or a sphygmomanometer to measure blood pressure.

Competitive sports use a range of devices to measure and count. Each measuring device has a specific function, and it is important to choose the correct device for the task.

Understanding mathematical calculations

When using units of measurement, some mathematical conventions are handy to know and understand. **Per** indicates division and can be written with a division line.

For example, metres per second can also be written as *m per sec* or as $\frac{m}{s}$. Commonly, you may see the division line written as a slash, as in *m*/*s*.

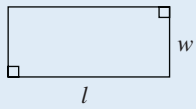
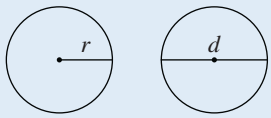
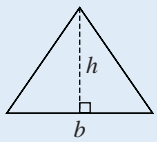
Another way of expressing this division is with an **index**. The notation s^{-1} simply means it is a divisor in a division. For example, *m*/*s* written as an index would be ms^{-1}.

Formulas and algebraic conventions

When we use algebra and formulas in mathematics, we follow some rules and short-cuts (conventions) for the words, expressions and symbols that we use. These were looked at in Chapter 4.

Here are some examples of measurement formulas for the perimeter and area of different shapes.

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Shape	Diagram	Formulas
Rectangle		Perimeter $P = 2l + 2w$ $P = 2(l + w)$ Area $A = lw$
Circle		Circumference $C = 2\pi r$ $C = \pi d$ Area $A = \pi r^2$
Triangle		Area $A = \frac{1}{2}bh$

Some algebraic conventions used in measurement

Word or term	Meaning
Pronumeral	When we use letters like *P, A, l* and *w* to stand for perimeter, area, length and width, they are called **pronumerals**.
Subject	In the formula $P = 2(l + w)$, P is called the **subject** of the formula.
Variable	In the formula $P = 2(l + w)$, the P, l and w are also called **variables** because they vary in value from one situation to another.
Dependent and independent variables	In the formula $P = 2(l + w)$, the P is called the **dependent** variable in the formula because its value depends on the value of the other two variables (l and w). On the other hand, the l and w are called **independent** variables.
Not using the × sign between numbers and pronumerals	A particular convention is when we multiply a number by a letter or pronumeral, as in $P = 2l + 2w$. The $2l$ or $2w$ means 2 times l or 2 times w. Similarly, $C = 2\pi r$ means $2 \times \pi \times r$.

Considering dimensions

One dimension (1D) is the measurement of a length.

For example, the electronic line at the finish of a race has one dimension.

When looking at area, you are considering **two dimensions** (2D).



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For example, a surveyor marking out a block of land considers the area in two dimensions. Surveyors commonly use units of measurement such as hectares (ha) or square metres (m^2).

When looking at the volume of solid objects or capacity for fluids, you are considering **three dimensions** (3D) which are length, width and depth (or height).

For example, this rubbish skip has three dimensions, and its volume is referred to in cubic metres (m^3).

The number of dimensions indicates how the units of measurement will be written.

One-dimensional units of measurement can include:

- Length in millimetres (mm), centimetres (cm), metres (m) and kilometres (km).



Two-dimensional units of measurement can include:

- Area in mm^2, cm^2, m^2 and km^2. We say **square metres** or **metres squared** (and the same for millimetres, centimetres, etc.)

Note that mm × mm = mm^2, cm × cm = cm^2, etc.



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Three-dimensional units of measurement can include:

- Volume of solid objects in mm^3, cm^3 and m^3. We say **cubic metres** or metres cubed (and the same for millimetres, centimetres, etc.)
- Capacity of fluids in millilitres (mL), litres (L) and kilolitres (kL).

Note that mm × mm × mm = mm^3, m × m × m = m^3, etc.

Think back to the one-metre cube you made. Then think of a one-litre drink container.

A litre is the amount of liquid held in a cubic container measuring 10 cm by 10 cm by 10 cm. The volume is the same as 10 × 10 × 10 = 1000 cubic centimetres (abbreviated to cc or cm^3).

Remember too that there are 1000 ml in 1 litre, so 1 ml is the same as 1 cc.

When you consider the amount of space occupied by the one-metre cube, it makes sense that one cubic metre occupies the same space as 1000 litres, or 1 kilolitre:

so, 1 m^3 = 1000 L = 1 kL.

Practice questions

1 Imagine you are to design packaging for biscuits.



a What factors need to be considered in the design of the shape and size of the packaging?

b What 3-dimensional shape will you choose for your packaging? Why?

c How many biscuits will you pack in each packet? What will be the approximate size of your packet?

d Draw a plan of your 3-dimensional biscuit packet including measurements. Note: Your plan does not need to be an accurate scale drawing.

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2 Consider the classroom that you are currently in.

a Estimate the dimensions of the classroom.

b What measuring device could be used to measure the dimensions of the room?

c If a measuring device is available, try to measure the dimensions of the room? What challenges exist in determining all the dimensions. How could those challenges be overcome?



3 Complete the table to list some uses for the following tools and devices, and to record the possible units of measurement.

Device	Used to measure	Units of measurement
Tape measure	lengths	mm, cm, m
Measuring cup		mL
Syringe	medicine for injections	
Bucket		
Bathroom scales		
Checkout scales		
Oven thermometer		
	areas	mm^2
	volumes	

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11C Conversion of units

We often need to convert between different units when we are undertaking tasks involving measurements. This is quite common in work practices. There were some examples in the previous chapter when we looked at scale drawings and plans and at how timber is sold in both units of mm and m.

Everyday examples include when we're baking bread and a recipe calls for 600 g of flour. You might need to work out how many kilograms of flour would you need to make five loaves? Or when you go shopping at the delicatessen and you want some cold meat or other deli-type food. You often ask for this type of food in grams ('Can I have about 200 grams of salami please?'). But the weighing scales and the costs are measured in kilograms as shown below:



Derived units of measurement

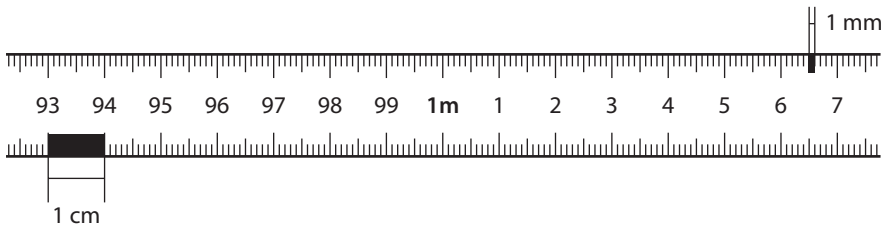
Sometimes, units of measurement can be used together. These are known as derived units of measurement. For instance, a car travelling at speed has two types of measurement – distance and time. The speed of a car is usually measured in km/hour, whereas a sprint runner would be measured in m/s. Runners in long-distance races refer to pace, which is minutes per km, and they check their time as they pass the kilometre-distance markers.



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How units relate to each other

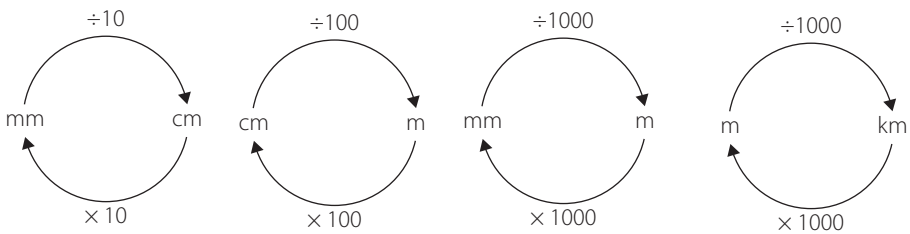
In the previous chapter we looked at the relative sizes of millimetres (mm) and centimetres (cm).



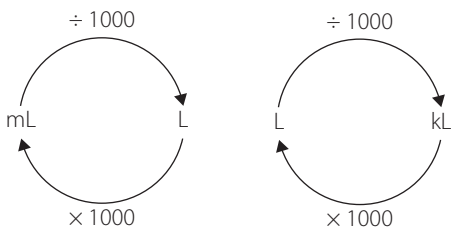
You can see from the image above that millimetres are smaller divisions of centimetres.

When you convert from a smaller unit of measurement to a larger one, you divide, because you do not need as many of the larger unit. It is a bit like when you exchange *ten* $5 notes for *one* $50 note: the number of the smaller-value notes is divided by the conversion factor of 10.

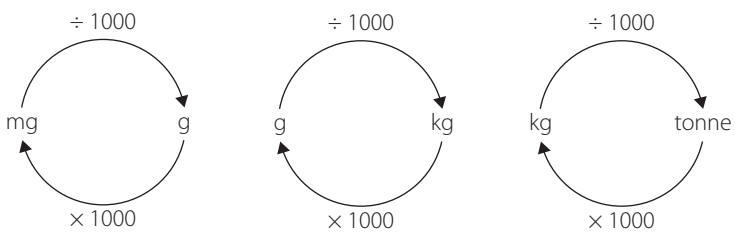
Length conversion key



Volume/capacity conversion key



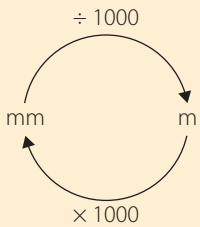
Mass conversion key



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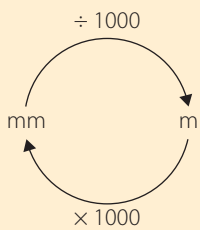
Example 1 Converting units of measurement

Tom needs to convert a 5 m length into mm to write it on a building plan. What is 5 m in mm?

THINKING	WORKING
STEP 1	
Choose the conversion. Since we are converting from a larger unit to a smaller unit, we need to multiply.	
STEP 2	
Input into your calculator.	$5 \times 1000 = 5000$ mm

Example 2 Converting units of measurement

When you convert from a smaller unit of measurement to a larger one, you *Divide.*
For example, converting mm to m, or m to km.
Sophie needs to convert a 1015 mm length into m on a building site

THINKING	WORKING
STEP 1	
Choose the conversion.	
STEP 2	
Input into your calculator	$1015 \div 1000 = 1.015$m

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11C Tasks and questions

Thinking task

1 For each of the derived units of measurement below, write the abbreviation, and give one example where this unit may be used.

- **a** square metres
- **b** metres per second
- **c** kilometres per hour
- **d** cubic metre
- **e** grams per centimetre cubed
- **f** minutes per kilometre

Skills questions

2 Convert the following to cm.

a 50 mm **b** 100 mm **c** 80 mm

3 Convert the following to mm.

a 4 cm **b** 18 cm **c** 120 cm

d 6 m **e** 9 m **f** 25 m

4 Convert the following to m.

a 4000 mm **b** 3200 mm **c** 2790 mm

d 500 cm **e** 890 cm **f** 468 cm

5 Convert the following to km.

a 3500 m **b** 4000 m **c** 2500 m

6 Convert the following to mL

a 5 L **b** 7.5 L **c** 1.25 L

d 0.25 L **e** 2.1 L **f** 0.125 L

7 Convert the following to L.

a 500 mL **b** 17.5 mL **c** 2500 mL

d 1250 mL **e** 50 mL **f** 12 250 mL

8 Convert the following to kL.

a 5000 L **b** 17 500 L **c** 2500 L

d 125 000 mL **e** 50 L **f** 1 200 000 mL

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9 Convert the following to mg.

a 2.5 g **b** 75 g **c** 125 g

d 0.25 g **e** 2 kg **f** 0.125 kg

10 Convert the following to kg.

a 2500 g **b** 32750 g **c** 650 g

d 25.5 g **e** 2.75 tonne **f** 200 000 mg

11 Convert the following to tonnes.

a 12 754 kg **b** 750 kg **c** 2.75 kg

d 0.1275 kg **e** 55 755 g **f** 5 250 000 mg

12 Mixed practice.

Convert the following

a 375 mm to cm **b** 2.5 tonne to kg **c** 2.5 L to mL

d 3.755 km to m **e** 85 mL to L **f** 25 650 cm to km

g 1125 kg to tonne **h** 725 000 cm to km **i** 0.333 kL to L

j 200 000 mg to g **k** 50 mg to g **l** 200 g to mg

Mathematical literacy

13 Create a mind map of words related to metric measurement units. Next to each word, write the abbreviation, if there is one, and place a picture demonstrating the word.

For example, road distance: Kilometre (km)



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Application tasks

14 Convert the following to mm.

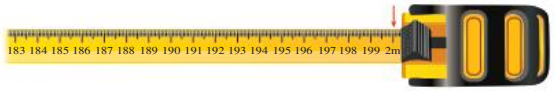
a



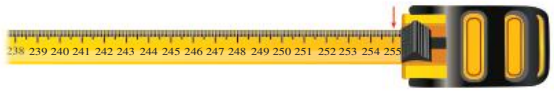
b



c



d



e 10 cm

f 35 cm

g 2 m

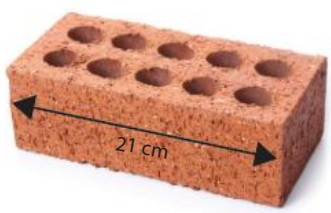
h 2 m and 55 cm

For parts **c** and **d**, remember that 100 cm = 1 m.

i



j



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15 Think of another unit of measurement to express the following.

a



b



c



d



e



f



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11D Measurement practice

In life, at home, in the community and work we carry out a myriad of measurements every day. Most of these measurements are now automated or carried out digitally, and you will read and interpret the measurement.

When you wake up in the morning, you may have an alarm clock which measures time. You might catch public transport, and you will know what time you need to leave home in order to walk the distance to the bus stop. If you get in the car, the speed of the car will be measured using the speedometer. The fridge in your kitchen has a thermostat that measures the temperature inside the fridge and freezer. Likewise, the kettle measures the boiling point of water and then automatically switches off. When cooking you often need to set the oven temperature to a specified value.

At work, measurement may be more labour-intensive depending on your work situation. Health professionals may take body measurements and pharmacists will measure out medications. Trades may carry out measurements of length, area and volume using both analogue and digital tools, and hairdressers at expert at estimating length of hair.

11D Tasks and questions

Thinking task

1 Make a list of ten things you measure at home. Consider each room in your home, and outside in the garden and the garage. Your list may include measurements related to cooking, medicine, clocks, clothes washing or repairs.

Skills questions

2 Measure the lengths of the following lines.

a _____ **b** _____

c _____

d _____

e _____ **f** _____

g _____ **h** _____

i _____

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Mathematical literacy

3 For each item you listed in the Thinking task (Question **1** above), name the instrument you would use to measure it. For example, cordial: measuring jug.

Application tasks

4 The clothes washing detergent bottle contains two litres of detergent. Each cap is estimated to hold 50 ml of detergent. For the following questions, follow the directions shown below for the type of washing machine you have at home – either a front loader or top loader.

Top Loader	Front Loader	Soaking / Stains
Small load 1 cap	Small load $\frac{3}{4}$ cap	Stains: Rub a little laundry liquid onto the stain, then wash immediately.
Normal load $1\frac{3}{4}$ caps	Normal load $\frac{3}{4}$ cap	Soaking: Pour 1–2 caps of laundry liquid into 5 litres of water. Leave to soak for 30 minutes or overnight. Wash as usual.
Large load $2\frac{1}{4}$ caps	Large load Full cap	

a Approximately how many **normal** loads can you get from this bottle?

b If half the loads were **large** loads and the other half were **normal**, how many washes can you get from the bottle?

c Think of another combination of loads and determine how many washes you will be able to do.



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5 This delicious banana cake can be baked at home in the kitchen. The recipe is tried and tested by generations of Australians.

BANANA CAKE

Ingredients

125 g butter
$\frac{1}{2}$ cup sugar
2 eggs
$1\frac{1}{2}$ cups self-raising flour
1 tsp cinnamon
1 tsp mixed spice
1 tsp bicarbonate of soda
2 tbsp milk
3 ripe bananas, mashed
Pinch of salt



Method

Cream the butter and sugar in a large bowl, add the eggs and then the sifted dry ingredients.

Dissolve the soda in the milk, then add to the bowl.

Lastly, fold in the bananas and salt.

Bake for one hour in a moderate oven (180°C).

Source: The Country Women's Association of Victoria

a If one block of butter is 250 g, what fraction of the block is 125 g?

b If you halved the recipe, how much butter would you need?

c A standard measuring cup is 250 mL. How many mL of sugar is required for the recipe?

d How many mL of flour?

e Write the recipe out for double the amount of banana cake.

f Make the cake, accurately measuring all ingredients.

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6 Men's clothing – Tops / Shirts / Jackets

Size		Chest		Neck
		(cm)	(inch)	(cm)
28	XS	87	34	35
30	X	92	36	37
32	M	97	38	39
34	L	102	40	41
36	XL	108	42.5	43
38	XXL	114	45	45
40	XXXL	120	47	46
42	3XL	122	48	47
44	4XL	127	50	48
46	5XL	132	52	50
48	6XL	137	54	52
50	7XL	143	56	54

When shopping online, you must know which clothing size you need to order because you can't try the clothes on first.



Which size shirt would you buy for the following measurements?

- Chest 100 cm and neck 41 cm.
- Chest 118 cm and neck 46 cm.
- Chest 96 cm and neck 40 cm.
- Chest 113 cm and neck 46 cm.

a Go to a website and search for a shoe-sizing guide. One example is Betts.com.au. What size shoe would you buy for a foot measuring 220 mm?

b For a foot measurement of 250 mm, list all the shoe sizes you could buy.

c Measure your own foot with a measuring device, and decide which size shoe you should buy.

d Record your classmates' foot lengths in mm, and write down which size shoe they should buy, in both Australian and US sizing.

e What is the most popular shoe size in your sample? This number may be called the **most common number** and in mathematical terms is known as the **mode**.

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7 How full is the petrol tank in the car-fuel gauges shown below?

a



b



c



d



e For each of the above petrol gauges, estimate how much fuel is left in the petrol tank for a car with a petrol tank capacity of 50 L.

8 Ravi is a site manager and has a car with a 60 L petrol tank.

a If the petrol tank is $\frac{3}{4}$ full, roughly how many litres might be left in the tank?

b If Ravi needs to drive from Melbourne to Portland to visit an aluminium smelter, how many kilometres will he drive in total, there and back?

c A fuel-efficient small car on a highway can travel roughly 500 km from a 60 L tank. How many tanks of petrol will Ravi need to drive from Melbourne to Portland and back?

d Choose three different destinations and calculate how many tanks of petrol will be needed to reach these destinations from your home, based on a car that can travel 500 km on a 60 L tank.

e Investigate the cost of unleaded fuel, and calculate how much it will cost in petrol for each of these journeys? How much will the cost vary as the petrol price changes?

f If you have a car, when and how do you decide to fill up your tank? What considerations do you take into account?

9 Brendan must return his rental car to the car hire kiosk at the airport within 30 minutes, otherwise he will be late for his plane. Brendan sees on a sign that he has 10 km to reach the airport and is travelling in a 60 km zone.

Does he have enough time to return his car?

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11E Measuring time

Time is a constant feature of our lives. We use it to describe a **sequence** of events, such as counting our birthdays in *years*. We also use time to describe the **duration** of events, such as the number of minutes in a lesson. We can measure time down to thousandths of a second to decide the results of athletics and motor racing competitions.

Time is measured in many ways around the world. A year in western time is 365 days (366 days in a leap year) from 1 January to 31 December. In western financial markets, a year runs from 1 July to 30 June, which is called a **financial year**. Western time is based on the **Gregorian calendar**, although some communities still use their traditional calendar to mark important dates.

In Muharram, the Muslim calendar, the length of the year is based on the cycles of the moon, and a year varies in length from 354 to 355 days.

The Lunisolar calendar is based on the moon (lunar) and the sun (solar). Every 19 years, (metonic cycle) there is a catch-up. In seven of the 19 years, a leap month is inserted, so these years have 13 months. These months are the 3rd, 6th, 8th, 11th, 14th, 17th and 19th years.

The Mayan calendar ran out of digits in the year 2012. This led to some conspiracy theorists predicting the world would end in that year. It did not happen.

Units of time

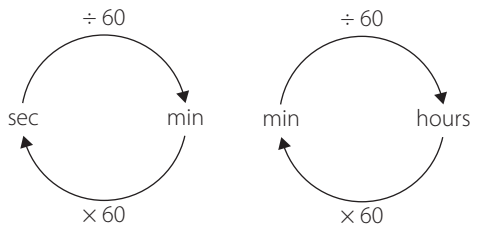
The units of time are shown below. The conversion factors are a mixed set of numbers, some of which date back to ancient astronomers.

- 1000 milliseconds in one second
- 60 seconds in one minute
- 60 minutes in one hour
- 24 hours in one day
- 7 days in one week
- 14 days in one fortnight
- On average, 30 days in one month. (But remember: Thirty days has September, April, June and November. All the rest have thirty-one, excepting February alone, which has twenty-eight days, and in a leap year twenty-nine.)
- 12 months in one year
- 365 days in one year (366 in a leap year)

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If we need to convert between seconds, minutes and hours, we multiply or divide by a factor of 60.

Time conversion key:



Tasks and questions

Thinking task

1 How many days are there from today's date until your birthday? How many school days are there until the end of the year?

Skills questions

2 Calculate the following time intervals.

a 9:00 am till 5:00 pm

b 6:15 am till 4:00 pm

c 5:45 pm till 11:00 pm

d 4:30 pm till 12:15 am

3 Convert the following times from seconds to minutes.

a 80 secs **b** 300 secs

c 30 secs **d** 90 secs

4 Convert the following times from minutes to hours.

a 60 mins **b** 120 mins **c** 400 mins

d 90 mins **e** 330 mins

5 Convert the following times.

a 5 hours to minutes

b 10 minutes to seconds

c 9000 seconds to hours

d 1 hour to seconds

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6 Mixed practice

a How many minutes in half an hour?

b Convert 90 minutes to hours.

c How long is it from 10:47 am to 1:15 pm?

d Quarter-past 5 means how many minutes past 5?

e Convert 76 seconds to minutes.

f How many minutes in three-quarters of an hour?

g Convert 390 000 seconds to hours.

h Quarter-to means how many minutes till the next hour?

i How long is it from 3:18 pm to 7:36 pm?

j How many minutes does half-past mean?

Mathematical literacy

7 Research calendars from around the world. Give the names for years, months, weeks and days in at least one other language.

Share these words with your class.

Application tasks

8 Complete the following work roster.

	Start	Finish	Time worked (hr:min)
Mon	-	-	
Tues	6:00 pm	9:15 pm	
Wed	8:00 am	4:00 pm	
Thurs	8:00 am	12:00 pm	
Fri	4:30 pm	9:15 pm	
Sat	8:00 am	1:30 pm	
Sun	-	-	

9 How long is a financial year in Australia? On which dates does a financial year start and finish?

10 You have your Learners Test booked on 18 September. How many months and days from today until your test?

11 How many school days are left for this year, including today's date?

12 You request online help through a chat function. A notification tells you that you have 1253 seconds to wait for your turn. How many minutes is this?

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13 You start your stopwatch for a run, and the run is timed at 930 secs. How many minutes did you run for?



14 A hairdresser makes an appointment for you every 6 weeks. Your last visit was on 12 March. When is your next appointment scheduled to be?

15 A building contract states that the Building Period for a renovation on a house is as follows.

The Building Period includes 157 days of actual building work and the following estimates for delays.

- Inclement weather and the effects of inclement weather = 18 days.
- Weekends, public holidays, rostered days off and other foreseeable breaks in the continuity of works = 70 days.
- Other days that are reasonable, having regard to the nature of the Building Work Days = 10 days.

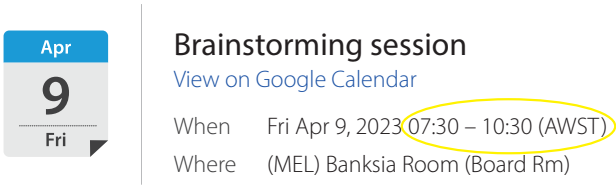
Note: The Building Period is the total days of actual building work and *includes* estimates for delays.

a How many days *in total* is the Building Period?

b If the start date is 16 October, when is the end date?

c If the builder extends the contract by 6 months, what is the new end date?

16 Namiko gets an invitation to attend a meeting online where she lives in Melbourne, but the invitation says 7:30–10:30 AWST. What time is the meeting in Melbourne? Do you need to consider daylight savings time?



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11F A special number – π

Find some circular objects such as a plate, rubbish bin lid, Frisbee, or a bucket. Take a piece of string and cut it to match the diameter; that is, the distance across the middle of the object from one side to the other.

Next estimate how many times this length of string will go around the outside of the object; that is, the circumference.

What did you notice?

From this activity you can see that the circumference is always 3 and a bit times the diameter. This number is the special number π.

Some people use $\frac{22}{7}$ (or 3.14) as a close approximation of π. How close are the two values? When might the difference actually matter?

Locate π on your calculating device.



Circumference is the word used for the perimeter (distance around) a circle, and we saw from the activity above that it's a bit more than three times the diameter.

We can calculate the exact circumference by using π. For circumference, C, and diameter, d, then:

$$C = \pi \times d$$

11F Tasks and questions

Thinking task

1 Research the values of π, and the common approximations of π.

- **a** What is the story about the number of digits in π? How many digits are there?
- **b** What approximations did you find? What are different ways to write π?
- **c** Whose approximation is closest to the actual value?
- **d** What is the current record for the person who can recite the most digits in the number π?

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Skills questions

2 For each of the objects below, complete the following tasks.

i Estimate the circumference.

ii Calculate the circumference using the formula $C = \pi \times d$.

a Object with a diameter of 10 cm

b Object with a diameter of 12 m

c Object with a diameter of 5000 mm

d Object with a diameter of 35 cm

e Object with a radius of 6 cm

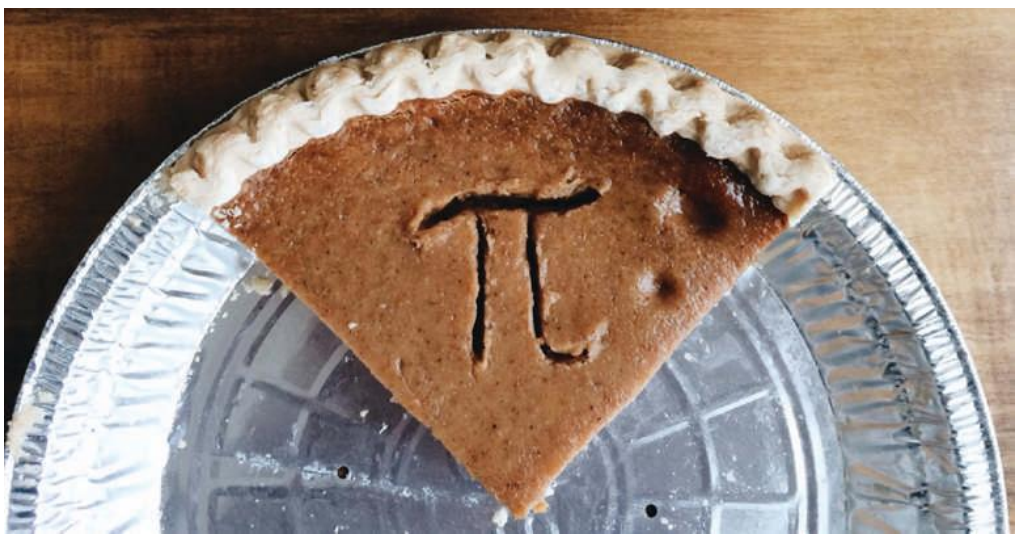
f Object with a radius of 13 m

Mathematical literacy

3 Who discovered *pi*?

Design a social media post celebrating the discovery of *pi*.

When do some countries celebrate *pi* day?



Application tasks

4 Measure the diameter and then calculate the circumference of the following round items in your classroom.

a Rubbish bin

b Drink bottle

5 If you double the diameter of a shape, what happens to the circumference?

6 If you want to halve the circumference of a shape, what change must you make to the diameter?

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11G Area

Area is the two-dimensional space that a shape occupies.

There are different formulae which can be used to calculate area, depending on the shape. These were summarised is section 11B.



Square shape

$$\begin{aligned}\text{Area} &= \text{length} \times \text{length} \\ &= l \times l \\ &= l^2\end{aligned}$$



Rectangle shape

$$\begin{aligned}\text{Area} &= \text{length} \times \text{width} \\ &= l \times w\end{aligned}$$



Triangle shape

$$\begin{aligned}\text{A} &= \frac{1}{2} \times \text{base} \times \text{height} \\ &= \frac{1}{2} bh\end{aligned}$$



Circle shape

$$\begin{aligned}\text{Area} &= \pi \times \text{radius} \times \text{radius} \\ &= \pi \times r \times r \\ &= \pi \times r^2\end{aligned}$$

(Remember π can be found on your calculator.)

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Trapezium $\text{Area} = \frac{1}{2}(\text{top} + \text{bottom}) \times \text{height}$

$= \frac{1}{2}(a + b) \times h$

(note: height must be at right angles with the bottom)

11G Tasks and questions

Thinking task

1 Thinking of the price of pizzas in assorted sizes, check out the way the price of a small, medium and large pizza is related to the *area* of the pizza at a couple of different pizza shops. Share your findings with classmates.



What size is the best value? How do you define **value**?

Skills questions

2 For the shapes below, complete the following tasks.

i Sketch a rough diagram of the shape.

ii Measure and label the sides.

iii Calculate the area of the shape.

a The top of the table you are sitting at

b The size of the window nearest to you

c The base of a drink bottle

d A computer or laptop screen

e The lid of a lunchbox

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f A door

g A step

h A plate

i A slab of concrete

j The bonnet of a car

Mathematical literacy

3 Research the history of **metrication** and make a list of some countries that use **metric measurements** for area. (For example, Australia and Indonesia.)

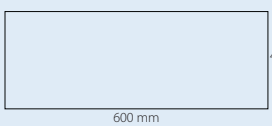
Find some countries that do not commonly use metric units for area. How do they measure area?

Application tasks

4 Using a camera or phone, take photos of shapes in your neighbourhood.

Find the following shapes: square, rectangular, triangular, circular and trapezoidal. Try to include at least one of each shape.

Where possible, measure the sides of the shape in two dimensions, and then find the area. Note your findings in a table like the one shown here. Include the units of measurement you used.

Picture or sketch	Side lengths	Formula to be used	Area (units^2)
	l = 600 mm w = 400 mm	$A = l \times w$	$A = l \times w$ = 600 mm × 400 mm = 240 000 mm^2 = 0.24 m^2

5 Site manager Ravi must consider how many car parking spaces are needed in the new city building he is managing.

a Find the area of a single car parking space and a double car parking space with the following dimensions.

6.0 m × 3.5 m for a single car space

6.0 m × 5.5 m for a double car space

b What is the difference between the area for a double car parking space and a single car parking space?

c How many times bigger is the double space compared with the single space?

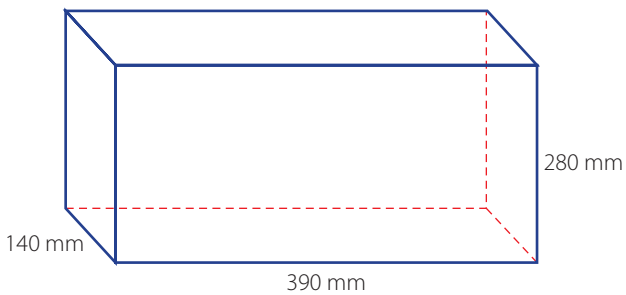
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11H Surface area

Total surface area (TSA) is the value when the outer 2D areas of the different faces of a 3D object are added together.



The dimensions of this box are as shown.



There are 6 surfaces or faces to this box.

The large front and back faces have an area of 390 mm × 280 mm.

$2 \times 390 \times 280 = 218\,400$ mm^2

The two small sides have an area of 140 mm × 280 mm.

$2 \times 140 \times 280 = 78\,400$ mm^2

The top and bottom faces have an area of 140 mm × 390 mm.

$2 \times 140 \times 390 = 109\,200$ mm^2

The **total surface area** of the parcel box is found by *adding* the areas of all the faces together.

$218\,400 + 78\,400 + 109\,200 = 406\,000$ mm^2

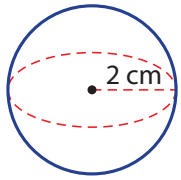
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A special case – surface area of a sphere

A sphere only has one surface, and there is a special formula to calculate the area of this surface.

To find the surface area of a sphere, we use the formula $TSA = 4\pi r^2$.

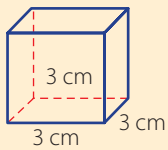
Note: The total surface area of a cylinder also has a special formula, as it has one curved surface. The formula to use is shown in the formula list on page 166: $TSA = 2\pi r\,(r + h)$.

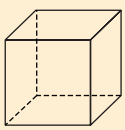


$TSA = 4 \times \pi \times 2^2$
$= 16\pi$
$= 50.27\text{cm}^2$

Example 3 Finding total surface area

Find the total surface area of a cube measuring 3 cm in length, width and height.



THINKING	WORKING
STEP 1	
Find the area of one surface 	$A = l \times w$ $A = 3 \times 3$ $A = 9\text{ cm}^2$
STEP 2	
Calculate how many surfaces a cube has and multiple the area by this number for a cube where all sides are the same length	$TSA = 6\text{ sides} \times 9\text{ cm}^2$ $TSA = 54\text{ cm}^2$

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11H Tasks and questions

Thinking task

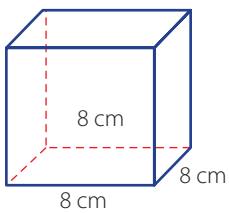
1 Bring into class some leftover wrapping paper from opening presents. Take one sheet of paper and cut it to the correct size to closely wrap an object on your table.

- **a** What is the area of the piece of wrapping paper?
- **b** How many surfaces does the object have?
- **c** When you have wrapped the object, has the area of the object changed?
- **d** How much overlap do you need to allow when wrapping?

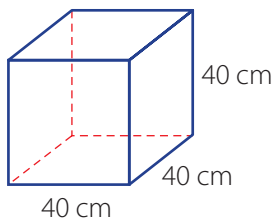
Skills questions

2 Find the total surface area of the following objects.

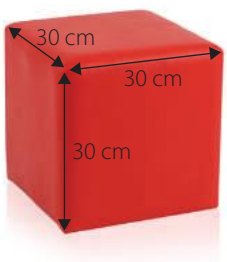
a



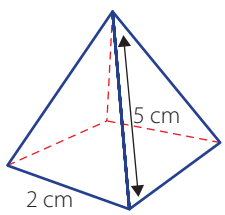
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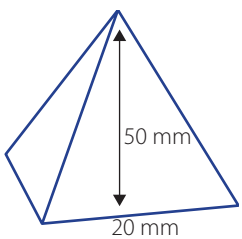
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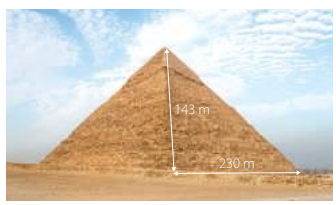
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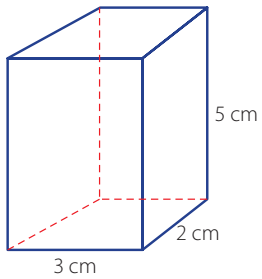


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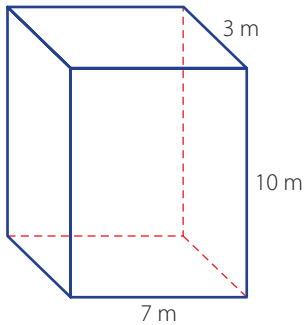


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h

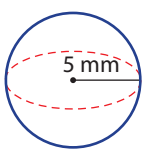


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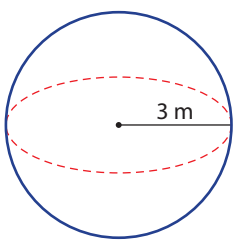


3 Find the total surface area of the following spheres. Round your answers to 1 decimal place.

a



b



c



Radius of one sphere = 1500 mm

d



Sphere diameter = 2.5 m

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4 Calculate the following.

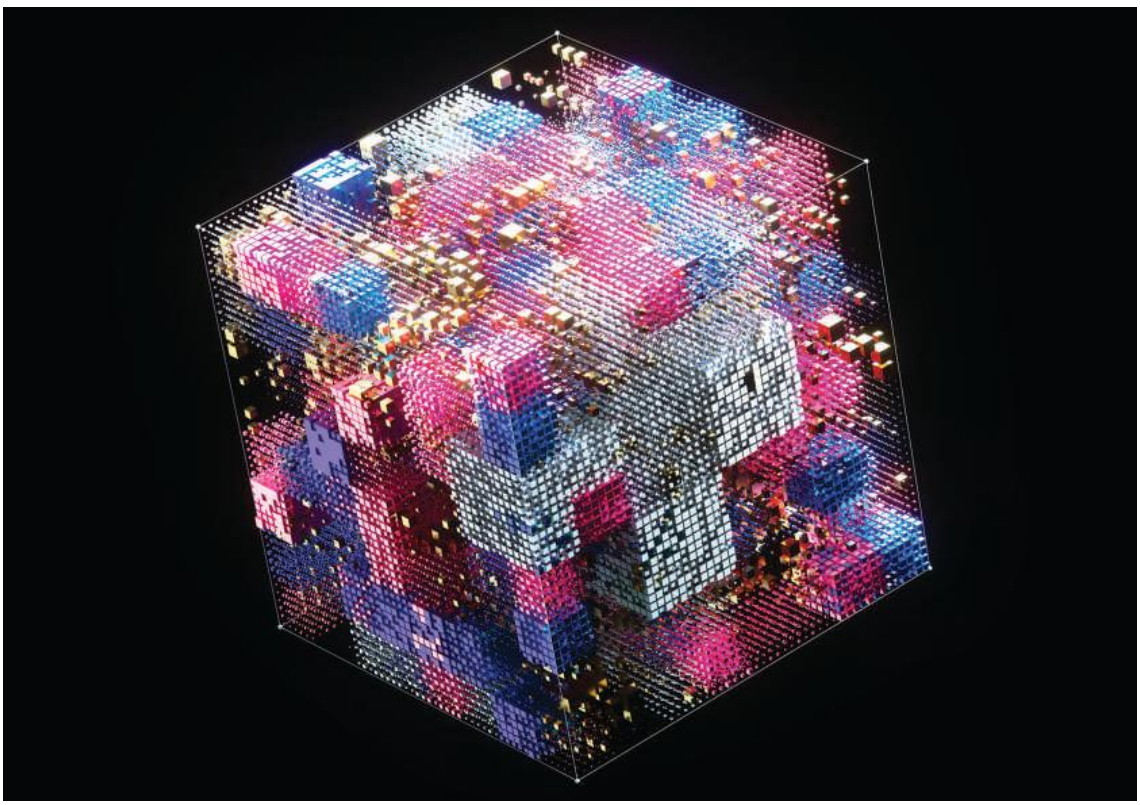
a The perimeter of a square with a side length of 8 cm.

b The area of a triangle with a vertical height of 9 m and a base side length of 5 m.

c The TSA of a cylinder with a radius of 40 mm and a length of 20 mm.

d The total surface area of a cube with a side length of 8 cm.

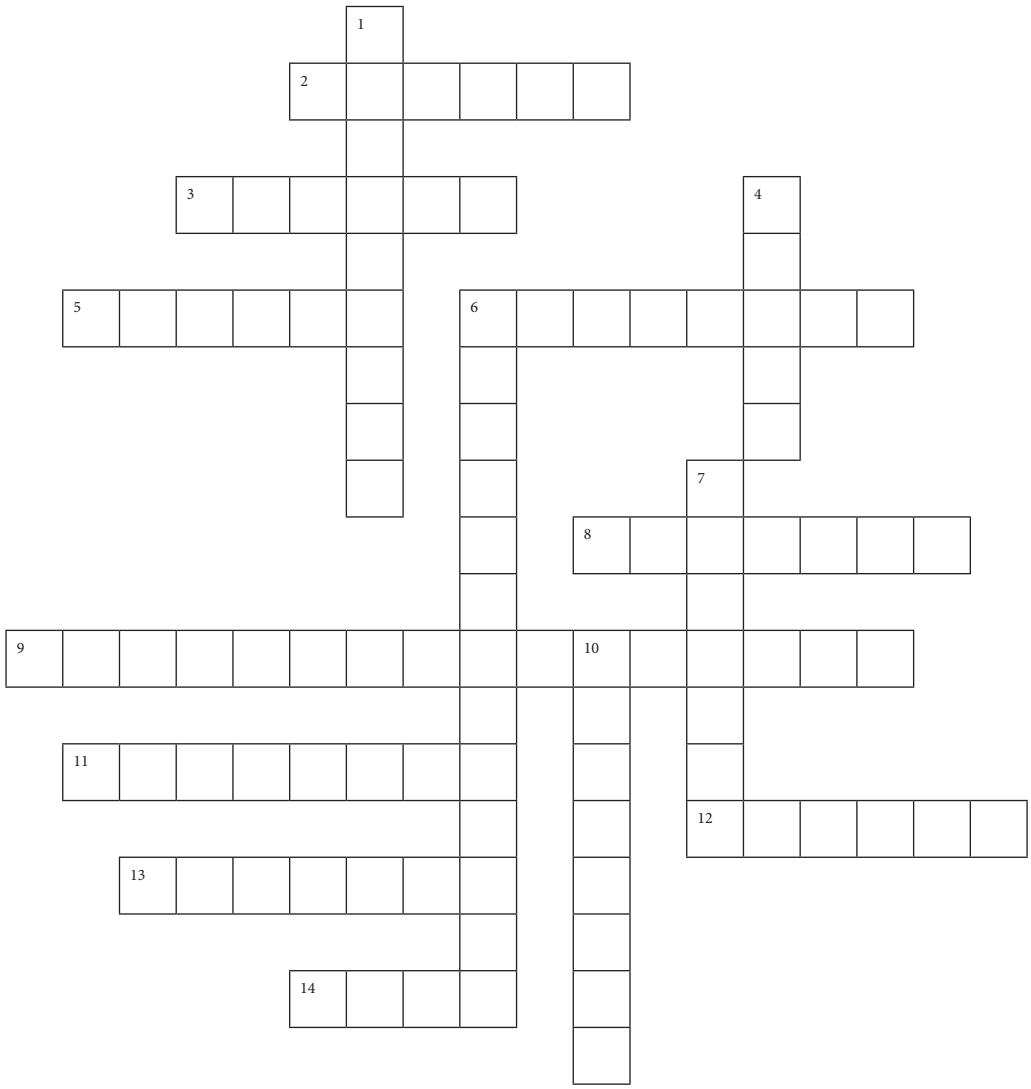
e The total surface area of a square-based pyramid with a side length of 800 mm and a slant height of 950 mm.



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Mathematical literacy

5 Complete the crossword.



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Down:

1 The distance around the edge of a shape.

4 Three-dimensional object with two identical ends and flat sides.

6 The distance around the edge of a circle.

7 Another name for the width or how wide an object is.

10 A solid or hollow tube with long straight sides and two circular ends the same size.

Across:

2 The measurement of an object from end to end.

3 A line from the middle of a circle or sphere to the outside edge.

5 The amount of space contained in a 3D object.

6 The total number or amount of things an object can hold.

8 An object with a square base and sides that form a point at the top.

9 The area of *all* the outer surfaces of something.

11 A line from one side of a circle or sphere to the opposite side, passing through the middle.

12 The distance of an object from top to bottom.

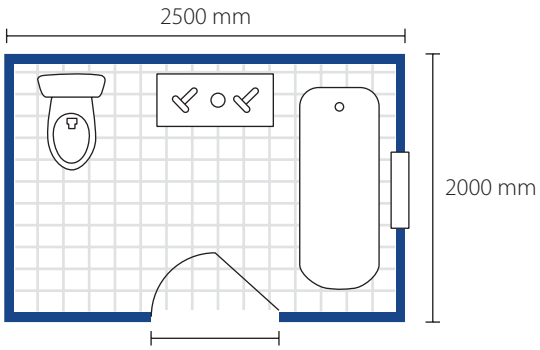
13 A flat shape with three or more sides.

14 The bottom part of an object.

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Application tasks

6 A bathroom on the plan for Ravi's building is measured up as shown in the diagram below.



Height of ceiling – 3000 mm

The entire floor and each wall are to be tiled to a height of 2000 mm (2 m) all around the room. There is one small window above the level of the tiles and one door that is 800 mm wide and 2000 mm high. Find the area, in square m, of the following.

a Each wall

b The floor

c The total area to be tiled.

7 A certain tile shop sells the type of tiles that Ravi needs for the bathroom at $75 a box. One box is enough to tile one square metre.



a How many boxes of tiles will Ravi need to tile the bathroom?

b What is the total cost of tiles for this bathroom?

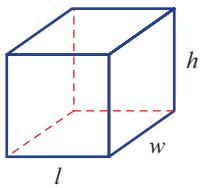
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11I Volume

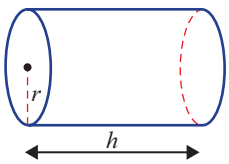
Capacity and volume are similar concepts.

- Volume measures the space *inside* a 3D object.
- Capacity measures the *amount of liquid* a 3D container will hold.

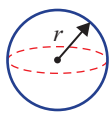
Common formulas for calculating volume are shown here.



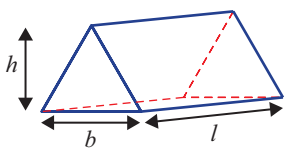
$V = l \times w \times h$



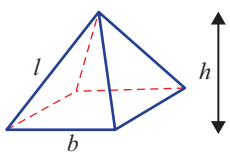
$V = \pi r^2 \times h$



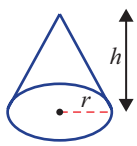
$V = \frac{4}{3}\pi r^3$



$V = \frac{1}{2} b \times h \times l$



$V = \frac{1}{3} b \times h \times l$

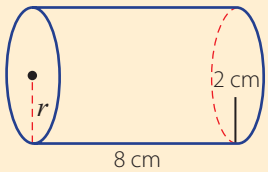


$V = \frac{1}{3}\pi r^2 \times h$

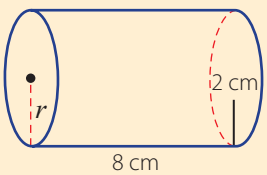
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Example 4 Finding the volume of a cylinder

Calculate the volume of a cylinder with a length of 8 cm and a circle with a radius of 2 cm. Round your answer to 2 decimal places.



THINKING	WORKING
STEP 1	
Choose the appropriate formula and identify the measurements	$V = \pi r^2 \times h$ Radius = 2 cm Height = 8 cm
STEP 2	
Replace the pronumerals with the corresponding measurement	$V = \pi \times 2^2 \times 8$ $V = \pi \times 4 \times 8$ $V = 32\pi$ $V = 100.53 \text{ cm}^3$



11I Tasks and questions

Thinking task

1 Take two drinking glasses of different shapes. Mark a 10 cm height on the outside of each glass, and fill with water to that level.

a Do the glasses hold the same amount of water?

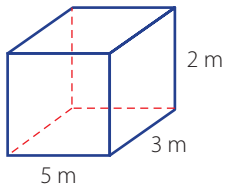
b Why or why not?

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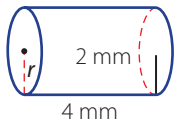
Skills questions

2 Calculate the volume of the following shapes. Round your answers to 1 decimal place where appropriate.

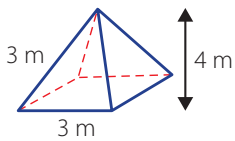
a



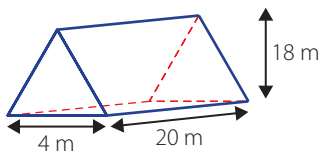
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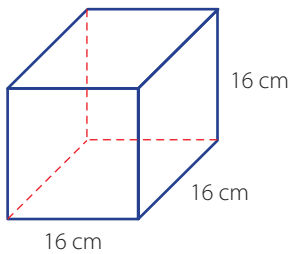
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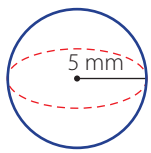
d



e



f



3 Mixed practice

a How many cm in 1800 mm?

b What is the area of a rectangle with a height of 8 m and a width of 25.6 m?

c Find the volume of a cylinder with a radius of 45 mm and a length of 120 mm. Write your answer in cm^3 to 1 decimal place.

d Convert 2.5 km to m.

e What is the volume of a sphere with a radius of 55 mm? Write your answer in cm^3 to 1 decimal place.

Mathematical literacy

4 Design a poster for young children, demonstrating the difference between volume and capacity.

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Application tasks

5 Estimate the volume of liquid in each measuring device.

a



b



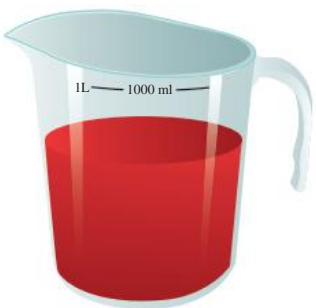
c



d



e



f



6 Take a look at the information in the table below about how to use a common garden fertiliser.

FOR WATERING CAN APLICATION 1 capful = 10 mL Approx. 9 litres diluted mixture covers 2–4 square metres.		
PLANT/APPLICATION TYPE	**RATE Per 9 L watering can**	**APPLICATION FREQUENCY**
Ferns	20 mL	Every 2 – 4 weeks
Foliar Applications & Indoors	20 mL	Every 2 – 4 weeks
Transplanting & Planting	30 mL	At planting and again 1 week later
Vegies, Herbs and Annuals	30 mL	Every 2 weeks
Established Garden	30 mL	Every 2 – 4 weeks
New Lawns	50 mL	Every 7 – 10 days while establishing
Lawns	100 mL	Every 2 – 4 weeks to maintain
Large Stressed Trees	100 mL	Apply monthly to soil around dripline of tree.

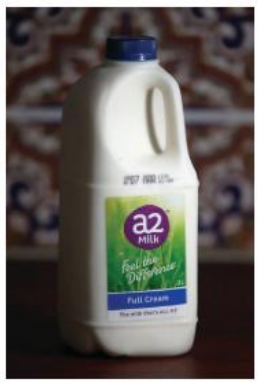


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a To fertilise an established garden, how many mL of Seasol would you use? How many capfuls is this? How much water would you need to dilute the Seasol?

b If a bucket holds 9 L, how many buckets would you use? Would the solution and the water fit in the bucket?

7 Thinking about the milk consumed by a family of 5 in a week, answer the following questions.



a If $\frac{1}{2}$ a litre of milk per person is used each day, how many litres should the family buy for one week?

b Find out the cost of milk in your local supermarket for a common brand. How much will the family pay for a week's worth of milk?

8 A hard rubbish collection can include 2 cubic metres of hard and metal waste (2 metres long × 1 metre wide × 1 metre high).

Choosing from the approved items below, estimate how many would fit within the 2 cubic metre allowance.



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9 If the cleaning bottle holds 200 mL, how much cleaning solution and how much water should you add?



10 For the pools shown below, complete the following tasks.

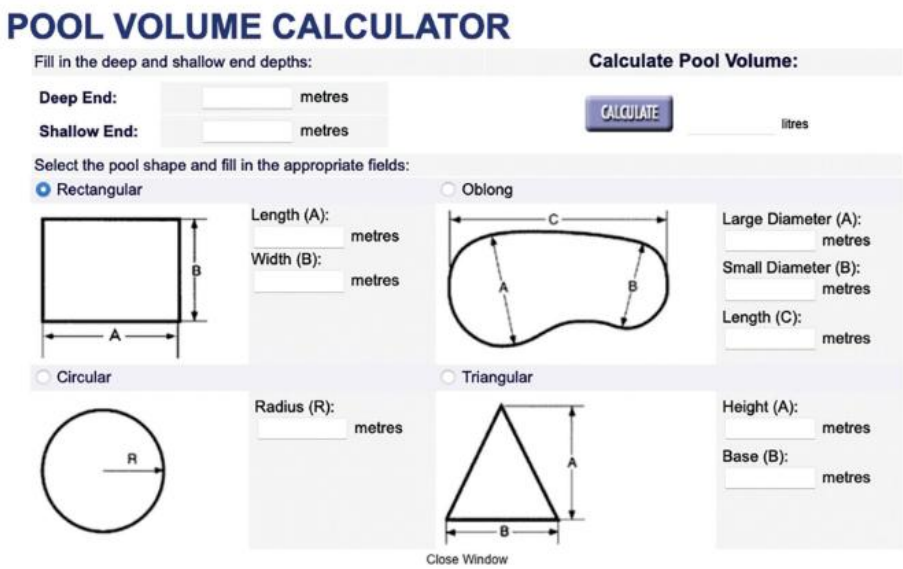
i Use the pool calculation tool to find the capacity of each pool.

Remember: 1 m^3 = 1000 L.

ii Hence, find the volume of water needed to fill each pool.

iii Use the internet to search for the cost of water per litre.

iv Calculate the cost of filling each pool.



Source: www.pentairpool.com.au

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a Rectangular design:

A = 5 m and B = 3 m

Deep end = 2 m and shallow end = 1.2 m

b Oblong design:

A = 5 m, B = 4 m and C = 6 m

Uniform depth = 2 m

c Circular design:

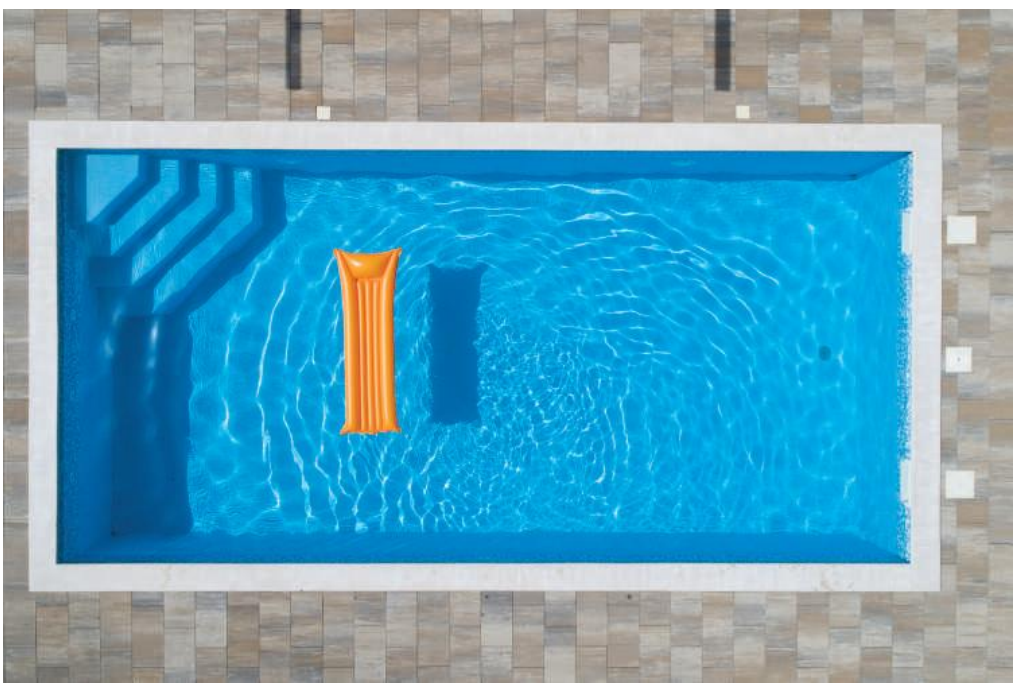
R = 4 m

Uniform depth = 1.6 m

d Triangular design:

A = 3 m and B = 4.5 m

Uniform depth = 1.4 m

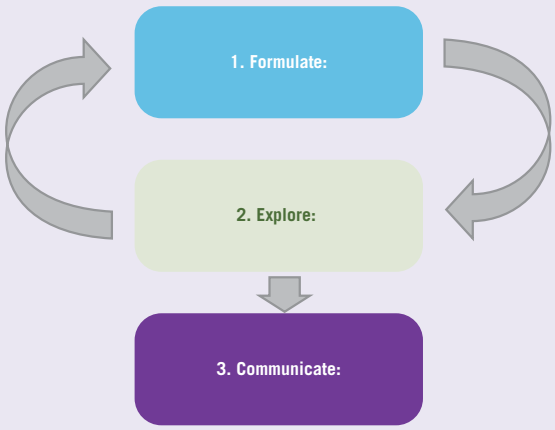


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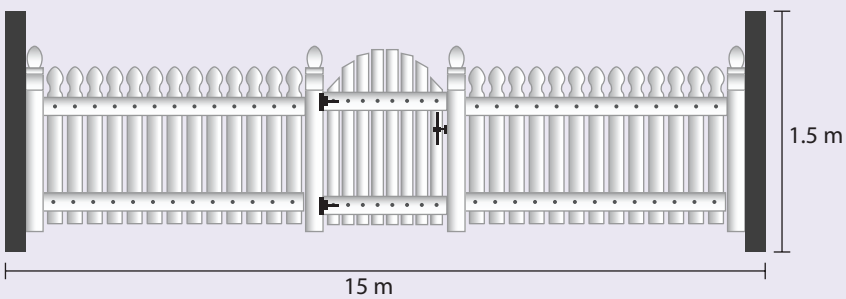
Investigations

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. Painting the front fence



Your friend Fatima's 15 m front fence is just about falling down, and the pedestrian gate is stuck open. She is considering replacing it with a 1.2 m high picket fence and gate – but she's worried about the cost of painting this new fence. Impressed by how well you repainted your bedroom, she's asked you to provide a quote for painting the new picket fence.

a Use a fencing calculator from the internet to work out how many posts and pickets will be needed for her fence.

b Explain why this fence will need more paint than a flat wall of the same dimensions.

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c Research exterior paint coverage to work out how many tins of paint you will need.

d Research what this will cost.

e Estimate how long it will take you to do 2 coats of paint on this fence.

f What will you charge per hour for your labour?

g To complete your quote, total your expenses and labour, then include GST.

h If Fatima thinks this is too much money, include screenshots of other types of fencing she could consider.

2. Setting up the home office

Your task is to provide an illustration with the correct ergonometric measurements for your home computer station.

a Find a picture that shows the correct ergonometric positions for a home computer station. Include the hyperlink.

b Measure your computer chair when you are sitting with your feet flat on the floor.

c Use this to calculate the height of the tabletop, the monitor, and the angle of the monitor.

d Put these measurements and angles into your drawing.

e Briefly explain why setting up your computer station correctly is important for you.

f Briefly explain why ergonometric considerations are important in the workplace.

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Key concepts

- When we **convert** from a smaller unit of measurement to a larger one, we multiply. When we convert a larger unit of measurement to a smaller one, we divide. Some useful facts to bear in mind include:
  - 10 mm = 1 cm, 100 cm = 1 m, and 1000 m = 1 km.
  - 1000 mL = 1 L, 1000 L = 1 kL.
  - 1000 mg = 1 g, 1000 g = 1 kg
  - 60 seconds = 1 minute, 60 minutes = 1 hour.
- **Perimeter** is the distance around the boundary of a figure.
  - The perimeter of a circle is called the **circumference**.
  - Circumference = $\pi \times$ diameter
  - The perimeter of a rectangle = (2 × length) + (2 × width)
- **Area** is the size of a region inside a 2D shape.
  - Area of a **square** = side length^2
  - Area of a **rectangle** = length × width
  - Area of a **triangle** = $\frac{1}{2}$ (base × height)
  - Area of a **circle** = $\pi \times r^2$
  - Area of a **trapezium** = $\frac{1}{2}(a + b) \times$ height
- The **total surface area (TSA)** is calculated by adding up all the areas of each surface on a 3D object.
- **Volume** is the amount of physical space a 3D object takes up.
  - To calculate the volume of a **prism**, we calculate Volume = Area of base × height.
    - Volume of a **cube** = edge length^3
    - Volume of a **rectangular prism** = length × width × height
    - Volume of a **triangular prism** = $\frac{1}{2}$ (width of triangular base × perpendicular height) × length
    - Volume of a **cylinder** = $\pi \times$ radius$^2 \times$ height
  - To calculate the volume of a **pyramid** or **cone**, we calculate Volume = $\frac{1}{3} \times$ area of base × height
    - Volume of a **square-based pyramid** = $\frac{1}{3} \times$ length of base side$^2 \times$ height
    - Volume of a **rectangular-based pyramid** = $\frac{1}{3} \times$ length of base × width of base × height
    - Volume of a **cone** = $\frac{1}{3} \times \pi \times$ radius$^2 \times$ height
  - The volume of a **sphere V** = $\frac{4}{3} \times \pi \times r^3$
- Before calculating perimeter, area, TSA or volume, dimensions should all be in the same units.

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Chapter 11 review questions

☐ I can **convert** metric measurements.

1 Convert the following measurements.

a 5 mm = ? m
b 96 minutes = ? hours
c 2750 m = ? km
d 7.5 tonne = ? kg
e 27.5 g = ? mg
f 0.563 kL = ? L
g 1.530 L = ? mL
h 6 754 kg = ? tonne
i 15 mL = ? L
j 12 500 mg = ? g

2 What is the area of the island shown below.

a Give your answer in square metres (m^2).
b Give your answer in hectares (ha).
(Note: 1 acre = 4047 m^2, and 1 hectare = 10 000 m^2)



330 ACRES

☐ I can **measure** objects accurately using the correct tool.

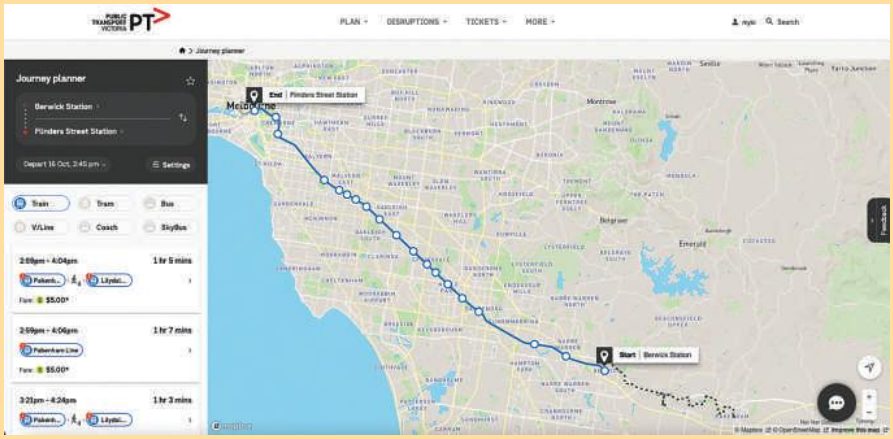
3 Measure the circumference of your head.
4 Measure the length of your foot.
5 Measure the height of the nearest doorway.
6 A cordial bottle has the instruction: Mix 1 part cordial to 9 parts water.
How much cordial and how much water are needed for the following.

a a 1 L jug? **b** a 2 L jug? **c** a 250 ml glass?

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I can measure **time**.

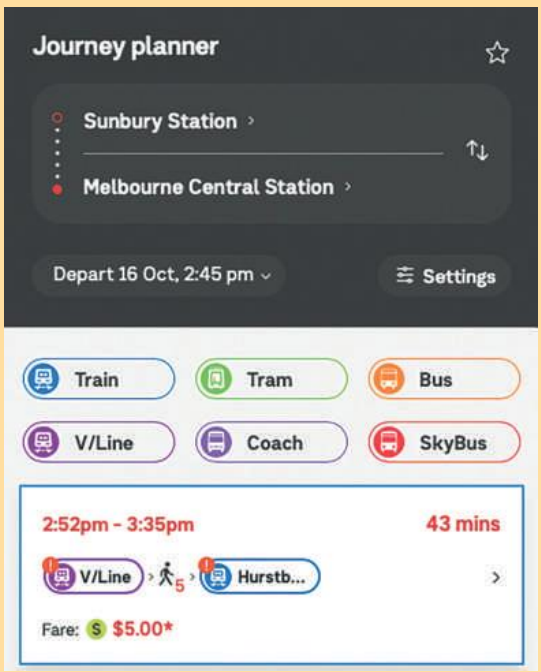
7 Safeen lives near Berwick Station. He is meeting some friends in Melbourne at 4:00 pm. The journey planner shows possible train services he could use.



a If it takes 10 minutes to walk to the destination from Flinders Street Station, which service should he catch?

b If it takes 18 mins to walk to the station to catch the service, and he allows an extra 5 minutes just to be sure, what time should he leave home?

8 Look at the journey planner app opposite. How long is the journey from Sunbury to Melbourne Central Station?



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☐ I can find the **perimeter** of objects.

9 Calculate the perimeter or circumference of the following.

a The top of this basket.

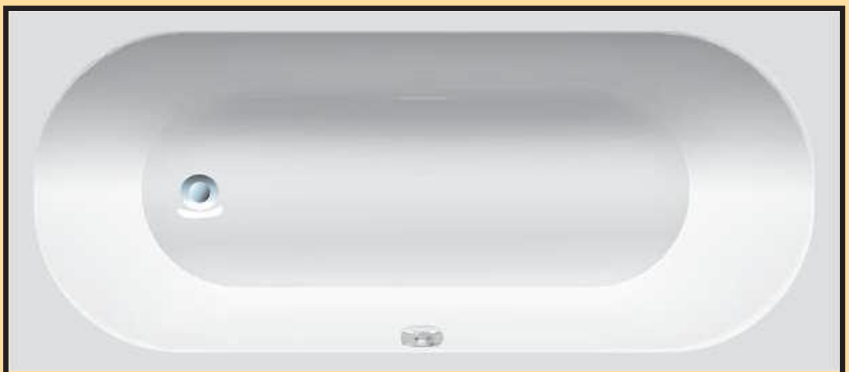


Laundry basket rectangular.

- Sturdy plastic design
- Made in Australia

Dimensions (mm) 590 x 420 x 260

b The top external dimensions of this bath.



EŚTILO

Eśtilo 1500 x 700 x 410mm White Acrylic Bath Tub

★★★½☆

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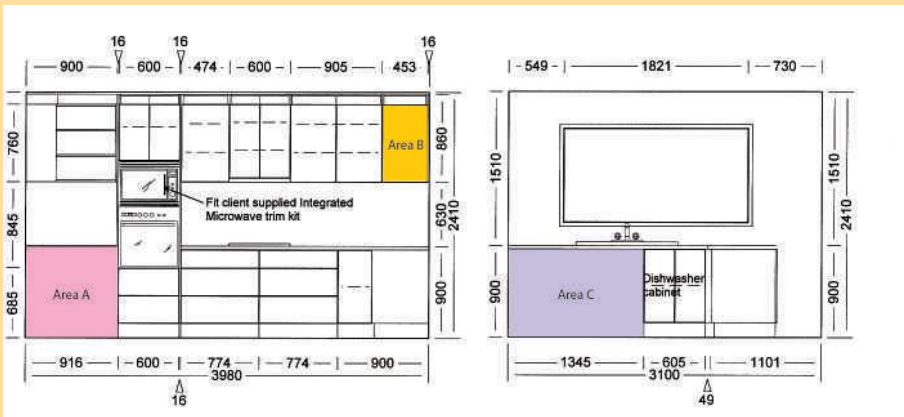
☐ I can find the **area** of objects.

10 What is the area of each of the following shaded areas on this kitchen plan?

a Area A?

b Area B?

c Area C?



11 What is the area of each of the three tray sizes? Give the answers in both mm^2 and m^2.



a Dual cabs

b Extra cabs

c Single cabs

Aluminium Tray Sizes (External Measurements)

- Standard Aluminium Tray for Dual Cabs:
  1880 mm Long × 1855 mm Wide × 250 mm Depth
- Standard Aluminium Tray for Extra Cabs:
  2180 mm Long × 1855 mm Wide × 250 mm Depth
- Standard Aluminium Tray for Single Cabs
  2480 mm Long × 1855 mm Wide × 250 mm Depth

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I can find the **surface area** of objects.

12 Find the surface area of the following shapes. Give the answers in cm^2 rounded to the nearest cm^2.

a Fuel drum



Dimensions: Height = 89 cm
Width = 58 cm

b Inflatable globe



Dimensions: Radius = 20 cm

c Shipping container 10 ft length, for exterior surfaces including base.

Typical shipping container dimension for 10 ft, 20 ft and 40 ft containers

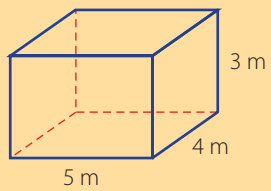
	Exterior			Interior			Door Opening	
	Length	Width	Height	Length	Width	Height	Width	Height
10 ft Standard Dry Container	304.8 cm	243.84 cm	259.08 cm	279.4 cm	234.8 cm	238.44cm	233.68 cm	227.2 cm
20 ft Standard Dry Container	609.6 cm	243.84 cm	259.08 cm	589.74 cm	234.8 cm	238.44cm	233.68 cm	227.2 cm
40 ft Standard Dry Container	1219.2 cm	243.84 cm	259.08 cm	1203.1 cm	234.8 cm	238.44cm	233.68 cm	227.2 cm

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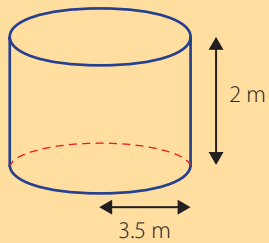
☐ I can find the **volume** of objects.

13 Find the volume of the following objects.

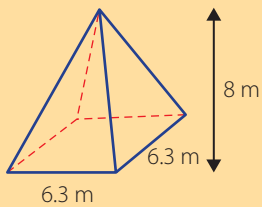
a



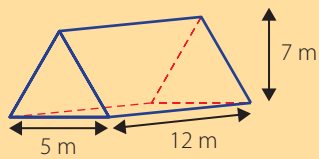
b



c



d



☐ I can **apply** these skills together.

14 The local council are planning to refurbish the community pool. It has the following dimensions: 25 m × 10 m × 1.6 m.

a Sketch the pool and write the dimensions on the sketch.

b Convert the measurements to mm and re-label your diagram.

c The pool will need to be protected in winter when it is not in use.
What is the area of the pool cover?

d The pool will need painting.
What is the total area of the surfaces to be painted?

e The council needs to calculate the amount of water needed to fill the pool, allowing a gap of 10 cm below the top of the walls.
What is the capacity of the pool?

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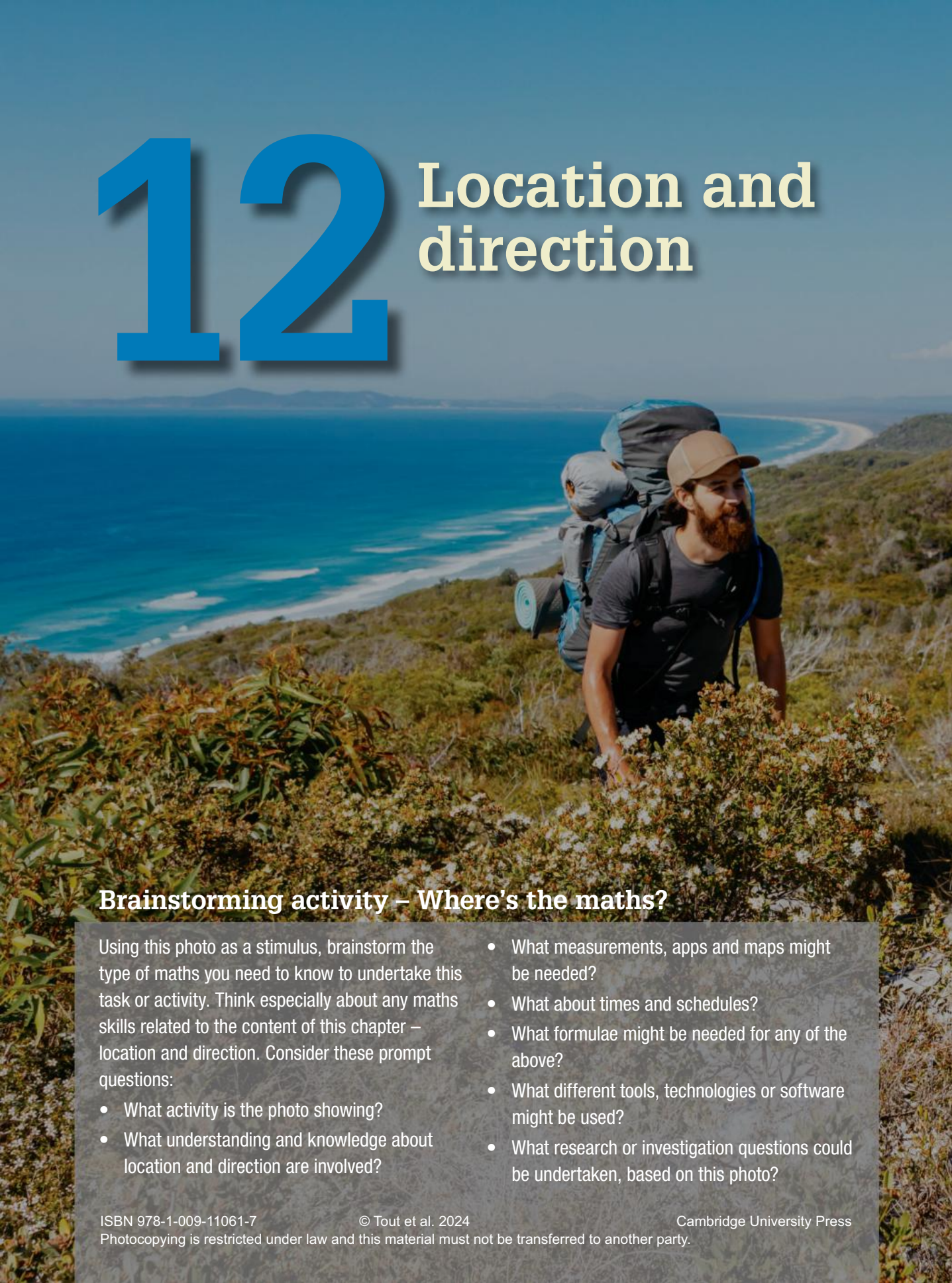
Key vocabulary

Here is a list of the key maths terms and their meanings used in this chapter.

Term	Meaning
Approximate, approximately	The result when a value is rounded off, for example, a lap time of 87.956 seconds is approximately 88 seconds.
Area	The size of the region inside a 2D shape.
Capacity	Refers to the volume of liquids, for example, litres (L).
Circumference	The word used for the perimeter of a circle.
Conversion	Changing between different units of measurement for the same quantity, for example, 2.3 metres = 230 centimetres = 2300 millimetres.
Cubic units	Measurements used for volume, for example, cubic metres (m^3).
Dimensions	The length, width and height of an object are its dimensions.
Estimate	A value arrived at by an 'educated guess' rather than by use of an accurate measuring device.
Face	Each surface of a 3D object, for example, the faces of a cube are six squares.
Mathematical literacy	Understanding and confidently using the language of mathematics.
Measure	Determine the size of a value using suitable units and an appropriate device.
Measurement device	A tool for accurate measuring, for example, a tape measure, laser, stopwatch or scales.
Perimeter	The distance around the boundary or outside edge of a 2D shape.
Square units	Measurements for area, for example, square metres (m^2).
Volume	The size of the space inside a 3D object.

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12 Location and direction



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 – location and direction. Consider these prompt questions:

- What activity is the photo showing?
- What understanding and knowledge about location and direction are involved?
- What measurements, apps and maps might be needed?
- What about times and schedules?
- What formulae 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?

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Chapter contents

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12B Tuning in
12C My place in space
12D Key features of maps
12E Using speed, distance and time
12F Distance and scales on maps
12G Timetables, trips and routes
12H Technology to the rescue
Investigations
Chapter review

From the Study Design

In this chapter, you will learn how to:

- interpret diagrams, plans, maps and models and evaluate their accuracy
- interpret information on maps to plan and describe travel routes, including use of navigational software and tools (Unit 2, Area of Study 4).

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Chapter overview

Introduction

In our lives, no matter whether as individuals, workers or citizens, we need to know where we are positioned and located. Knowing this allows us to give and follow directions to different locations, based on both digital and printed maps and diagrams. These days, we use digital tools, including mapping apps with Global Positioning Systems (GPS) and online transport timetables and public transport apps.

This chapter builds on the mathematical skills and knowledge covered in Chapters 10 and 11. It encompasses further aspects of maths that we engage with in our physical world – the concepts of position, location and direction. We will examine maps and directions, travel distances, speeds and times, and planning and organising routes and itineraries.

Learning intentions

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

- be familiar with the key conventions and language associated with direction, as well as able to measure direction
- be familiar with the key features of maps, such as scales, compass directions, keys and grid references
- use the formula connecting speed, distance and time
- use a scale to determine physical distances represented on a map
- interpret public transport timetables and calculate travel times in order to plan a trip
- using digital maps and public transport applications and websites
- apply the problem-solving cycle to complete investigations related to the topics contained within this chapter.

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Spotlight: Camille Acuna

An interview with a field operations officer in forest fire management

Tell us about the work you've done and what you do now.

I am a field operations officer in forest fire management at the Victorian Department of Environment, Energy and Climate Action. Previously I was a park ranger for three years with Parks Victoria.

What maths do you use regularly in your job? Could you give some examples?

I like when I get to use maths at work – it is kind of exciting when you get to use the formulas in real life.

Area, perimeter and ratios are the main calculations I do. When we're constructing things, we need to know areas and perimeters and volumes. For example, we might need to estimate how much gravel we need to do some road grading – we would need x-amount of cubic metres of gravel to cover up 200 metres of path in a 20-centimetre thick layer.

And when you're working with pesticides and chemicals, you need to know the right ratios and percentages, because that can impact the effectiveness when it comes to weed control.

What is the most useful tool or piece of technology that you use regularly in your job?

For maths, mostly the calculator on my phone or Excel spreadsheets. But when we're doing bushfire management, we have CSIRO Grassland Fire Spread Meters. These have several plastic disks, joined at their centres, with values for fire risk parameters around the edges. You spin them around to line up the values for the conditions of the day and location, such as wind speed and temperature, so you can work out how much fire danger you've got. There are different meters based on different site conditions, and that will change what the rate of spread would be for a fire.

What was your attitude towards maths when you were in school?

I didn't think I was that good at maths, but actually I really enjoyed it. Knowing that there's one solution, but there could be a whole bunch of different ways you get to that solution is fun. That is also helpful if you're struggling because your teacher could have another method of trying to solve a problem or a different way of explaining it. It's like solving a mystery but with numbers.

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12A Starting activities

Activity 1: Different types of maps

We use physical maps in shopping centres when we try to locate a particular store.

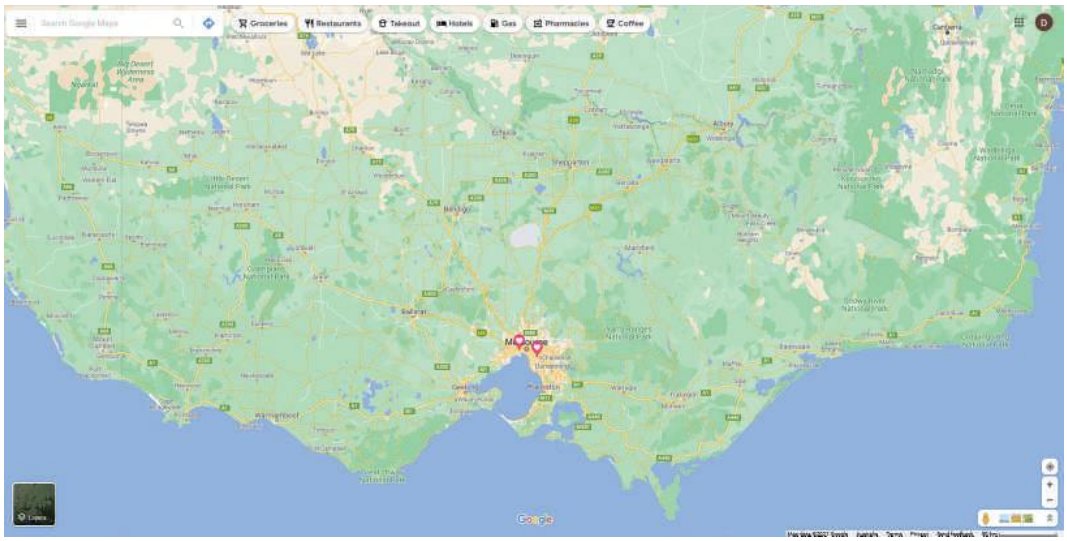


We use maps in educational settings when we need to know where different facilities are.

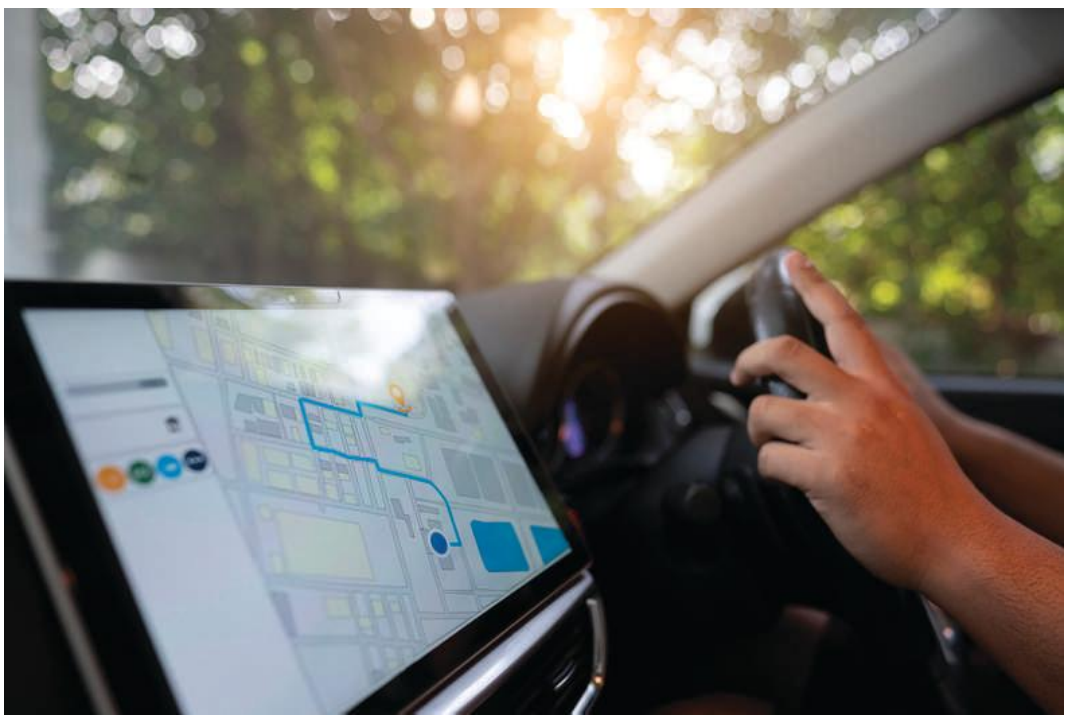


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One of the most common places we use maps is on our computers, tablets or mobile phones.



Travel by car is often done with the support of a GPS navigation system, or by a hands-free device like a mobile phone or tablet.



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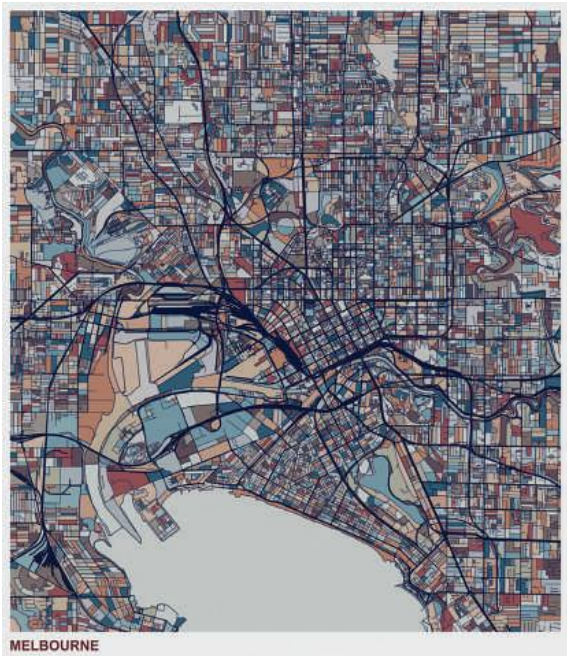
What maps do you use, and when and how do you use them? Make a list and include the following information about each. Try to find at least three examples.

1 Type of map or application (hard copy or digital? – and what device do you use it on?)

2 What is the map about?

3 What do you use it for?

4 What information does the map include?



Activity 2: Map of your school

Find a map of your school. It could be, for example, the plan of the buildings for emergency purposes. Take a photo or copy of it (you could ask your teacher if copies are available). Answer the following questions about the map.

1 What is the map of? The whole school? Parts of the school?

2 What is shown on the map? Describe what it includes.

3 Does it show North on the map? If not, work out where North is and draw it on your copy.

4 Is there a scale? If there is, what is the scale? How far would 1 centimetre (cm) on the map represent in reality? Give your answer in metres (m).

If there is no scale, can you still work out approximately how far 1 centimetre (cm) on the map represents in reality? Give your answer in metres (m).

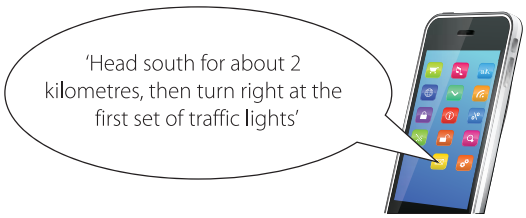
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12B Tuning in

In this chapter, we will see the importance of having a solid understanding about location and direction and the associated skills, to assist in planning routes and schedules, and in following and giving directions. We will also explore the relationship of speed to distance and travel time.

Introduction

Driving or walking around while following directions is something we do regularly. It can be part of our work if we deliver goods and need to find a building or room somewhere. It can be part of a holiday if we are trying to locate our accommodation or just want to go shopping or sightseeing.



We can be asked to give directions to someone else, too. Often we need to read a map or use a GPS app on our phone or in our car to do this.

Directions are associated with reading maps (both digital and hard copy), and directions are also important in giving and following instructions – whether from a person or from your GPS.

There are other circumstances, though, where understanding directions is critically important, such as with incident warnings about floods or bushfires and with dangerous weather events as in the example on the right.



This **Advice** message is being issued for Murray-Sunset and Underbool.

There is a bushfire 16 km North North West of Underbool near Lake Kenyon in Murray Sunset National Park that is not yet under control.

Working out routes and plans

Work is an area where giving and following directions can be an essential skill. This might be how to get to and from work. This can involve catching public transport and using timetables. You might use apps on your phone or computer to plan how to get to and from work by public transport.

There are many occupations where travel is a significant part of the job. This can include people who deliver goods and services, or taxi and Uber drivers. Planning routes and scheduling requires not only knowledge of location and direction but also an understanding of speed, distance and time, and the ability to calculate different durations of time.

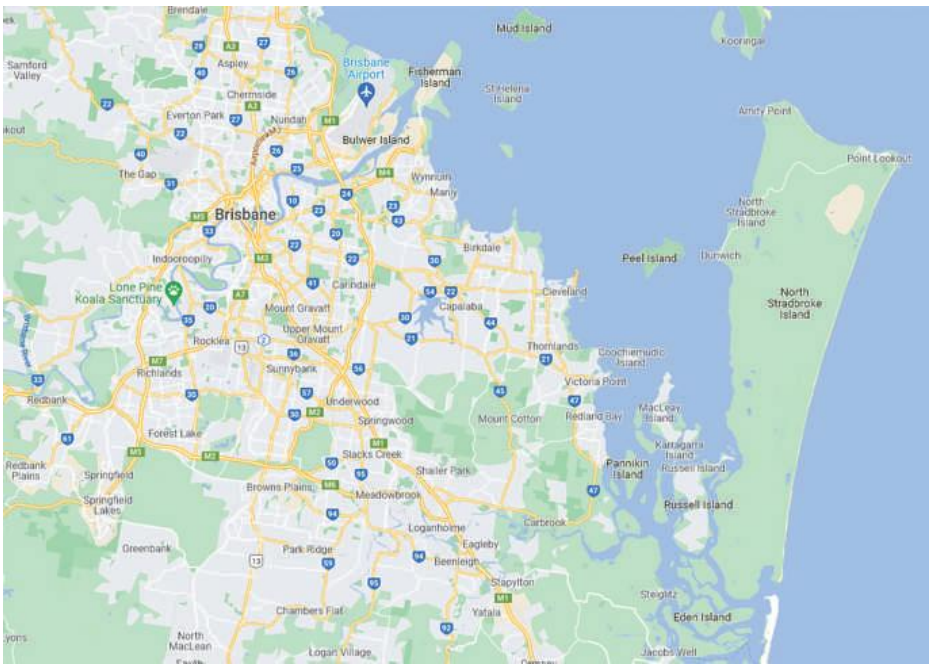
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Epic Fail – GPS navigation issues

Here is an Epic Fail, where just following GPS directions had significant consequences.

Trust your GPS? Tourists Drive into the Pacific Ocean in Australia

A group of tourists hired a car in Brisbane and wanted to drive out to North Stradbroke Island on the coast. They mapped out the path on their GPS system in the car.



The map didn't show the 9 kilometers of water and mud between the island and the mainland and didn't indicate the need to catch a ferry across Moreton Bay.

As the three drove their car into Moreton Bay, the GPS device guided them into mud. Stuck and unable to make it back onto the road, they were forced to abandon their car when the tide rose.

The three tourists made it about 50 metres offshore before they realised they were stranded. Eventually, they were given a lift by a tow truck driver and returned to the mainland. Although the car was insured, they still had to pay about $1500 that was not covered. But there was the embarrassment to cope with!

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You can see some footage of this classic GPS navigation epic fail on YouTube.



Discussion questions

- Search the internet for some GPS-related Epic Fails and share your favourites with the class.
- Do you know of any examples or cases like these?

Check and reflect – and connect maths to the real world.

Although we know GPS systems and apps are capable of being very accurate and helpful, like with all digital technologies, it is critical that we know their limitations and use our common sense and judgement to review and reflect on what the device is telling us. Check that what is on the screen matches what is actually happening out there in the real world!

The problem-solving cycle emphasises the need to check and reflect, and to connect the maths world to the real world, even when driving a car!

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Practice Questions

1 Work in groups of three. One student hides an object in the classroom. One student writes a list of directions for the third student to follow in order to locate the object. Switch roles and repeat.

2 Use Google Maps to analyse your commute to school. How long does Google maps suggest it would take to drive to school? Walk to school? What is the change in elevation?

3 You are surprising your best friend with a sight-seeing trip to visit a famous landmark in another state in Australia. Plan an itinerary to visit the landmark in one day. What is the nearest capital city? What time are flights to and from this city? How will you travel from the airport to the landmark? How long will this trip take. How long can you spend viewing this landmark?



Getting the message

From these examples and the ones above, we can see how important it is to have knowledge and understanding about location and direction across a wide range of real-world and everyday contexts. This chapter will remind us about some mathematical and practical features we need to know related to location and direction, including understanding how to use hard copy and digital maps, and travel skills concerning planning routes and giving and following directions.

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12C My place in space

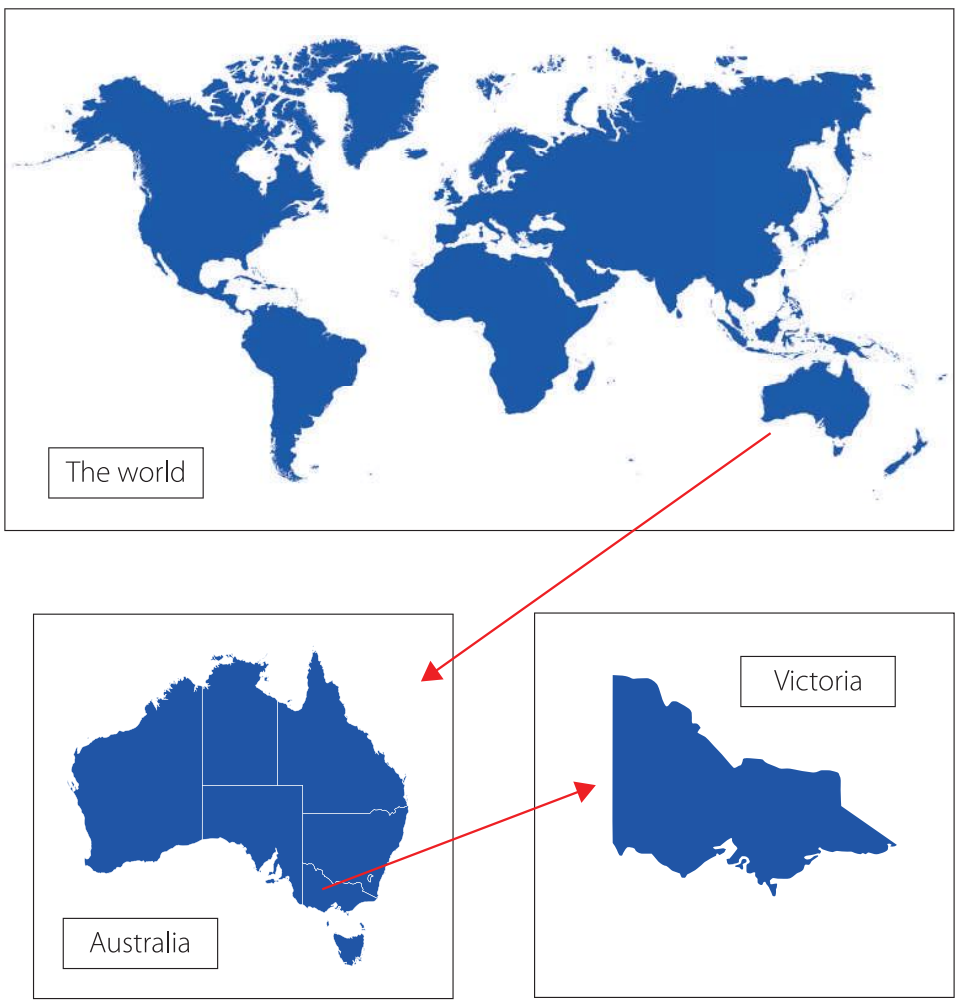
This section introduces us to some of the key features and conventions of location and direction and using maps.

A good place to start is to consider where we live in relation to the world around us. We live and work in the state of Victoria, which is a small part of Australia, which itself is one small part of the wider world.

So, we need to be able to describe our location compared to everywhere else. This is where the knowledge, and especially the language, of directions becomes critical.

Understanding where we are

Here is an example of a map of the world, including Australia, and below that, a map showing the state of Victoria.



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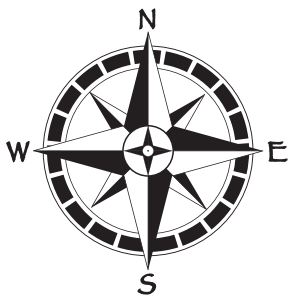
We need to know how to describe our location from many perspectives:

- Local
- State
- National – Australian
- Global – worldwide.

A major starting point is knowing how to use the directions of North, South, East and West, and how we measure directions.

Four main directions

In order to read maps or give or follow directions, we need to know about the main directions of the compass – **North**, **South**, **East** and **West**.

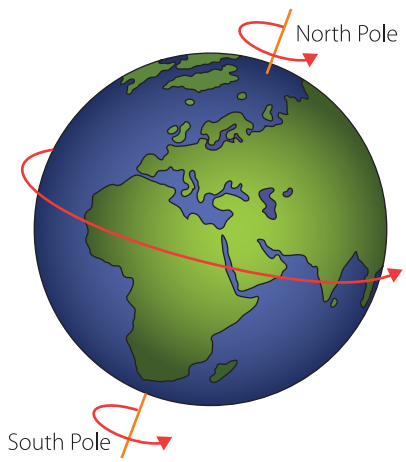


We usually shorten these as shown.

North to **N**, South to **S**, East to **E** and West to **W**.

Where is North?

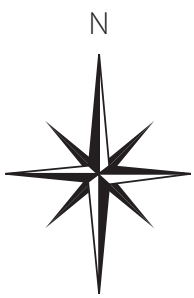
For our day-to-day navigation, North is the *top* of the Earth. What is called the Geographic North Pole is the northernmost point on the planet, where Earth's axis intersects with its surface.



Earth rotates on its axis that goes through the North and South Poles.

North is one of the four major compass points, specifically 0°, directed toward the North Pole.

A map usually indicates where North is using a simple **compass** or **compass rose** or a **direction indicator**. They can be like the one above, with all four key directions labelled, but they might be simplified. Here are a few examples you might find used on maps:





On a map, North is usually shown as pointing towards the top. Have a look at some maps. Does the direction indicator always show North as pointing towards the top of the page?

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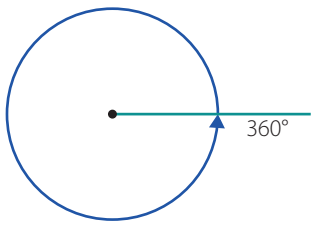
Important facts

One idea that we often use in relation to the key directions is that the sun rises in the East and sets in the West.

In relation to weather forecasts and wind direction, an Easterly wind means it is blowing *from* the East, and hence is heading in a Westerly direction.

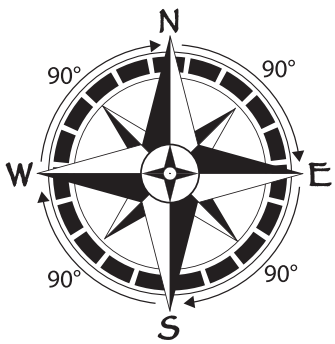
Measuring directions

We measure angles of direction in **degrees**. Degrees are abbreviated to °. Remember that to completely turn around so that you are pointing in the same direction again is a turn of 360° – called a full rotation.



To turn around so that you are pointing in the *opposite* direction is a turn of 180°. The expression 'do a 180' has a popular meaning of thinking the *opposite* of what you previously said or believed.

There is 90° between each of the four key directions of North, South, East and West.



A direction compass found on maps shows 360° around the outside, as shown in these examples, and can be used to check directions when you are bushwalking, orienteering or sailing.





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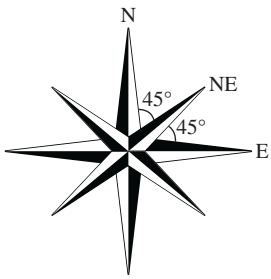
On mobile phones too!



If you want to learn more about directions and using a compass, you can download an app and use it throughout this chapter. There are a number of free apps available.

In between North, South, East and West

We also use the directions *in between* the four main directions – North East (**NE**), North West (**NW**), South East (**SE**) and South West (**SW**).

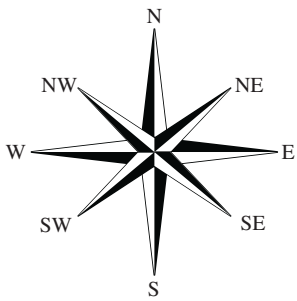


When a direction is halfway between each of the four main directions, we use a combination of the two directions that it is halfway between. You can see how it works by looking at the compass opposite.

Each of these directions will be *half* of 90°, which is 45° From the main N, S, E and W directions.

The direction that is halfway between North and East is called North East, NE, as marked on the compass.

Here are the other three similar directions, shown on the compass to the right.



My local surroundings

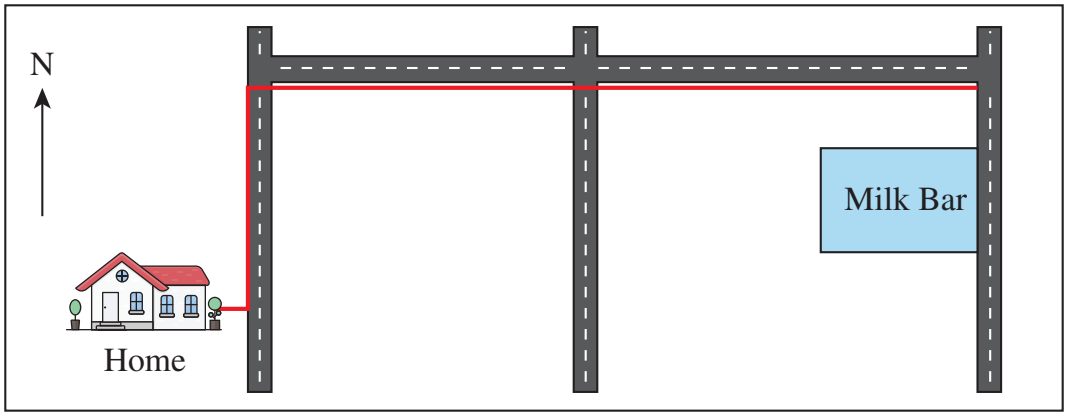
Often when we are travelling close to home, we don't think much about directions – we just know where to go and how long it might take. To become more familiar with using directions, it may help to think about questions like the following.

- Which direction does the front door of your home face?
- Which direction does your street run?
- Where is the closest main road?
- Is there something special, like a park, shop, sports ground or cafe, near your home?

If you do not know what direction your home faces, use a compass, or find a map, or use the internet or your mobile phone, or ask someone, so that you know.

Below is a rough map (often called a **mud map**) to get to a Milk Bar close to Sashi's home.

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Here is how Sashi could describe their walk to the Milk Bar, shown in red:

'I walk out the front door which is facing East. When I get out to the street, I turn left, heading North, and walk for about 100 metres, and then turn right, cross the road, and walk along a street for about 300 or so metres. I have to cross one street almost halfway along. When I get to the next street, I turn right down to the Milk Bar, which is not far down on my right. It takes me about 5 minutes to walk from home to the Milk Bar.'

12C Tasks and questions

Thinking task

1 Describe the route you take, walking or driving to school from your home, using compass directions.

2 We also use many other common words for directions. Words like:

- **a** adjacent
- **b** anticlockwise
- **c** behind
- **d** clockwise
- **e** in front
- **f** left
- **g** next to
- **h** opposite
- **i** right.

Do you know what they all mean? If not, use your dictionary or the internet to look them up so that you understand them.

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Skills questions

3 State the following.

a The direction opposite to South.

b If you are walking in an Easterly direction, the direction to your left.

c If you are heading directly into a Westerly wind, the direction you are going.

d The opposite direction to NW.

e The direction which is 45°**C**lockwise from South.

4 Here is a map of a small local shopping centre.

Two-dollar Shop	Fish Shop	**N** ↑				
Vacant shop	Hairdresser	Milk Bar	Supermarket		Bottle Shop	Flower Shop
			Daniel Street			
Noodle Shop	Pizza Restaurant	Bread Shop	Shoe Shop	Fruit Shop	Cafe	Post Office

a Select the correct expression from the list below to fill the gaps in the following sentences. Use each expression only once.

North of	East of	next to	left of	opposite to	South of

i The Milk Bar is _____ the Hairdresser.

ii The Shoe Shop is _____ Daniel Street.

iii The Post Office is _____ the Bread Shop.

iv The Fish Shop is _____ the Pizza Restaurant.

v The Milk Bar is _____ the Bread Shop.

vi The Bottle Shop is _____ the Flower Shop.

b Are the following statements **True** or **False**?

i Daniel Street runs North-South.

ii The Milk Bar is adjacent to the Hairdresser.

iii The Cafe is West of the Bread Shop.

iv The Fish Shop is behind the Hairdresser.

v You are in Daniel Street near the Cafe, and you are looking West. The Supermarket is on your left.

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5 Nailah is sitting at the beach, directly facing the sunset. Which way is she facing?

A North **B** South **C** East **D** West

6 Nailah warms her back in the morning sun. Which way is she facing?

A North **B** South **C** East **D** West

7 It is the late afternoon and Nailah can feel the left side of her face getting hot in the sun. Which way is she facing?

A North **B** South **C** East **D** West

8 **Capital cities of Australia**

Here is a map showing Australian capital cities and other key towns.

Use the direction indicator at the top right of the map to finish each of these sentences about where the different capital cities of Australia are. If you are unsure of the location of the capital cities, ask a friend.



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Use one of the eight directions below in your answers.

North	South	East	West	North-East	North-West	South-East	South-West

a Perth is on the _____ coast of Australia.

b Sydney is on the _____ coast of Australia.

c Sydney is _____ of Melbourne.

d Adelaide is _____ of Darwin.

e Hobart is _____ of Melbourne.

f Hobart is _____ of Darwin.

g Canberra is_____ of Sydney.

h Darwin is _____ of Perth.

9 Key towns of Victoria

Here is a map of Victoria showing Melbourne and other key towns.



Source: www.ontheworldmap.com

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Use one of the eight directions below in your answers.

North	South	East	West	North-East	North-West	South-East	South-West

a Casterton is _____ of Melbourne.

b Moe is _____ of Melbourne.

c Cann River is in the _____ of Victoria.

d Wangaratta is _____ of Melbourne.

e Melbourne is _____ of Forster.

f Mildura is in the _____ of Victoria.



g Melbourne is _____ of Echuca.

h Anglesea is _____ of Melbourne.

Mathematical literacy

10 Complete the sentences below. Select words from the following list.

Adjacent	Anticlockwise	Compass	Direction	Location

a A _____ is an instrument that shows us directions with a small magnetic needle that points North/South.

b The place where something is or where it is occurring is called its _____.

c The _____ is the line or course on which something is going – where something is pointing.

d _____ means next to each other.

e The opposite direction to the way the hands of a clock move is called _____.

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Application task

11 Taking a walk

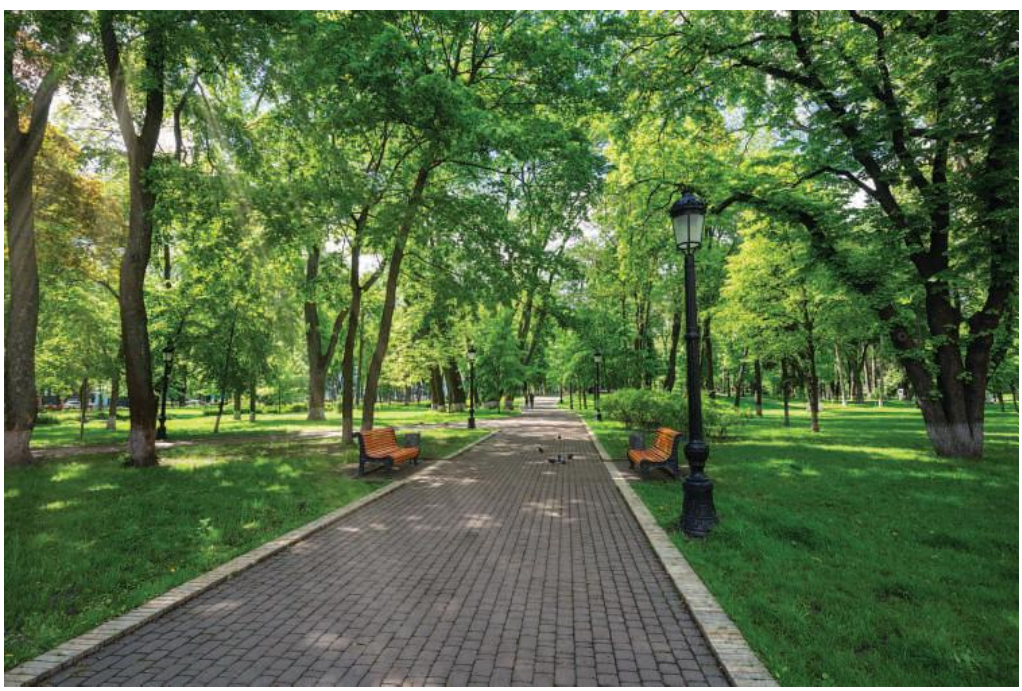
Think about a short walk that you make from your home or from school. This walk could be to a park, a shop, a friend's place, a bus stop or work. Like Sashi's walk to the Milk Bar described above, there should be about 6 to 10 steps to your walk, so it doesn't need to be a long or complicated walk.

Sketch a mup map of your walk, similar to the sketch shown for Sashi's walk. You do not have to measure any lengths or worry about a scale as it is only a mud map.

Make sure you indicate where North is on your mud map.

After drawing your mud map, briefly describe the walk. This should be like the paragraph above that Sashi used to describe getting from her home to the Milk Bar. Remember to include the relevant directional information about the turns you make, and describe how far it is and how long it takes you.

After you have made your mud map and written down your directions, take your directions with you and walk the route – just follow your directions and your mud map. Does it work? Did you get there? Did it take as long as you thought? A good test of the mud map and your instructions is to give them to a friend, brother or sister and see if they can follow them and get there.



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12D Key features of maps

Maps have a number of important features. These include:

- Compass directions or Direction indicator
- Scale
- Key or Legend
- Grid references.

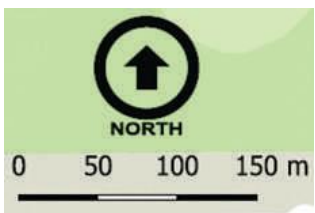
Scale and compass directions on maps

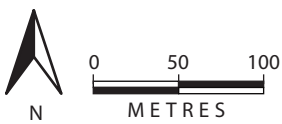
Maps will normally show you which direction North (N) is, allowing you to orient yourself with the map and the street and landmark directions. This is often integrated with the **scale** of the map.

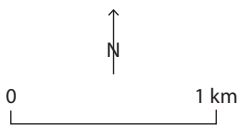
The scale indicates how real distances are represented on the map. We look at scales in more detail in section 12G.

Sometimes, maps are not drawn to scale, like the mud maps we looked at earlier.

Here are the scales and compass directions from some maps we will use here.







Keys

An important feature, especially on a local map, is a **key** or **legend,** which tells us where the main places are, for example, toilets, bus stops, train stations, schools, libraries, police stations and hospitals. Local maps show a small geographic area, such as a rural township, a tourist destination, a shopping centre complex or an education campus.

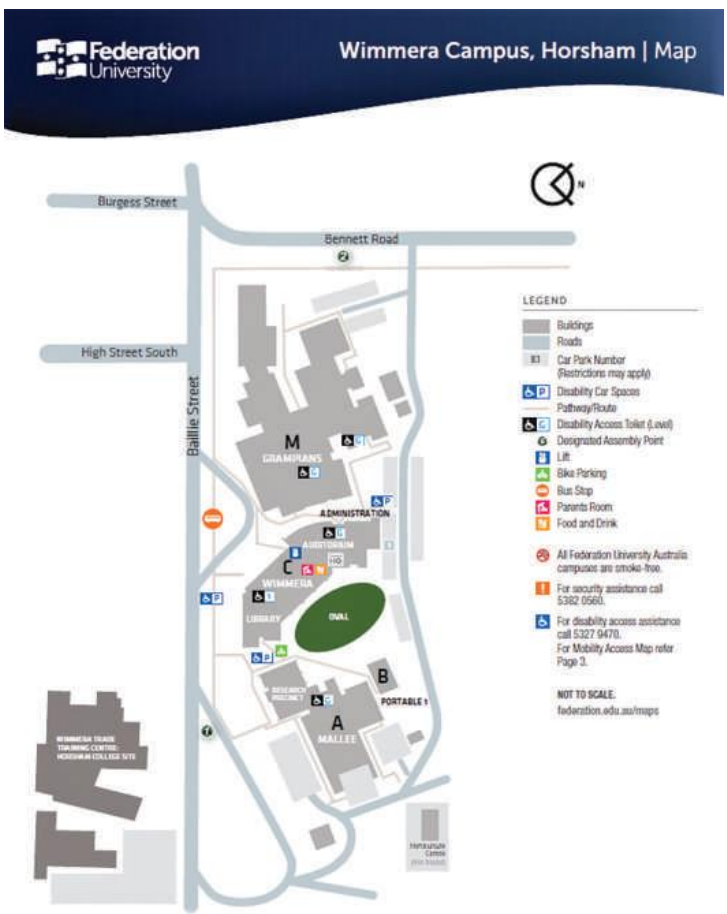
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Below is a map of the Cobram city centre.



Source: Moira Shire Council website

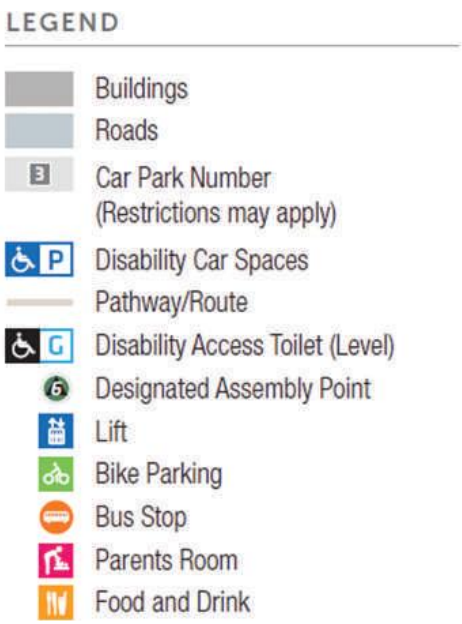
Here is a local map of the Wimmera Campus of Federation University in Horsham.



Source: Federation University website

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Here is part of the **Legend** from the Federation University map, shown larger.



In this Legend:

shows you where the cafe is to buy food and drinks.

shows you where the bus stop is located.

Grid references

Traditional hard-copy street directories (like *Melways* and *UBD Gregorys* for Victoria) were constant companions for most drivers across Melbourne and often Victoria. They had large numbers of pages, with each page covering different areas of Melbourne or Victoria. The map would show local streets and suburbs and features such as train stations, shops, traffic lights, sports facilities and much more.



Taxi dispatcher Tim Rowe using a Gregorys *on the job on 27 August 1984.*

Street directories used **grid references** – a feature that involves horizontal and vertical lines which form grid squares. The directories also provided a very comprehensive index of locations, street names and other key features and gave the relevant map number and its associated grid reference so that you could locate the place you were searching for. Versions of these street directories are still available, as well as interactive online versions.

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Grid lines and grid references are still used on hard-copy local maps, such as shopping centre maps. The grids are labelled using a combination of numbers along one axis and letters along the other axis. This way, the two coordinates aren't easily confused.

Below is an image of a shopping centre directory that uses grid references.



Here is how to use the grid references to find stores on the map.

- Rivers is located at F7.
- Cotton On is located at G7 and G8.

12D Tasks and questions

Thinking task

1 Create a grid map of Australia by doing the following.

- **a** Place gridlines over a map of Australia. This may be a printed map, or you might want to take a screenshot of a map and use an online drawing package or app.
- **b** Place letters across the top of the gridlines and numbers down the sides.
- **c** Give grid references for each capital city of the states of Australia.
- **d** Describe where each capital city is in relation to Melbourne, using compass directions.

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Skills questions

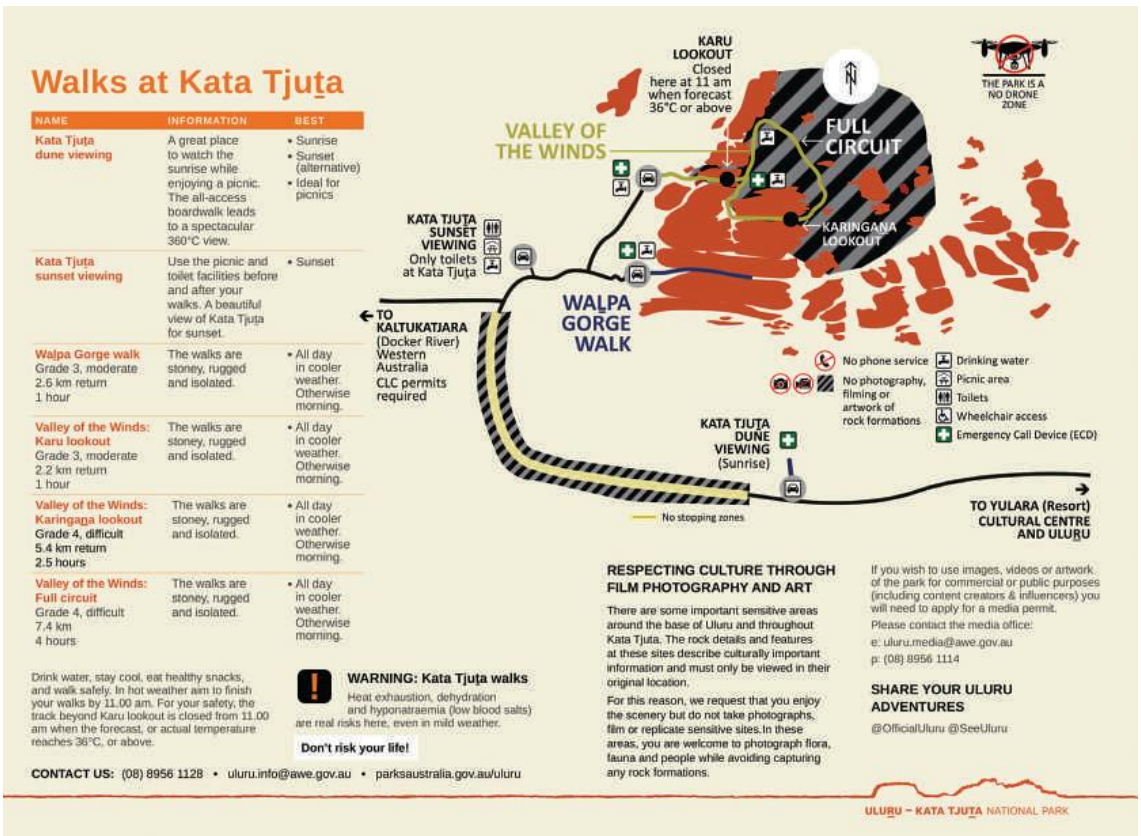
2 Use the previous map of Cobram (and zoom in using the digital version of the textbook) to answer the following questions.

- **a** How many Recharge Points are on the map?
- **b** What building is on the corner of Bank St and High St in the centre of town?
- **c** Which direction does Broadway Street run?
- **d** Which direction is the Hospital from the Police Station?

3 Use the previous map of Federation University (and zoom in using the digital version of the textbook) to answer the following questions.

- **a** How many Disability car spaces are there?
- **b** Is Bennett Road on the North boundary of the University campus?
- **c** Which direction is the Library from the oval?

4 Here is a map of Kata Tjuta (formerly known as The Olgas) near Uluru in the Northern Territory.



Source: Parks Australia website

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a In which corner of Kata Tjuta is the Valley of the Winds car park?

b Which direction are you going when driving from Yulara Cultural Centre past the Kata Tjuta Dune Viewing (Sunrise and Sunset) area?

c If you walk the Valley of the Winds full circuit walk, and turn right soon after the Karu Lookout, which direction are you walking – clockwise or anticlockwise?

5 Use the previous Mid Valley store directory.

i What are the grid references for the location of the following stores?

a Muffin Break

b The ATMs

c The Reject Shop

ii Which shops are located at these grid references?

a A1 and A2

b H6

c I5 and I6

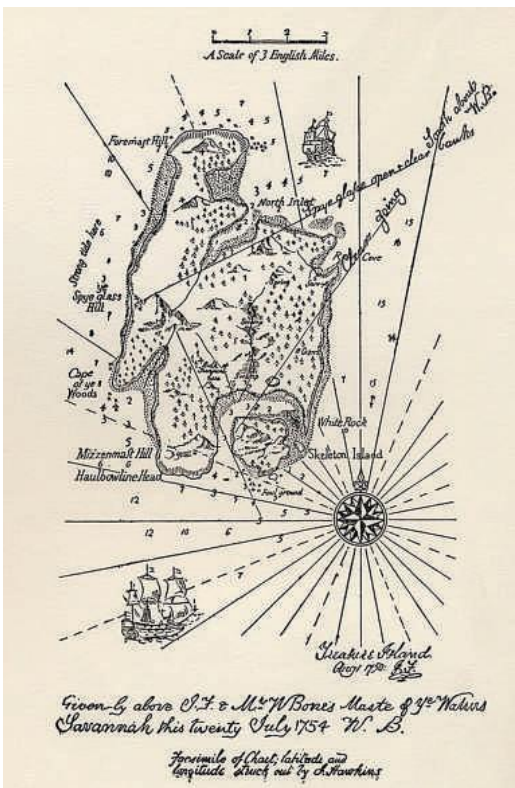
Mathematical literacy

6 Make a treasure map.

a Sketch out your treasure map. For stylistic inspiration, shown here is the map of 'Treasure Island' from Robert Louis Stevenson's famous novel of the same name.

b Overlay a grid reference and include a compass, scale and legend.

c Including at least 10 steps, write instructions to find the location of the treasure. Your instructions must include both grid references and compass directions.



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Application tasks

Use the map of Euroa below to answer questions **7-10**



Source: Strathbogie Shire Council website

7 What is located at the following grid references?

a D5 **b** C3 **c** B6

8 What are the grid references for the following places?

a The Railway Station

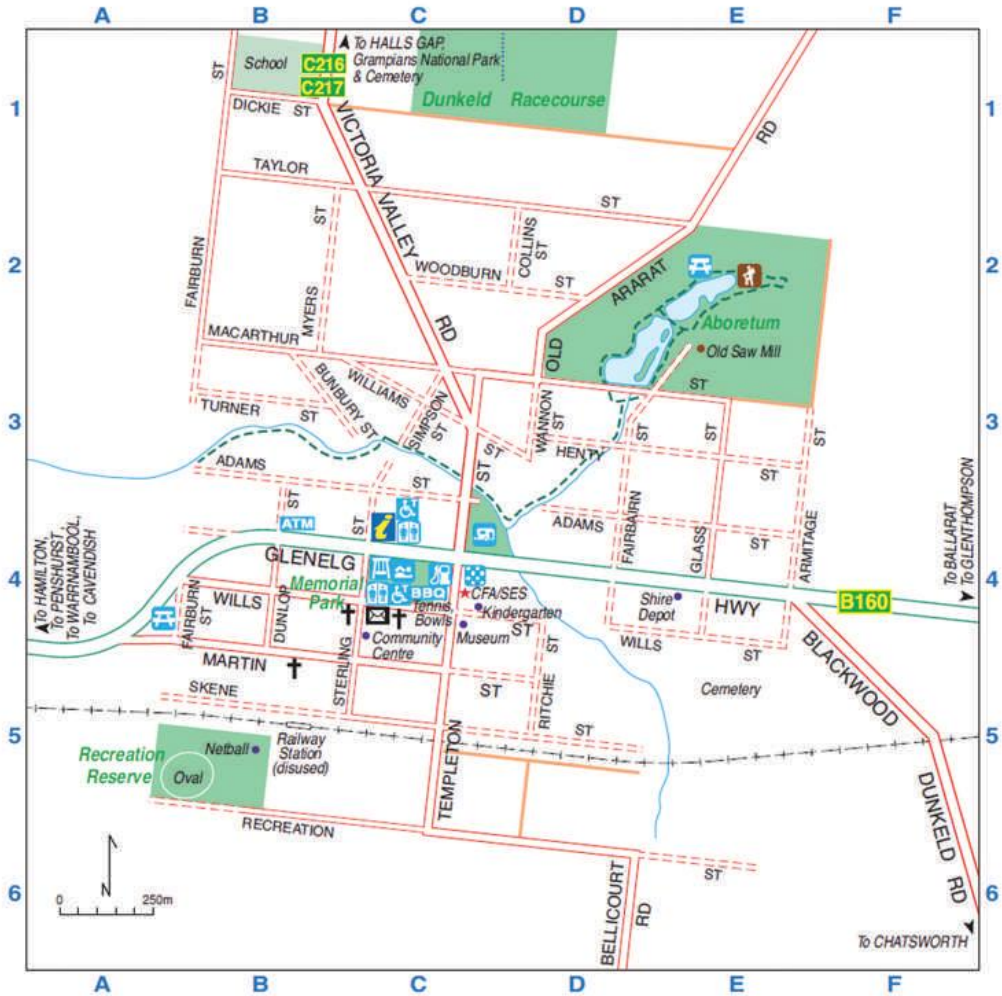
b Both Visitor Information centres.

9 Which direction is the Hume Freeway running on this map?

10 A train leaves the Railway Station and heads up to E1 on the map. Which direction is the train travelling?

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Use the map of Dunkeld below to answer the following questions.



11 What is located at the following grid references?

- **a** C1 and D1
- **b** B5

12 What are the grid references for these places?

- **a** The (disused) Railway Station
- **b** The Visitor Information centre
- **c** The Caravan Park

13 If you are driving North on Templeton Street at C5, then turn left at the Glenelg Hwy at C4, which direction are you now driving?

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12E Using speed, distance and time

Understanding **speed** and its relationship to the **distance travelled** and the **time taken** is an essential element of travel. Speed is how fast something moves, which is the distance it travels over a period of time. When people walk, run, travel in a car or fly in a plane, their speed of travel changes. When driving a car, you may speed up, slow down or pause for traffic.

Back in Chapter 4, we briefly introduced the formula for working out speed in terms of distance and time. We also changed the formula around to find distance and time.

Speed, s, is calculated by dividing the **distance**, d, by the **time**, t.	$s = \frac{d}{t}$
Distance, d, is calculated by multiplying **speed**, s, by **time**, t.	$d = s \times t$
Time, t, is calculated by dividing **distance**, d, by **speed**, s.	$t = \frac{d}{s}$

We will use these formulas throughout this section as they underpin many of our calculations about travel, for example, working out the **time** it might take us to get to different destinations.

Units of speed

Based on the standard metric system of units (SI), speed is measured in **metres per second.** This means how many metres something travels in one second.

We write it as metres/second which is abbreviated to m/s.

In most everyday situations, however, the common speed we use is **kilometres per hour**. This is how we talk about the speed of cars, for example. This is abbreviated in a number of different ways:

- km/h
- kph
- km/hr.

In some sporting events, athletes refer to their **pace**, and the units are reversed. Athletes think about running a long-distance race and taking so many **minutes per kilometre**. The kilometre markers alongside the running course make it easy to settle at a pace that they know suits them – you will see them checking their wristwatch as they run.

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What speed did Usain Bolt run?



Usain Bolt set the current 100 metre world record (as at the end of 2023) at the 2009 World Championships, running the 100 metres in 9.58 seconds.

So, Usain's average speed over the 100 metres is:

$$s = \frac{d}{t}$$

$$s = \frac{100}{9.58} \text{ m/s} = 10.4384 \ldots$$

$$= 10.4 \text{ m/s}$$

What is his speed in km/h?

Have a guess. Is it about 15 km/h or is it more than that? Or less? Let's work it out.

Example 1 Calculate the speed in km/h when the distance and time are known

Usain Bolt ran the 100 metres in 9.58 seconds. What is his speed in km/h?

THINKING	WORKING
STEP 1	
Write the values that are known.	Bolt's distance ***d*** is 100 m, which in kilometres is 0.1 km, and the time ***t*** is 9.58 seconds
STEP 2	
Change 9.58 seconds into hours.	60 seconds in a minute and 60 minutes in an hour, so $60 \times 60 = 3600$ seconds in an hour.
STEP 3	
Write the time as a decimal fraction of an hour.	$9.58 \div 3600$ hours $= 0.00266111 \ldots$ hours
STEP 4	
Find the speed using kilometres and hours $s = \frac{d}{t}$	$s = \frac{0.1}{0.00266111}$ $= 37.578\ldots$ $= 37.6$ km/h
STEP 5	
Write the answer in context	Bolt's **average speed** over the 100 m in km/h is 37.6 km/h.

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Usain Bolt's **top speed** over 100 metres has been estimated at 44.7 km/h from the 60–80 m stretch of the race.

Working out distances and times

If you know your walking speed, you can use that information to work out how far you can walk in a particular time, by multiplying your speed by the time spent walking. The formula for this is:

$$d = s \times t$$

As well, you can use your walking speed to work out how long it will take you to walk a particular distance – you do this by dividing the walking distance by your average speed. The formula for this is:

$$t = \frac{d}{s}$$

Here are a couple of examples of how you can use this information.



Example 2 Calculate the distance when the speed and time are known

Britt has an average walking speed of approximately $5\frac{1}{2}$ or 5.5 km/h.
How far could Britt walk in 90 minutes?

THINKING	WORKING
STEP 1	
Write the values that are known.	Britt's speed s is 5.5 km/h and the time t is 90 minutes or 1.5 hours
STEP 2	
Use $d = s \times t$.	$5.5 \times 1.5 = 8.25$ km
STEP 3	
Write the answer in context.	Britt will be able to walk a bit more than 8 km in 90 minutes.

Note: Rounding the answer to 'a bit more than 8' is realistic as it allows for her speed to vary 'approximately' as she goes along.

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Example 3 Calculate the time when the distance and speed are given

How long would it take Britt to walk 12 kilometres, if her average walking speed is approximately 5.5 km/h?

THINKING	WORKING
STEP 1	
Write the values that are known.	d is 12 and s is 5.5
STEP 2	
Use $t = \frac{d}{s}$	$\frac{12}{5.5} = 2.181818 \ldots$ hours
STEP 3	
To change this into hours and minutes, we need to multiply the fraction of hours by 60.	$0.181818 \ldots \times 60 = 10.9090 \ldots$ minutes
STEP 4	
Write the answer in context.	Britt will take about 2 hours 11 minutes to walk 12 kilometres.

Note: The question says 'how long' and here it means 'long' as in time, not distance; language can be tricky.

12E Tasks and questions

Thinking task

1 Work with a partner or in a small group to discuss different speeds you might know about, then complete the following table.

Method of travel	Your guesses/estimates (km/h)	Typical range of speeds (km/h)
Bike riding		
Car		
Plane		
Rocket		
Japanese Fast Train		

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2 What about different animals and birds?

See if you can complete the following table, and add in some more too.

Animals	Your guesses/estimates (km/h)	Speeds (km/h)
Kangaroo		
Greyhound		
Cheetah		
Peregrine falcon		

Skills questions

3 Work out the following speeds in km/h. Give your answers correct to 1 decimal place.

a The current women's world 100 m sprint record of 10.49 seconds is held by Florence Griffith-Joyner.

b The current women's world 50 m freestyle swimming record of 23.67 seconds is held by Sarah Sjöström.

c The Melbourne Cup horse race record is held by the 1990 winner Kingston Rule with a time of 3:16.3 (3 minutes and 16.3 seconds) for the distance of 3200 metres.

d The current world record in the men's wheelchair marathon (T53/54 classification) is held by Switzerland's Marcel Hug in 1 hour, 17 minutes and 47 seconds.

4 Work out the following average speeds in m/s (give your answer correct to one decimal place).

a A greyhound that runs 395 m in 23.46 seconds.

b A racehorse that runs 900 m in 53.63 seconds.

c An athlete who runs the 400 m in 55.25 seconds.

d A bike rider who rides 37.5 km in 45 minutes and 33 seconds.

e A go-kart rider who takes 7 minutes and 32 seconds to drive 0.771 km.

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5 Work out each of the following times. Give your answers in hours and minutes.

- **a** How long it would take a person to travel 12.5 km at an average speed of 4 km/h.
- **b** How long it would take a car to travel 256 km at an average speed of 90 km/h.
- **c** How long it would take a plane to travel 2750 km at an average speed of 645 km/h.

6 Work out each of the following distances. Give your answers in kilometres (km) correct to one decimal place.

- **a** How far someone could drive in 2 hours 45 minutes at an average speed of 85 km/h.
- **b** How far someone could ride in 3 hours 10 minutes at an average speed of 25 km/h.
- **c** How far a long-distance runner could run in 1 hours 50 minutes at an average speed of 7 km/h.

Mathematical literacy

7 Undertake a small research project to undertsand how traffic speed cameras work. Present your finidings to the class.



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Application tasks

8 Calculate your own average walking speed and then answer each of the following questions:

- **a** How long it would take you to walk 2.5 km.
- **b** How far could you walk in 45 minutes.
- **c** How far you could walk in 4 hours, allowing for rest and drink stops for 45 minutes.
- **d** How long it would take you to walk 12 km.

9 A group of friends estimate that they can go jogging together at an average speed of 8 km/h. Work out each of the following:

- **a** How far they could jog in 45 minutes.
- **b** How long it would take them to jog 6 km.
- **c** How long it would take them to jog 15 km, including if they had a 15-minute rest at about halfway.



10 Work out each of the following. Give your answers in the most appropriate units, correct to one decimal place.

- **a** The speed of an athlete who runs the 400 m in 55.25 seconds.
- **b** The speed of a bike rider who rides 37.5 km in 45 minutes and 33 seconds.
- **c** How long it would take to travel 12.5 km at an average speed of 4 km/h.
- **d** How long it would take to travel 256 km at an average speed of 90 km/h.
- **e** How far someone could drive in 2 hours 45 minutes at an average speed of 85 km/h.
- **f** How far someone could ride in 3 hours 10 minutes at an average speed of 25 km/h.

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12F Distances and scales on maps

Distances are very important on maps, and as we saw in the previous section, we need the distance for working out travel times and speeds. Here are some examples:

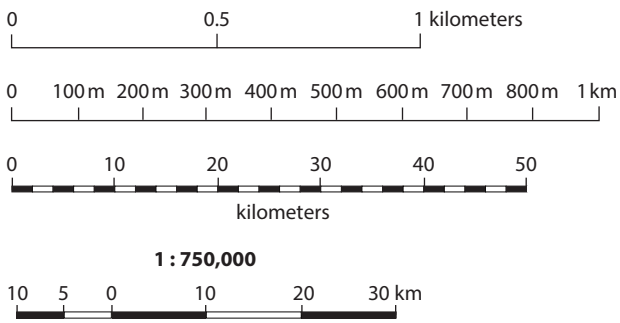
'Walk for about 100 metres, then the shop should be on your right.'

or

'Drive for about 20 kilometres, and just after the bridge, turn left, and the house will be another kilometre down on your right.'

Scales

The **scale** on a map tells you how real distances are represented. This is similar to the scales on drawing plans that we looked at in Chapter 11. On maps, scales are usually given by a diagram like one of the following.



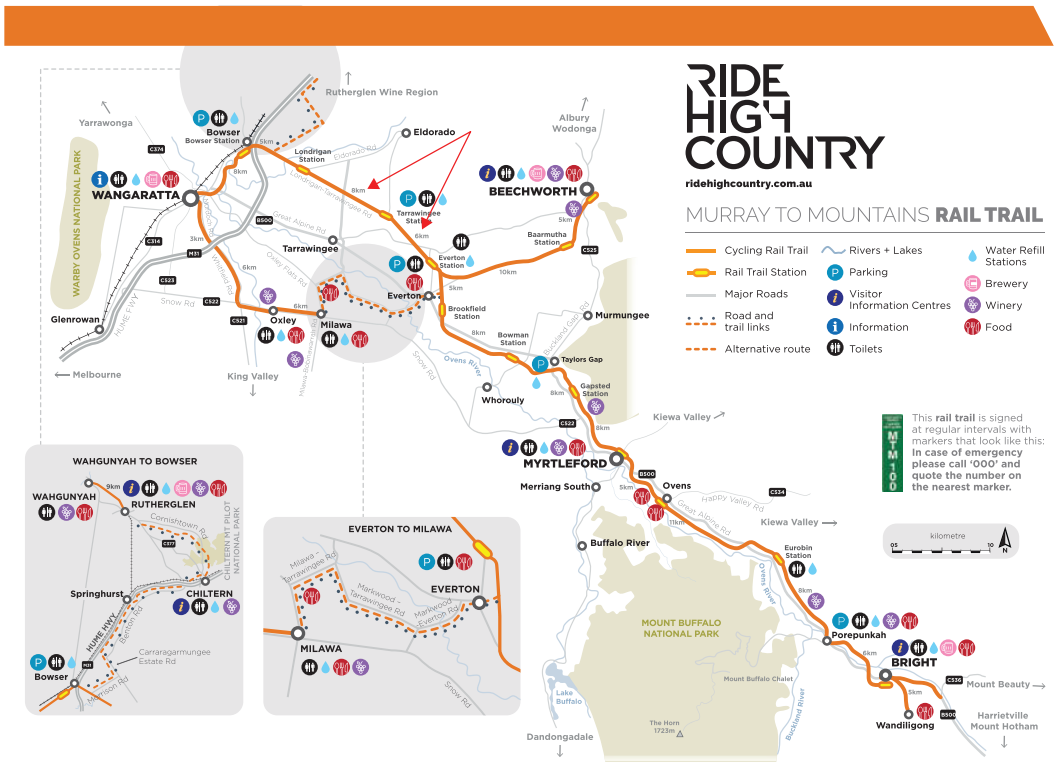
The scale tells you what the real distance is for a specific length or unit on the map. Sometimes, as in the last example above, the scale will also be given as a mathematical **ratio** (1 : 750 000). A ratio or scale of 1 : 10 000 tells you that the real distance is 10 000 times the distance on the map. A scale of 1 : 250 000 tells you that the real distance is 250 000 times the distance on the map.

The scale on a map depends on two key factors: the geographical area covered by the map and the size of the paper or screen the map is being viewed on.

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Understanding scales and ratios on maps

Sometimes, a hard-copy map shows you the distance between main towns or places.



Source: Ride High Country website

The distances between the different stops or towns on this bike trail map around Wangaratta are shown with these numbers (in km).

But if a map has no distances marked, or there are a lot of smaller distances to add up, approximate distances can be measured and calculated using the **scale** of the map.

Often, ratios are harder to understand, so some maps will also write the scale as a relationship between the measurement on the map and the actual distance, like 1 cm = 100 m. So, although this makes it a bit easier to understand – each 1 cm on the map represents 100 metres in real life – it does mean that the map must be printed out at exactly the correct size.

You can use a ruler or even a piece of string to measure the length on a map, and then match it against the diagram of the scale to estimate the actual distance, or alternatively, use the ratio to calculate the actual distance.

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Changing from a ratio

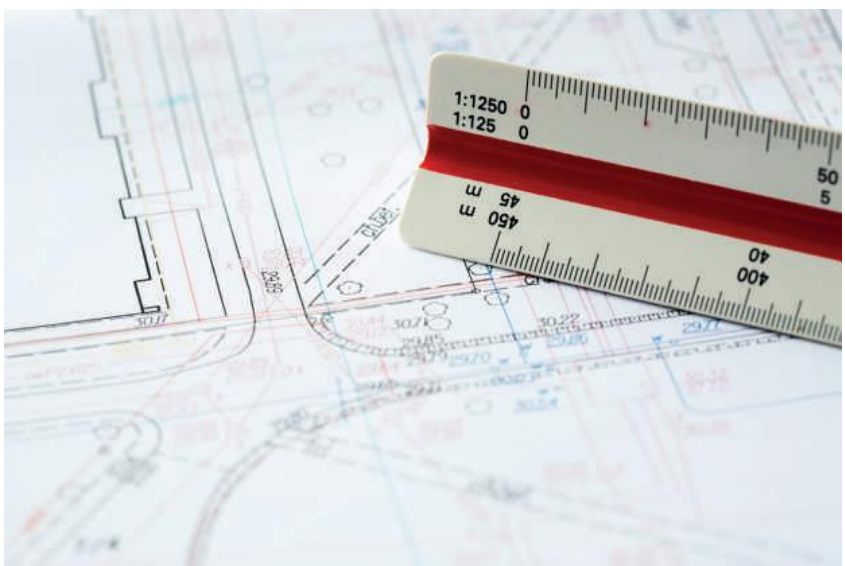
If you see a scale like 1 : 20 000 and want to change it to actual distances so that you know what 1 cm represents, you can easily change it. Just start by thinking of it as a ratio of cm to cm (in a ratio, the units always need to be the same).

Example 4 Change a ratio to a distance relationship

Change a scale of 1 : 20 000 to an actual distance.

THINKING	WORKING
STEP 1	
Write the values that are known.	In a ratio, the units always need to be the same, so start with 1 cm : 20 000 cm.
STEP 2	
Convert 20 000 cm to a more 'friendly' distance, such as metres.	20 000 cm divided by 100 = 200 m (because there are 100 cm to a metre).
STEP 3	
Write the answer in context	A scale of 1 : 20 000 is the same as 1 cm to 200 m.

Note: This means that 2 cm on the map will actually be 2 × 200 m = 400 m, and 5 cm will be 5 × 200 m = 1000 m = 1 km.



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Example 5 Change a ratio to a distance relationship

Change a scale of 1 : 750 000 to an actual distance.

THINKING	WORKING
STEP 1	
Write the values that are known.	In a ratio, the units always need to be the same, so start with 1 cm : 750 000 cm.
STEP 2	
Convert 750 000 cm to a more 'friendly' distance, such as kilometres.	750 000 cm divided by 100 = 7500 m, then 7500 m divided by 1000 = 7.5 km (because there are 1000 m in a km).
STEP 3	
Write the answer in context	A scale of 1 : 750 000 is the same as 1 cm to 7.5 km.

Note: This means that 5 cm on the map will actually be 5 × 7.5 km = 37.5 km, and12 cm will be 12 × 7.5 km = 90 km.

If we start with a scale that gives the length on the map to the real distance, we can also express it as a ratio.

Example 6 Change a distance scale to a ratio scale

For a scale that says 1 cm = 50 m, what is the scale as a ratio?

THINKING	WORKING
STEP 1	
In a ratio, the units always need to be the same, so change the 50 metres into centimetres, the same as the LHS.	As there are 100 cm in a metre, we need to multiply by 100: 50 m = 50 × 100 = 5000 cm.
STEP 2	
Write the answer in context	A scale of 1 cm = 50 m is the same as a ratio of 1 : 5000.

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Using the scale

Here is a map of the centre of Cobram. You can see the scale on the bottom right-hand side of the map. We can use this scale to estimate distances on the map.

Use a ruler to measure the length of the scale – you should find that 150 metres equals about 2 cm on the map scale.



Source: Moira Shire Council website

We can use this to work out distances. For example, how long is it along Main Street, from the Recharge Point next to the Visitor Information centre down to the corner of William Street? This distance is shown with a red line.

The length of the red line along Main Street is about 5 cm when measured.

The scale tells us that for every 2 cm, this is equal to 150 metres. Now, 5 cm is 'two-and-a-half' times 2 cm. Therefore, the actual length to walk along Main Street will be about 2.5×150, which is 375 metres. So, the walk is a bit less than 400 metres.

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12F Tasks and questions

Thinking task

1 Using the internet, find three examples of maps that use a scale. Take screenshots or copy these maps and explain the scale that is used on each.

Skills questions

2 What units do you think you might use when you measure distances on a map? (It could be more than one of these.)

A metres (m)
B kilometres (km)
C millimetres (mm)
D centimetres (cm)

3 What units do you normally use when you are travelling (in a car, on a bike, or walking)?

A metres (m)
B kilometres (km)
C millimetres (mm)
D centimetres (cm)

Hint Kilometres are the biggest unit, then comes metres, centimetres and finally millimetres, which are the smallest units that are usually used in normal, everyday measurements.

4 Answer these questions for a map with a scale of 1:15 000.

a How far would 1 cm represent?
b How far would 7 cm represent?
c How far would 6.4 cm represent?

5 Answer these questions for a map with a scale of 1:1 000 000

a How far would 1 cm represent?
b How far would 12 cm represent?
c How far would 17.5 cm represent?

6 On a map that has a scale of 1 cm = 2.5 km, what is the scale as a ratio?

7 On a map that has a scale of 1 cm = 200 m, what is the scale as a ratio?

8 Use the above map of the centre of Cobram to answer the following questions.

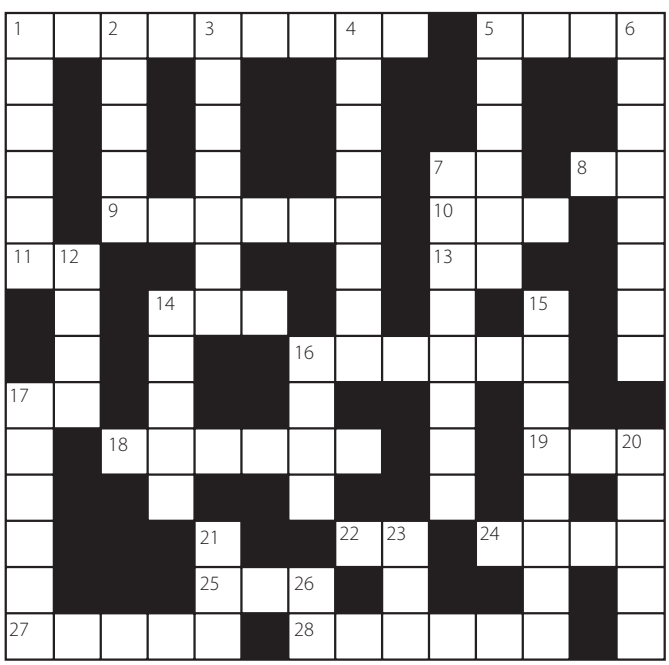
a About how far is it from the intersection of Queen Street and William Street up to Broadway Street?
b About how far is it from the Railway Station to the Cobram Community House on Punt Rd?
c Write two questions similar to part **a** and **b** and swap with a classmate.

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Mathematical literacy

9 Print out the Word version of this crossword (from the Offline Textbook) and complete the crossword about location and direction vocabulary and terminology.

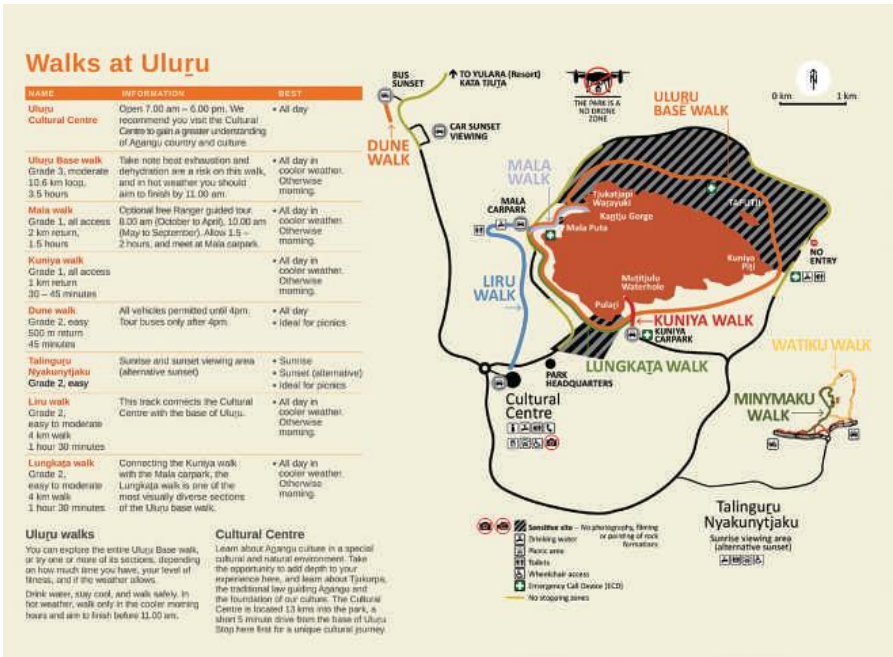
ACROSS	DOWN
1 Where something is pointing	**1** The northernmost Australian capital city
5 Opposite to right	**2** The side which is on the West when looking North
7 Western Australia (abbreviation)	**3** A tool that shows us directions
8 After midday	**4** In a position on the other side
9 A common form of public transport	**5** Find
10 Estimated Time of Arrival (abbreviation)	**6** The southernmost state in Australia
11 North-East	**7** A wind blowing to the east
13 Opposite to North-West	**12** Where the sun rises
14 Halfway between SE and S	**14** How fast something is travelling
16 Tells you about the main types of places on a map	**15** Next to
17 Street (abbreviation)	**16** A small street
18 The first part of an action	**17** What shows you the relationship between lengths on a map and the actual length on the ground
19 Software on a mobile device (abbreviation)	**20** A capital city on the west coast of Australia
22 Morning times	**21** Kilometres per hour (abbreviation)
24 Close to	**23** A drawing of part of the surface of the Earth
25 For each	**26** Road (abbreviation)
27 Opposite to North	
28 To go away from a place	



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Application tasks

10 Use the map of Uluru below to answer the following questions.



Source: Parks Australia website

a About how far is it as the **crow flies** from the Sunset viewing area for cars in the NW corner to the Talinguru Nyakunytjaku viewing area in the SE corner?

b About how far is it to **drive a car** from the Sunset viewing area for cars in the NW corner to the Talinguru Nyakunytjaku viewing area in the SE corner?

c About how far is the walk right around Uluru along the walking track, starting from the Kuniya car park on the south side of Uluru?

d A group of students are planning on riding bikes along the road from the Cultural Centre to the Talinguru Nyakunytjaku viewing area and back. They estimate they can average about 15 km/h and want to allow one hour there for a rest, to have a snack and drink and take photos.

Use the scale on the map to calculate the distance they need to ride and work out how long they need to allow for their bike ride?

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12G Timetables, trips and routes

One everyday skill we use in terms of location and direction is what route we might take from one place to another and how long the trip takes. Obviously, this depends on how we are intending to travel – are we walking, cycling, driving or taking a form of public transport like a bus, tram, train or even aeroplane?

There are specific skills related to understanding and working with different travel times and durations, and the need to be able to use and interpret timetables and related apps.

Understanding travel times and counting on

When travelling, we often want to decide on the most time-efficient manner to get to our destination. Depending on the purpose, this can save a lot of time, especially if it is a journey that we take on a regular basis, such as our daily trip to school or work.

There are two common calculations that we have to do with time, related to travel.

- Working out what the time will be in so many hours and minutes from now, or
- Working out how much time there is between a starting and finishing time (or a departure and arrival time).

It is often quickest and easiest to work out by adding on the time from the starting time. This is sometimes called 'counting on'.

These types of calculations often happen when using timetables, working out how long you have worked, working out when you need to start and finish cooking something, and so on. And it is usually in digital time.

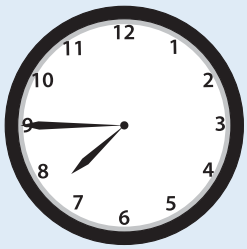
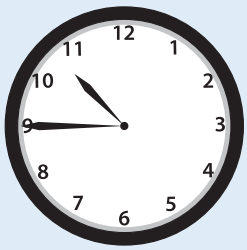
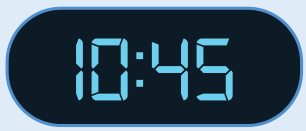
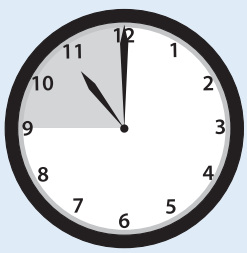
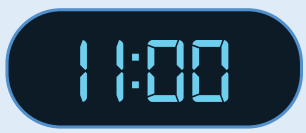
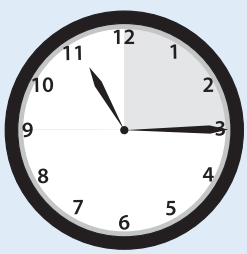
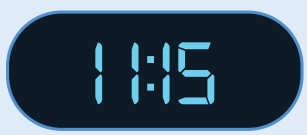
What will the time be?

To start with, it is important to know how much time there is from any time up to the next whole hour. For example, if it is now 6:40 pm, then it will be another 20 minutes to the next hour of 7 o'clock. In each case, you need to be able to work out how many more minutes there are to get to 60 minutes.

For example, if you are catching a train that leaves at 7:45 am, and the train trip takes $3\frac{1}{2}$ hours, what will the time be when you arrive?
Let's look at this on both an analogue and a digital clock.

But the main thing is that we **always start by adding on the whole hours first!**

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Starting time		
Add on 3 whole hours first – so this takes us to 10:45 am.		
Next, add on the extra 30 minutes, or half an hour. First, 15 minutes would take us to 11:00 o'clock.		
Then we have to still add on the other 15 minutes, which would take us to 15 minutes after 11:00. or 11:15 am.		

So, $3\frac{1}{2}$ hours after 7:45 am is 11:15 am.

Using timetables

Timetables are essential for travel purposes. We use timetables for getting to and from school, work, social or sporting events, appointments and holidays. Timetables are especially important for public transport, and are commonly available for buses, trains and trams.

They are often available for use at train stations or at bus and tram stops, and are now available in the form of apps on your mobile devices.

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Reading timetables

Public transport timetables display information like the extracts shown here – one is a country train timetable, and the other is a tram timetable. Such timetables are usually constructed in similar ways.

Reading down, the *first column* is the list of location names of all the stops or stations.

Reading across, the *row* for each location shows the departure times from that location.

Reading down each *column* gives you the departure times from each stop on the route. Each of these columns is a different service.

yarra trams PT

Route 59 Airport West to Flinders Street Station (City)

Service operates from 27.01.2022 until further notice

	Monday to Thursday																
Morning (am) / Afternoon (pm)	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am
59-Airport West/Matthews Ave (Airport West)	–	–	5:18	5:30	5:41	5:53	6:04	6:12	6:20	6:28	6:35	6:43	6:50	6:57	7:04	7:09	7:15
58-Marshall Rd/Matthews Ave (Airport West)	–	–	5:19	5:31	5:42	5:54	6:05	6:13	6:21	6:29	6:36	6:44	6:51	6:58	7:05	7:10	7:16
57-Hawker St/Matthews Ave (Airport West)	–	–	5:20	5:32	5:43	5:55	6:06	6:14	6:22	6:30	6:37	6:45	6:52	6:59	7:06	7:11	7:17
56-Earl St/Matthews Ave (Airport West)	–	–	5:21	5:33	5:44	5:56	6:07	6:15	6:23	6:31	6:38	6:46	6:53	7:00	7:07	7:12	7:18
55-Cameron St/Matthews Ave (Airport West)	–	–	5:22	5:34	5:45	5:57	6:08	6:16	6:24	6:32	6:39	6:47	6:54	7:01	7:08	7:13	7:19
54-Fullarton Rd/Matthews Ave (Niddrie)	–	–	5:22	5:34	5:45	5:57	6:08	6:16	6:24	6:32	6:39	6:47	6:54	7:01	7:08	7:13	7:19
53-Keilor Rd/Matthews Ave (Niddrie)	–	–	5:23	5:35	5:46	5:58	6:09	6:17	6:25	6:33	6:40	6:48	6:55	7:02	7:09	7:14	7:20
52-Treadwell Rd/Keilor Rd (Niddrie)	–	–	5:24	5:36	5:47	5:59	6:10	6:18	6:26	6:34	6:41	6:49	6:56	7:03	7:10	7:15	7:21
51-Bradshaw St/Keilor Rd (Essendon)	–	–	5:25	5:37	5:48	6:00	6:11	6:19	6:27	6:35	6:42	6:50	6:57	7:04	7:11	7:16	7:22
50-Cooper St/Keilor Rd (Essendon North)	–	–	5:26	5:38	5:49	6:01	6:12	6:20	6:28	6:36	6:43	6:51	6:58	7:05	7:12	7:17	7:23
49-Essendon North PS/Keilor Rd (Essendon North)	–	–	5:26	5:38	5:49	6:01	6:12	6:20	6:28	6:36	6:43	6:51	6:58	7:05	7:12	7:17	7:23
48-Service St/Keilor Rd (Essendon North)	–	–	5:27	5:39	5:50	6:02	6:13	6:21	6:29	6:37	6:44	6:52	6:59	7:06	7:13	7:18	7:24
47-Mt Alexander Rd/Keilor Rd (Essendon)	–	–	5:28	5:40	5:51	6:03	6:14	6:22	6:30	6:38	6:45	6:53	7:00	7:07	7:14	7:19	7:25
45-Glass St/Mt Alexander Rd (Essendon)	–	–	5:29	5:41	5:52	6:04	6:15	6:23	6:31	6:39	6:46	6:54	7:01	7:08	7:15	7:20	7:26
44-Thorn St/Mt Alexander Rd (Essendon)	–	–	5:29	5:41	5:52	6:04	6:15	6:23	6:31	6:39	6:46	6:54	7:01	7:08	7:15	7:20	7:26
43-Brewster St/Mt Alexander Rd (Essendon)	–	–	5:30	5:42	5:53	6:05	6:16	6:24	6:32	6:40	6:47	6:55	7:02	7:09	7:16	7:21	7:27
42-Grice Cres/Mt Alexander Rd (Essendon)	–	–	5:30	5:42	5:53	6:05	6:16	6:24	6:32	6:40	6:47	6:55	7:02	7:09	7:16	7:21	7:27
41-Fletcher St/Napier St (Essendon)	–	–	5:31	5:43	5:54	6:06	6:17	6:25	6:33	6:41	6:48	6:56	7:03	7:10	7:17	7:22	7:28
40-Nicholson St/Fletcher St (Essendon)	–	–	5:32	5:44	5:55	6:07	6:18	6:26	6:34	6:42	6:49	6:57	7:04	7:11	7:18	7:23	7:29
39-Hoddle St/Fletcher St (Essendon)	–	–	5:32	5:44	5:55	6:07	6:18	6:26	6:34	6:42	6:49	6:57	7:04	7:11	7:18	7:23	7:30
38-Pascoe Vale Rd/Fletcher St (Essendon)	–	–	5:33	5:45	5:56	6:08	6:19	6:27	6:35	6:43	6:50	6:58	7:05	7:12	7:19	7:24	7:31
37-Buckley St/Pascoe Vale Rd (Essendon)	–	–	5:34	5:46	5:57	6:09	6:20	6:28	6:36	6:44	6:51	6:59	7:06	7:13	7:20	7:25	7:32
36-Salisbury St/Pascoe Vale Rd (Moonee Ponds)	–	–	5:34	5:46	5:57	6:09	6:20	6:28	6:36	6:44	6:51	6:59	7:07	7:14	7:21	7:26	7:32
35-Queens Park/Pascoe Vale Rd (Moonee Ponds)	–	–	5:35	5:47	5:58	6:10	6:21	6:29	6:37	6:45	6:52	7:00	7:08	7:15	7:22	7:27	7:33

Source: Yarra Trams website

The Swan Hill train timetable uses 24-hour time, whereas the Route 59 tram timetable uses am and pm time. The Swan Hill train timetable uses a single point instead of a colon between the hours and minutes (but the time is not decimal time).

Example 1

Using the extract from the Route 59 tram timetable shown opposite, we can see that the first Route 59 tram leaves Stop 59 in Airport West at 5:18 am, and the next one leaves at 5:30 am.

The first tram that leaves at 5:18 am arrives at stop 47 in Essendon at 5:28.

Route 59 Airport West to Flinders Street Stat

	Monday to				
Morning (am) / Afternoon (pm)	am	am	am	am	am
59-Airport West/Matthews Ave (Airport West)	–	–	5:18	5:30	5:41
58-Marshall Rd/Matthews Ave (Airport West)	–	–	5:19	5:31	5:42
57-Hawker St/Matthews Ave (Airport West)	–	–	5:20	5:32	5:43
56-Earl St/Matthews Ave (Airport West)	–	–	5:21	5:33	5:44
55-Cameron St/Matthews Ave (Airport West)	–	–	5:22	5:34	5:45
54-Fullarton Rd/Matthews Ave (Niddrie)	–	–	5:22	5:34	5:45
53-Keilor Rd/Matthews Ave (Niddrie)	–	–	5:23	5:35	5:46
52-Treadwell Rd/Keilor Rd (Niddrie)	–	–	5:24	5:36	5:47
51-Bradshaw St/Keilor Rd (Essendon)	–	–	5:25	5:37	5:48
50-Cooper St/Keilor Rd (Essendon North)	–	–	5:26	5:38	5:49
49-Essendon North PS/Keilor Rd (Essendon North)	–	–	5:26	5:38	5:49
48-Service St/Keilor Rd (Essendon North)	–	–	5:27	5:39	5:50
47-Mt Alexander Rd/Keilor Rd (Essendon)	–	–	5:28	5:40	5:51
45-Glass St/Mt Alexander Rd (Essendon)	–	–	5:29	5:41	5:52
44-Thorn St/Mt Alexander Rd (Essendon)	–	–	5:29	5:41	5:52

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Example 2

Using the extract from the Swan Hill train timetable shown below, we can see that the first train departs Southern Cross station for Swan Hill at 7:39 am, and the next one leaves at 10:06 am.

The first train that leaves at 7:39 am arrives at Kerang at 11:35 am. That trip is expected to take 3 hours and 56 minutes (with these times it's easy to see that the trip takes 4 minutes less than 4 hours).

Melbourne to Swan Hill

		Monday to Friday		M, W, F	Tuesday
Service		TRAIN	TRAIN	TRAIN	TRAIN
Service Information		★♥			
SOUTHERN CROSS	*dep*	07.39	10.06	13.06	13.06
Footscray		07.48u	10.14u	13.14u	13.14u
~~BENDIGO~~	*arr*	09.55	11.58	14.57	14.57
Change Service			COACH	COACH	COACH
Service Information			♿	♿	♿
BENDIGO	*dep*	10.00	12.17	15.07	15.09
Eaglehawk Station		10.08	–	–	–
Eaglehawk		–	–	–	15.22
Sebastian		–	–	–	–
Raywood		–	–	–	–
Dingee Station		10.38	–	–	–
Dingee		–	–	–	–
Mitiamo		–	–	–	–
Serpentine		–	12.57	–	15.51
Bears Lagoon		–	13.03	–	15.56
Durham Ox		–	13.18	–	16.12
Pyramid Station		11.07	–	–	–
Pyramid		–	–	–	16.28
Cohuna		–	–	–	16.59
Kerang		11.35	13.53	–	17.29
Lake Charm		–	14.08	–	17.43
Lake Boga		–	14.23	–	17.59
Maiden Gully				15.17	

Source: V/Line website

You can also see that the timetable tells you that the trains that depart at 10:06 and at 13:06 all change to a coach (bus) at Bendigo. It also shows you that the trains often do not stop at a number of stations, such as Sebastian, Raywood, etc.

Planning a trip

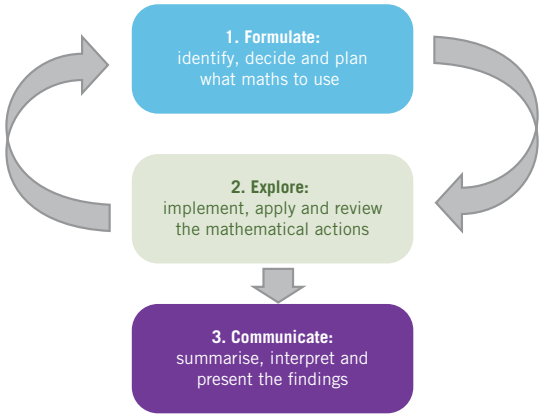
A common travel requirement is to work out what time you might need to leave home to get to (and sometimes back) from an activity – it could be for school, for work, for a holiday or to go out to see a movie. This requires using the above skills, including the need to read and interpret timetables.

To work and back

Claudia wants to work out what time she needs to leave home to get to work. She lives in Tamora Way, Sydenham, and has a job working Friday and Saturday nights at a Vietnamese restaurant in Hopkins Street, Footscray. She goes to work by train. To work this out, she needs to follow the problem-solving cycle steps:

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- Formulate – here it means to plan and sort out what she needs to know in order to work out what time to leave home.
- Explore the information she finds, and work out the best time to leave.
- Communicate the results – maybe write a note somewhere, in her diary, in her phone or calendar.



Formulate

The question is, what time does she needs to leave home on a Friday in order to get to the restaurant on time. This needs to take into account the following.

- How long it takes to walk to her nearest train station, Watergardens.
- What times the trains leave and what time they arrive at Footscray Station.
- How long it takes to walk to the restaurant.
- What time she needs to get to work.

Explore

Claudia decides that she knows a few bits of the information required, but there is some that she needs to explore and find.

- She knows it takes her about 15 minutes to walk to Watergardens Station from home, and only about 5 minutes to walk to the restaurant from Footscray Station.
- Claudia does not want to get to work late, plus she feels she needs to allow some extra time in case the train is late. Her boss wants her there by 6:00 pm. She decides it would be good to plan to get to work by 5:50 pm.
- To decide what train to catch, she needs to look up the train timetable for the Watergardens line on a Friday. She finds the relevant part of the Sunbury train timetable online (Watergardens is on the Sunbury line). An extract is shown below.

  Claudia checks the timetable and sees that there might be two possible trains: the one that leaves Watergardens at 5:07 pm or the one that leaves at 5:27 pm. But given that she has decided to get there **before** 5:50 pm, and it takes her 5 minutes to walk to the restaurant, the second option does not meet her requirements to not be late to work. So, Claudia decides she should catch the 5:07 pm train that gets her to Footscray at 5:30 pm.

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Monday to Friday																		
Wheelchair Accessible Services	♿	♿	♿	♿	♿	♿	♿	♿	♿	♿	♿	♿	♿	♿	♿	♿	♿	♿
Morning (am) / Afternoon (pm)	pm	pm	pm	pm	pm	pm	pm	pm	pm	pm	pm	pm	pm	pm	pm	pm	pm	pm
Sunbury Station (Sunbury)	–	–	–	–	–	–	–	–	4:56	–	–	–	5:16	–	–	–	5:36	
Diggers Rest Station (Diggers Rest)	–	–	–	–	–	–	–	–	5:00	–	–	–	5:20	–	–	–	5:40	
Watergardens Station (Sydenham)	–	–	4:40	–	–	4:56	–	–	5:07	–	–	–	5:27	–	–	–	5:47	
Keilor Plains Station (St Albans)	–	–	4:44	–	–	5:00	–	–	5:11	–	–	–	5:31	–	–	–	5:51	
St Albans Station (St Albans)	–	–	4:46	–	–	5:02	–	–	5:13	–	–	–	5:33	–	–	–	5:53	
Ginifer Station (St Albans)	–	–	4:48	–	–	5:04	–	–	5:15	–	–	–	5:35	–	–	–	5:55	
Albion Station (Sunshine North)	–	–	4:52	–	–	5:08	–	–	5:19	–	–	–	5:39	–	–	–	5:59	
Sunshine Station (Sunshine)	–	–	4:54	–	–	5:10	–	–	5:21	–	–	–	5:41	–	–	–	6:01	
Tottenham Station (West Footscray)	–	–	4:57	–	–	5:13	–	–	5:24	–	–	–	5:44	–	–	–	6:04	
West Footscray Station (West Footscray)	–	–	4:59	–	–	5:15	–	–	5:26	–	–	–	5:46	–	–	–	6:06	
Middle Footscray Station (Footscray)	–	–	5:01	–	–	5:17	–	–	5:28	–	–	–	5:48	–	–	–	6:08	
Footscray Station (Footscray)	4:56	5:01	5:03	5:06	5:17	5:19	5:21	5:26	5:30	5:37	5:41	5:46	5:50	5:57	6:01	6:06	6:10	
South Kensington Station (Kensington)	4:59	5:04	|	|	5:20	|	5:24	|	|	5:40	5:44	|	|	6:00	6:04	|	|	
North Melbourne Station (West Melbourne)	5:02	5:07	5:08	5:12	5:23	5:24	5:27	5:32	5:35	5:43	5:47	5:52	5:55	6:03	6:07	6:12	6:16	
Southern Cross Station (Melbourne City)	5:05	5:10	5:12	5:15	5:26	5:28	5:30	5:35	5:39	5:46	5:50	5:55	5:59	6:06	6:10	6:15	6:19	
Flinders Street Station (Melbourne City) ARR	5:09	5:14	5:17	5:19	5:30	5:32	5:34	5:39	5:44	5:50	5:54	5:59	6:04	6:10	6:14	6:19	6:23	
Flinders Street Station (Melbourne City) DEP	–	–	5:17	–	–	–	–	–	5:44	–	–	–	–	–	–	–	6:25	
Parliament Station (Melbourne City)	–	–	5:20	–	–	–	–	–	5:47	–	–	–	–	–	–	–	6:28	
Melbourne Central Station (Melbourne City)	–	–	5:22	–	–	–	–	–	5:49	–	–	–	–	–	–	–	6:30	
Flagstaff Station (Melbourne City)	–	–	5:23	–	–	–	–	–	5:50	–	–	–	–	–	–	–	6:31	

Source: Public Transport Victoria website

- It takes Claudia 15 minutes to walk to the station, so she decides she needs to leave a bit more than 15 minutes before 4:56 pm to allow for tapping on with her Myki card. Fifteen minutes before is 4:41 pm, so Claudia decides it would be sensible to leave at about 4:35 pm.

Communicate

Claudia writes a big note and pins it to the board in her bedroom. The note says that she needs to leave home for work on Fridays at 4:35 pm.

12G Tasks and questions

Thinking task

1 Work with a partner or in a small group to share and discuss how you plan trips and when you need to read timetables. Each person is to think about a trip they have made on public transport where they needed to refer to and use timetables for getting there (and back). Undertake the following:

- Share where the trip was from and to – and the mode of transport.
- Did you need to do some calculations with time – like what time you needed to catch the train, bus or tram in relation to when you wanted to arrive or leave?
- What timetables did you need to use? Were they digital and on a device or computer? Was it an app or journey planner? Or were they printed, like at a train station or bus or tram stop?
- Discuss and share the different information and skills you needed to use to undertake the trip.

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Skills questions

2 How many minutes from these times to the next hour?

a 10:30 am **b** 05:50 **c** 6.12 pm **d** 15:37 **e** 2123

3 You are catching a plane that leaves at 2:15 pm. The trip takes 2.5 hours. What will the time be when you arrive? (Assume you've stayed within the same time zone.)

4 You are catching a train that leaves at 11:20 am. The train trip takes 4 hours and 50 minutes. What will the time be when you arrive?

5 Use the extract for the Route 59 tram given earlier in this section to answer these questions.

a What time does the Route 59 tram that leaves stop 59 at 5:30 am get to stop 44 in Essendon?

b What time does the Route 59 tram that leaves stop 59 at 5:41 am get to stop 53 in Niddrie?

c How long does it take to get from stop 58 to stop 45?

d You are catching a tram from Stop 57 in Airport West. You want to get to Stop 44 in Essendon by 5:45 am. What tram or trams could you catch?

6 Use the extract from the Swan Hill train timetable given earlier in this section to answer these questions.



a What time does the Swan Hill train that leaves Southern Cross Station for Swan Hill at 7:39 am get to Pyramid? How long is the trip expected to take?

b If you catch the Swan Hill train that leaves Southern Cross at 13:06 on Tuesday, what time are you expected to arrive at Cohuna? How long is the trip expected to take?

c If you want to get to Bendigo by 1:00 pm on a Tuesday, what train or trains could you catch?

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Use the train timetable below to answer questions **7-11**.

		Sunday																
Wheelchair Accessible Services		♿	♿	♿	♿	♿	♿	♿	♿	♿	♿	♿	♿	♿	♿	♿	♿	♿
Morning (am) / Afternoon (pm)		am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am
Cranbourne Station (Cranbourne)		–	–	10:09	–	–	–	10:29	–	–	–	10:49	–	–	–	11:09	–	–
Merinda Park Station (Cranbourne North)		–	–	10:12	–	–	–	10:32	–	–	–	10:52	–	–	–	11:12	–	–
Lynbrook Station (Lynbrook)		–	–	10:15	–	–	–	10:35	–	–	–	10:55	–	–	–	11:15	–	–
Dandenong Station (Dandenong)	ARR	–	–	10:23	–	–	–	10:43	–	–	–	11:03	–	–	–	11:23	–	–
Dandenong Station (Dandenong)	DEP	10:13	–	10:23	–	10:33	–	10:43	–	10:53	–	11:03	–	11:13	–	11:23	–	11:33
Yarraman Station (Noble Park)		10:16	–	10:26	–	10:36	–	10:46	–	10:56	–	11:06	–	11:16	–	11:26	–	11:36
Noble Park Station (Noble Park)		10:19	–	10:29	–	10:39	–	10:49	–	10:59	–	11:09	–	11:19	–	11:29	–	11:39
Sandown Park Station (Springvale)		10:21	–	10:31	–	10:41	–	10:51	–	11:01	–	11:11	–	11:21	–	11:31	–	11:41
Springvale Station (Springvale)		10:23	–	10:33	–	10:43	–	10:53	–	11:03	–	11:13	–	11:23	–	11:33	–	11:43
Westall Station (Clayton South)		10:26	–	10:36	–	10:46	–	10:56	–	11:06	–	11:16	–	11:26	–	11:36	–	11:46
Clayton Station (Clayton)		10:28	–	10:38	–	10:48	–	10:58	–	11:08	–	11:18	–	11:28	–	11:38	–	11:48
Huntingdale Station (Oakleigh)		10:31	–	10:41	–	10:51	–	11:01	–	11:11	–	11:21	–	11:31	–	11:41	–	11:51
Oakleigh Station (Oakleigh)		10:33	–	10:43	–	10:53	–	11:03	–	11:13	–	11:23	–	11:33	–	11:43	–	11:53
Hughesdale Station (Hughesdale)		10:35	–	10:45	–	10:55	–	11:05	–	11:15	–	11:25	–	11:35	–	11:45	–	11:55
Murrumbeena Station (Murrumbeena)		10:37	–	10:47	–	10:57	–	11:07	–	11:17	–	11:27	–	11:37	–	11:47	–	11:57
Carnegie Station (Carnegie)		10:39	–	10:49	–	10:59	–	11:09	–	11:19	–	11:29	–	11:39	–	11:49	–	11:59
Caulfield Station (Caulfield East)		10:42	10:46	10:52	10:56	11:02	11:06	11:12	11:16	11:22	11:26	11:32	11:36	11:42	11:46	11:52	11:56	**12:02**
Malvern Station (Malvern)		|	10:49	|	10:59	|	11:09	|	11:19	|	11:29	|	11:39	|	11:49	|	11:59	|
Armadale Station (Armadale)		|	10:51	|	11:01	|	11:11	|	11:21	|	11:31	|	11:41	|	11:51	|	**12:01**	|
Toorak Station (Armadale)		|	10:53	|	11:03	|	11:13	|	11:23	|	11:33	|	11:43	|	11:53	|	**12:03**	|
Hawksburn Station (South Yarra)		|	10:55	|	11:05	|	11:15	|	11:25	|	11:35	|	11:45	|	11:55	|	**12:05**	|
South Yarra Station (South Yarra)		10:49	10:57	10:59	11:07	11:09	11:17	11:19	11:27	11:29	11:37	11:39	11:47	11:49	11:57	11:59	**12:07**	**12:09**
Richmond Station (Richmond)		10:52	11:00	11:02	11:10	11:12	11:20	11:22	11:30	11:32	11:40	11:42	11:50	11:52	**12:00**	**12:02**	**12:10**	**12:12**
Parliament Station (Melbourne City)		10:55		11:05		11:15		11:25		11:35		11:45		11:55		**12:05**		**12:15**
Melbourne Central Station (Melbourne City)		10:57		11:07		11:17		11:27		11:37		11:47		11:57		**12:07**		**12:17**
Flagstaff Station (Melbourne City)		10:59		11:09		11:19		11:29		11:39		11:49		11:59		**12:09**		**12:19**
Southern Cross Station (Melbourne City)		11:01		11:11		11:21		11:31		11:41		11:51		**12:01**		**12:11**		**12:21**
Flinders Street Station (Melbourne City)	ARR	11:05	11:04	11:15	11:14	11:25	11:24	11:35	11:34	11:45	11:44	11:55	11:54	**12:05**	**12:04**	**12:15**	**12:14**	**12:25**
Flinders Street Station (Melbourne City)	DEP	–	–	–	–	–	–	–	11:36	–	–	–	–	–	–	–	–	–
Southern Cross Station (Melbourne City)		–	–	–	–	–	–	–	11:39	–	–	–	–	–	–	–	–	–

Source: Public Transport Victoria website

7 If you catch the 10:09 am train from Cranbourne Station, how long does it take you to get to Flinders Street station?

8 How long does the 10:43 am train from Springvale Station take to get to Parliament Station?

9 How long does a train normally take to get from Malvern Station to Richmond Station?

10 Tamsin lives in Noble Park and wants to meet a friend in the city at midday on Sunday. They decide to meet at the Flinders Street Station steps. She will go by train. Her closest train station is Yarraman, which is about a 20-minute walk from home.

- **a** What time do you think Tamsin needs to leave home so she meets her friend on time?
- **b** What time train will she catch from Yarraman?
- **c** How long is her train trip?

11 Jakub is heading off by train to see a movie at Melbourne Central in the city on Sunday. The movie starts at 11:30 am. Jakub's closest train station is Clayton, and it takes him about 15 minutes to ride his bike to the station. Jakub wants to allow half an hour to get from Melbourne Central Station to the cinema in order to buy his ticket and snacks and find his seat prior to the movie beginning.

- **a** What time do you think Jakub needs to leave home so he gets to the movie on time?
- **b** What time train will Jakub catch from Clayton?
- **c** How long is his train trip?

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Mathematical literacy

12 Write an itinerary for taking a trip to your nearest or favourite beach, lake or river where you can go for a swim. You must use public transport for at least some part of the trip. Remember to include your expected arrival and departure times, and the time it takes you to travel to and from the public transport.

Application tasks

13 Use the timetable for the bus that runs between Traralgon and Churchill Shopping Centre (SC) in Gippsland to answer the following questions.

- **a** How many times a day during the working week does the bus run from Traralgon to Churchill?
- **b** How many stops are there between Traralgon Plaza and Churchill SC?
- **c** How long is the whole trip from Traralgon Plaza to Churchill SC?

Route 3 Churchill

	Monday to Friday					
Wheelchair Accessible Services	♿	♿	♿	♿	♿	♿
Morning (am) / Afternoon (pm)	am	am	am	pm	pm	pm
Traralgon Plaza SC/Franklin St (Traralgon)	6:50	8:50	10:50	12:50	2:50	4:50
Traralgon Station/Princes St (Traralgon)	6:53	8:53	10:53	12:53	2:53	4:53
Deakin St/Princes St (Traralgon)	6:53	8:53	10:53	12:53	2:53	4:53
Mates St/Bank St (Traralgon)	6:55	8:55	10:55	12:55	2:55	4:55
Fernlea St/Hazelwood Rd (Traralgon)	6:58	8:58	10:58	12:58	2:58	4:58
Dalkeith Heights Ret Village/Hazelwood Rd (Traralgon)	6:58	8:58	10:58	12:58	2:58	4:58
Church Rd/Hazelwood Rd (Hazelwood North)	7:04	9:04	11:04	1:04	3:04	5:04
Mathison Park/Tramway Rd (Churchill)	7:09	9:09	11:09	1:09	3:09	5:09
Federation University/Northways Rd (Churchill)	7:12	9:12	11:12	1:12	3:12	5:12
Churchill SC/Georgina Pl (Churchill)	7:17	9:17	11:17	1:17	3:17	5:17

Source: Public Transport Victoria website

Route 3 Traralgon

	Monday to Friday					
Wheelchair Accessible Services	♿	♿	♿	♿	♿	♿
Morning (am) / Afternoon (pm)	am	am	pm	pm	pm	pm
Churchill SC/Georgina Pl (Churchill)	8:07	10:07	12:07	2:07	4:07	6:07
Federation University/Northways Rd (Churchill)	8:12	10:12	12:12	2:12	4:12	6:12
Mathison Park/Tramway Rd (Churchill)	8:13	10:13	12:13	2:13	4:13	6:13
Church Rd/Hazelwood Rd (Hazelwood North)	8:18	10:18	12:18	2:18	4:18	6:18
Karri Ct/Hazelwood Rd (Traralgon)	8:26	10:26	12:26	2:26	4:26	6:26
Fernlea St/Hazelwood Rd (Traralgon)	8:26	10:26	12:26	2:26	4:26	6:26
Mates St/Bank St (Traralgon)	8:26	10:26	12:26	2:26	4:26	6:26
Cath Teychenne Centre/Breed St (Traralgon)	8:28	10:28	12:28	2:28	4:28	6:28
St Michaels PS/Church St (Traralgon)	8:31	10:31	12:31	2:31	4:31	6:31
Traralgon Plaza SC/Franklin St (Traralgon)	8:34	10:34	12:34	2:34	4:34	6:34

Source: Public Transport Victoria website

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14 Stefan lives in Drouin and is studying at Federation University in Churchill. On the weekdays when he has classes, Stefan catches the 7:38 am train from Drouin Station that gets to Traralgon Station at 8:32 am. When coming home from University, he catches the 5:20 pm train back from Traralgon that gets into Drouin at 6:08 pm. He uses the Route 3 bus to travel between Traralgon and the University.

a At what time would he arrive at the University?

b What time bus does he need to catch to get back to Traralgon in time for his train home? Note that the closest bus stop to the station is Traralgon Plaza SC which is about a 7-minute walk.

c How long will he be on the train and buses for on his trip from Drouin to the University and back?

15 Use the extracts below from the Swan Hill train timetable to work out this trip for Amani. This is what he wants to do:

- Amani wants to visit his brother in Footscray on Saturday and return home on Sunday.
- He is not an early riser so does not want to catch a train or coach before 9:00 am.
- He wants to get to Footscray on the Saturday to see the Bulldogs AFLW team play a game at the Western oval. The game starts at 5:00 pm.
- Amani wants to get back home to Swan Hill on Sunday but does not want to catch the coach service.

		Saturday & Sunday		
Service		TRAIN	TRAIN	TRAIN
Service Information		★▼		★▼
SOUTHERN CROSS	*dep*	07.40	10.06	18.43
Footscray		07.48u	10.14u	18.51u
BENDIGO	*arr*	09.55	11.57	20.52
Change Service			COACH	
Service Information			♿	
BENDIGO	*dep*	10.00	12.17	20.57
Eaglehawk		10.08	–	21.05
Dingee Station		10.38	–	21.34
Serpentine		–	12.57	–
Bears Lagoon		–	13.03	–
Durham Ox		–	13.18	–
Pyramid		11.07	–	22.03
Kerang		11.35	13.53	22.31
Lake Charm		–	14.08	–
Lake Boga		–	14.23	–
SWAN HILL	*arr*	12.22	14.35	23.19

Source: V/Line website

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		Saturday			Sunday		
Change Service		TRAIN	COACH	TRAIN	TRAIN	COACH	TRAIN
Service Information		★♥		★♥	★♥		★♥
SWAN HILL	*dep*	06.56	09.40	13.37	06.56	12.50	16.38
Lake Boga		–	09.52	–	–	13.02	–
Lake Charm		–	10.08	–	–	13.18	–
Kerang Station		07.40	10.26	14.21	07.40	13.36	17.22
Pyramid		08.07	–	14.48	08.07	–	17.49
Durham Ox		–	10.56	–	–	14.06	–
Bears Lagoon		–	11.11	–	–	14.21	–
Serpentine		–	11.16	–	–	14.26	–
Dingee		08.37	–	15.18	08.37	–	18.19
Eaglehawk		09.06	–	15.47	09.06	–	18.48
BENDIGO	*arr*	09.18	11.57	15.59	09.18	15.07	19.00
Change Service			TRAIN			TRAIN	
BENDIGO	*dep*	09.20	12.26	16.01	09.20	15.26	19.02
Footscray		11.19d	14.14d	17.58d	11.19d	17.14d	21.01d
SOUTHERN CROSS	*arr*	11.30	14.24	18.09	11.30	17.24	21.12

Source: V/Line website

Plan Amani's trip for him and write it up. Include answers to the following questions.

a What times and trains he needs to catch on each day. Give his departure and arrival times.

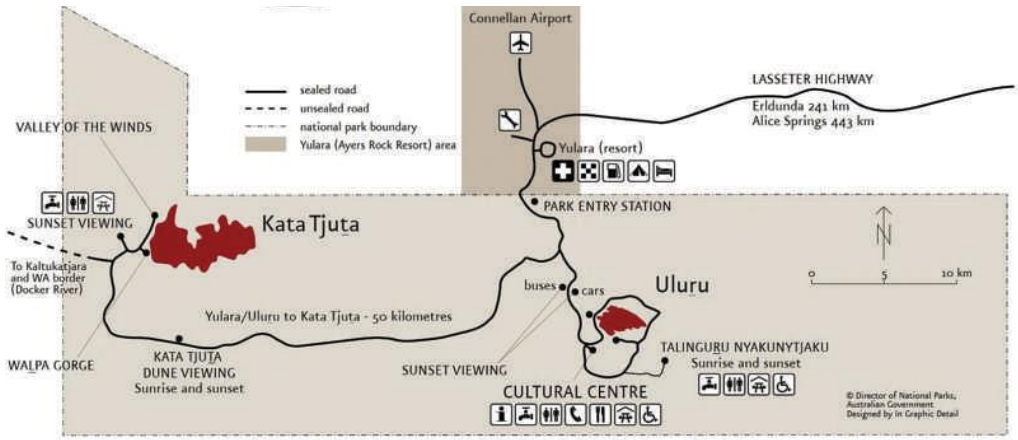
b If Amani lives about a 20-minute walk away from the Swan Hill train station, what time do you think he needs to leave home on the Saturday so he does not miss his train?

c How long will he be on the train and coaches over his whole trip.



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16 Crist is having a holiday at Uluru in the NT and is planning a day trip out at the Kata Tjuta national park area. They are camping at Yulara. Their aims for the day trip are:



Source: Parks Australia website

i Drive from Yulara out to the Valley of the Winds in Kata Tjuta and back. Note that the speed limit in the Uluru and Kata Tjuta national park is 80km/h.

ii Go for a walk, including having their lunch, out at the Valley of the Winds.

iii The walk is 7.4 km long and is considered difficult, so Crist estimates they can only average about 2 km/h including breaks.

iv They add on an extra half an hour for their lunch.

v Because of the heat, Crist wants to be out at the Valley of the Winds to start walking before 9:00 am.

Use the map above to plan Crist's day trip. Include the following:

a Work out their travel times for the drive and for the walk.

b Write up her itinerary, including her departure and arrival times from when they leave Yulara to when they are due to return. (Note: An *itinerary* is a travel plan for a trip or route, detailing where you will depart and when you will arrive at your destination.)

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12H Technology to the rescue

GNSS-based digital maps

The use of Global Navigation Satellite Systems (GNSS) has become widespread in how we access directions and maps in the 21st century. We can use GNSS-based maps and related navigation systems on our mobile phones, tablets, computers and in our cars. They have become an everyday piece of technology that we use for travel purposes, no matter whether we are walking, riding a bike, driving a car or catching public transport.

What is GNSS and how does it work?

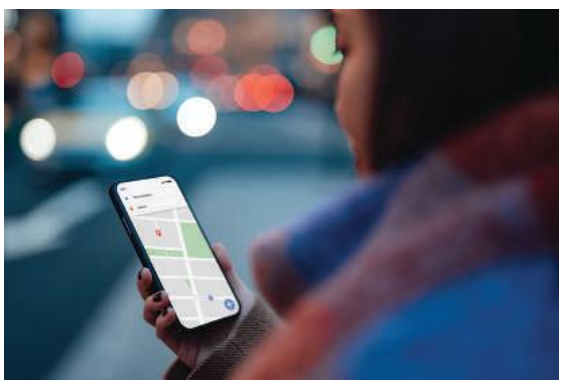
One type of GNSS is GPS. GPS stands for Global Positioning System. GPS is just one of many navigation system that uses satellites to provide very accurate information and data for use in air, sea and land travel.

The GPS satellite system consists of about 24 satellites in six different sets of orbits at about 20 000 km above the Earth and travelling at speeds of around 14 000 km/h.

A GPS navigation device consists of the following.

- A global positioning system receiver that picks up satellite signals to determine your exact position.
- A computer processor to calculate routes, distances and times.
- A map database which includes points of interest, such as schools, police stations, car parks, petrol stations and hospitals.
- A screen displaying maps and route instructions.
- A speaker for providing verbal instructions.





GPS apps for smartphones

When it comes to basic travel navigation, GPS apps on mobile phones can perform just as well as bigger units, like those used in cars.

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While you can pay for such apps, there are a number of free ones available as well, including default map apps included with your Android or iOS device.

Digital maps versus paper maps

Advantages of paper maps

In the digital age, it is very easy to overlook using traditional paper maps, but they still serve some helpful purposes. Here are three advantages of paper maps over digital.

- Paper maps do not run out of battery power or lose access to GPS satellite signals – still quite a common issue in some areas of Australia.
- Sometimes it is easier to mark-up a paper map, especially when planning a trip, walk, drive or ride. Then you can use the digital maps once you get going.
- Paper maps are useful for gaining better spatial awareness. The broader scale and greater details in paper maps can give you an advantage in geographic and directional perception.

Advantages of digital maps

When you open a traditional paper map, you don't know your position on that map.

Whereas, on smart phones and devices with a GNSS receiver, your location on the map is (usually) automatically displayed, and locations and movements can be recorded. You do not have to make the effort to find out where you are physically by looking around for street names to identify your location.

The apps also provide voice navigation to give you the instructions to follow to get from where you are starting (which can be called your **departure** point) to your **destination** (where you want to get to).

Which app on your mobile?

There are many advantages to using digital maps – no matter whether that be for driving cars, catching public transport, walking or bike riding. Handy smartphone apps are now an integral part of our lives. They are cheap, convenient and almost always available – until you run out of data or battery. Here is a quick look at what apps are available to use and what they can do.

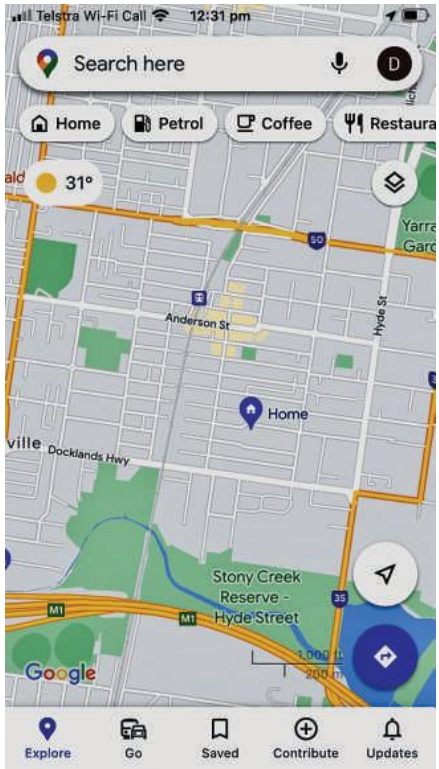
The most popular and common in-built navigation apps, such as Apple Maps and Google Maps, are excellent tools for everyday use. Both will store information about your home, where you go to school and work, and tell you how long it will take to get somewhere, how far it is and more. For example, with Google Street View, you can

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explore landmarks in 360-degree street view using augmented reality. Apple Maps works on iOS and Mac devices. It comes pre-installed and is ready to get you where you want to go.

On your phone or tablet, open Apple Maps or Google Maps.

Here is something similar to what you will see, depending on your app and where you are located.



A few key points:

- You can zoom in and out using two fingers.
- The view of the map is usually showing North to the top of the screen.

Use your mobile device and open up one of the Map apps – if your home (or school or work) is not already saved, here is how you can do that:

- Tap **Saved** at the bottom of the screen.
- Under 'Your lists', tap **Labelled**.
- Choose **Home** or **Work**, or you can add your own (like **School**).
- Enter the address.

Finding a route

Here are the normal steps we use to find a route on the map.

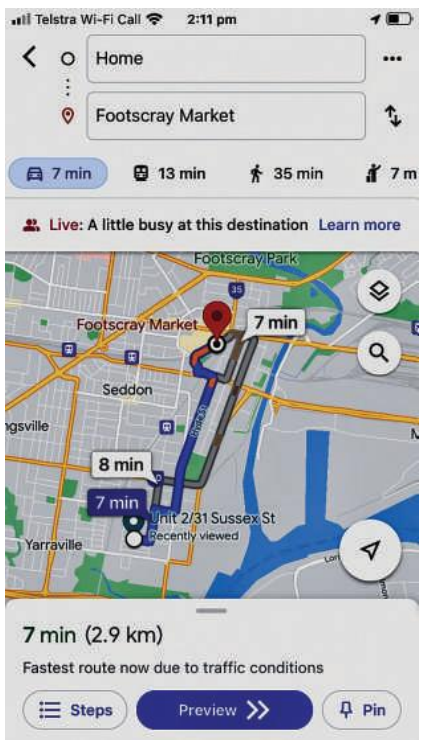
Search for a place or tap it on the map.

Tap the **Directions** icon:

Choose one of the following:

- Driving:
- Public transport:
- Walking:
- Rides:
- Cycling:

If alternative routes are available, they will be shown in grey on the map. To follow an alternative route, tap the grey line.



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The image illustrates what the results for such a trip might look like for travel by car.

You will see that this initial screen provides you with the following useful information:

- The starting point (also called the **departure** point).
- The **destination** (where you are going).
- Across the top, it shows the estimated times by the different methods of travel (car, public transport, walking and by taxi or Uber).
- At the bottom, it shows the travel time and the distance (for the main recommended route, shown in dark blue).

Adding extra stops to the trip

To add additional destinations, go to the top right and tap **More** ⋮ Add your stop. You can add up to nine stops. When you are finished, tap **Done**.

To start following your selected route

To start navigation, tap **Start** .

To stop or cancel navigation, go to the bottom and tap **Close** ×.

To see the map from where you are and your point of view, tap the **compass** icon.

Maps on your PC or laptop

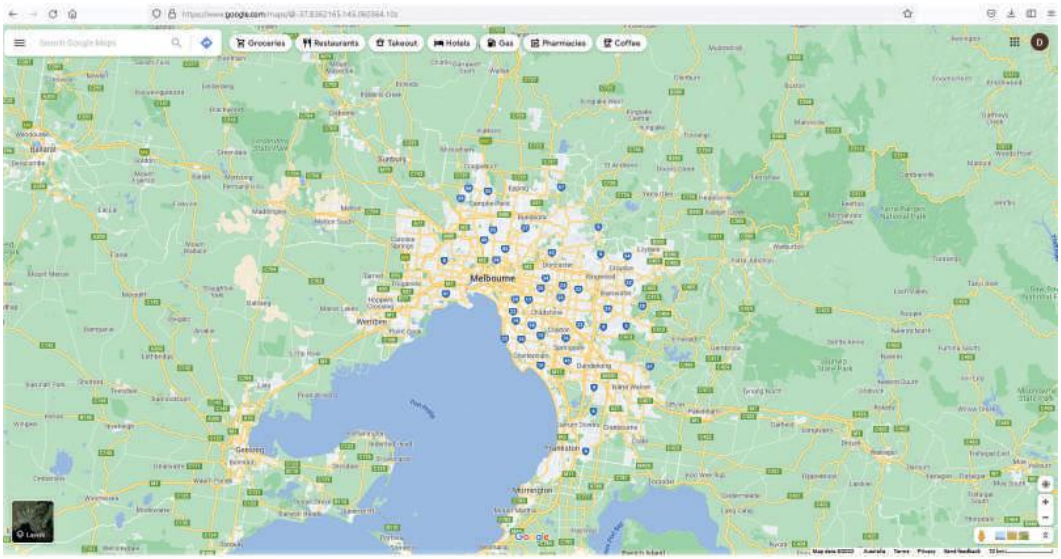
You can also use your PC or laptop to access GPS-based maps. The most common one is Google Maps.

When looking at maps on a PC or laptop, views will cover a much larger area, which can be easier to use for travel planning purposes. They will not (necessarily) have access to the GPS system, and are not mobile, like phones and tablets, so you will not be able to use them for following directions.



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Here is an example of what you might see on a larger-sized screen.



It works in very similar ways to a mobile app. Down at the bottom left-hand and right-hand corners, you will see information and tools to use.



The one on the left enables you to change the view of the map (map view or satellite view). These give you what we call a **bird's eye view –** a view from a high angle as if seen by a bird in flight.



The set of icons on the right allow you to click on the **person** icon and drag them onto a location on the map to get what is called a **street view**. It also shows the scale.

You can use the + and – icons to zoom in and out (if you do not have a touch screen).

⌖ This icon at the top will show your location on the map if you have access to GPS data.

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Websites and apps for planning public transport routes

There are some very useful and popular apps which you can use on your computer or hand-held digital device to help you plan trips using public transport.

These websites and apps are designed specifically for planning a trip which involves catching buses, trams or trains around Melbourne and Victoria.

PTV Journey Planner

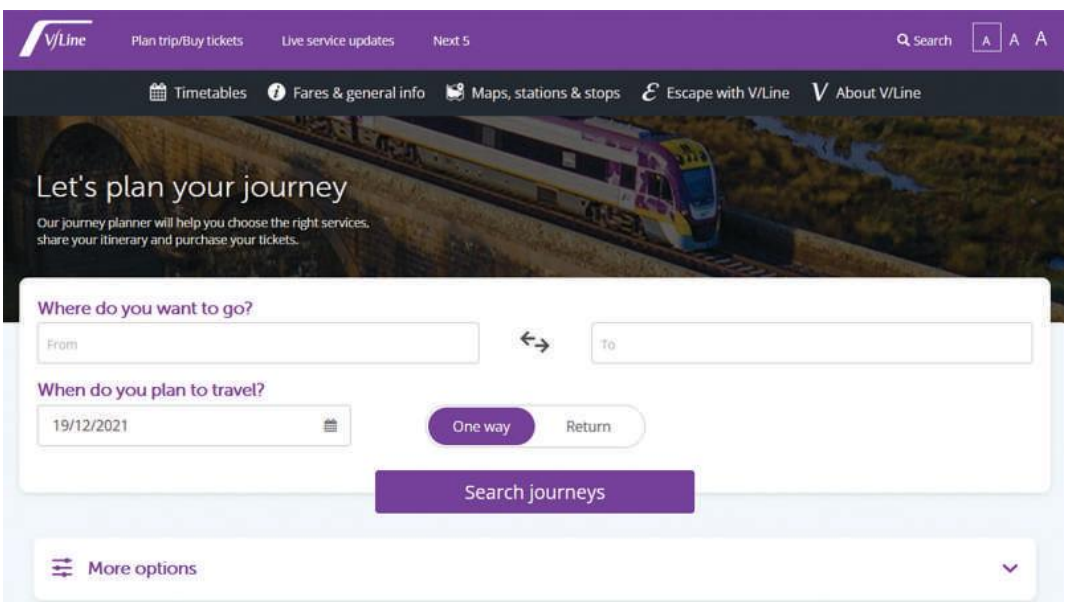
The images below show what the options are for catching a train from Watergardens Station to Footscray Station in the late afternoon on a weekday.

Each screen shows you more detail as you select the most appropriate option. The final screen tells you everything you need to know to catch the train – the departure time, arrival time and duration of the trip. It also tells you the cost, number of stops and the platforms (where appropriate).

V/Line Journey Planner

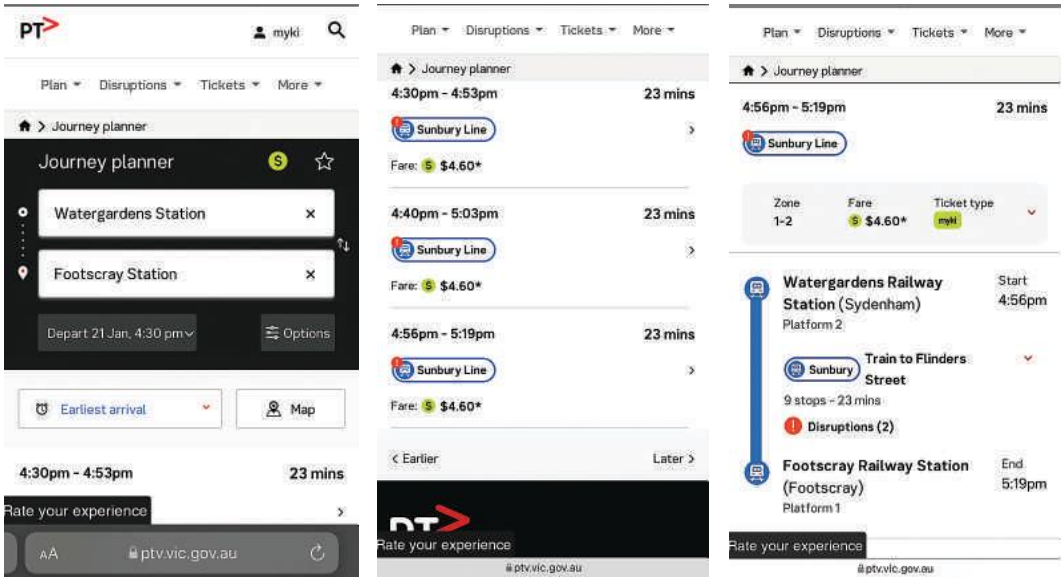
A similar set of options and information is available when you use the *V/Line Journey Planner*. Each screen shows more detail as you select the most appropriate option. The final screen tells you everything you need to know to catch the train – the departure, arrival time and duration of the trip.

V/Line's journey planners can be accessed on PCs or mobile devices.



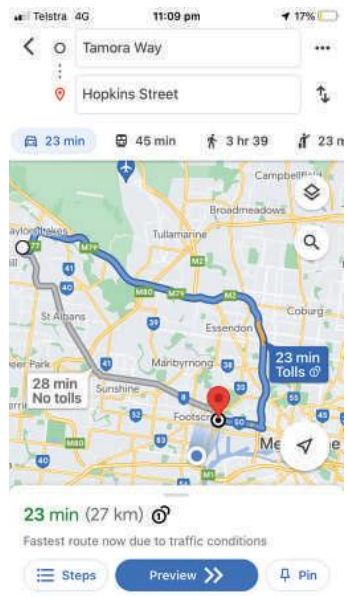
Source: V/Line website

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Source: Public Transport Victoria website

Map apps for planning routes



You can access GPS-based digital maps and related travel apps or websites on mobile devices that will assist in planning walks, rides or drives – including providing public transport options.

As we saw in the earlier section about using GPS-based digital maps, Google Maps not only shows you the information and options for driving, it also shows the options, routes and times for catching public transport, or for walking or riding your bike.

The information provided presents a number of different options.

The set of icons across the screen towards the top allow you to select the mode of transport.

On a mobile device, it also shows you the times next to each mode.



On a PC or laptop, it allows you to select the mode here:

The time for each trip is displayed underneath.

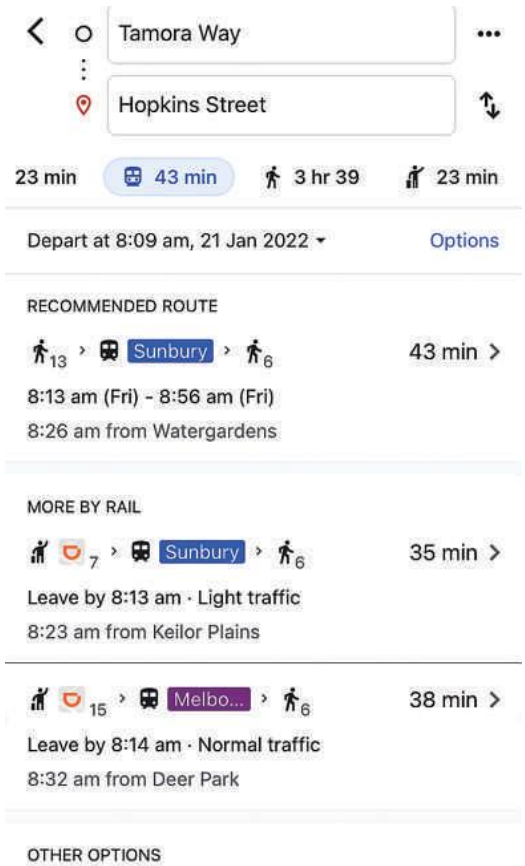


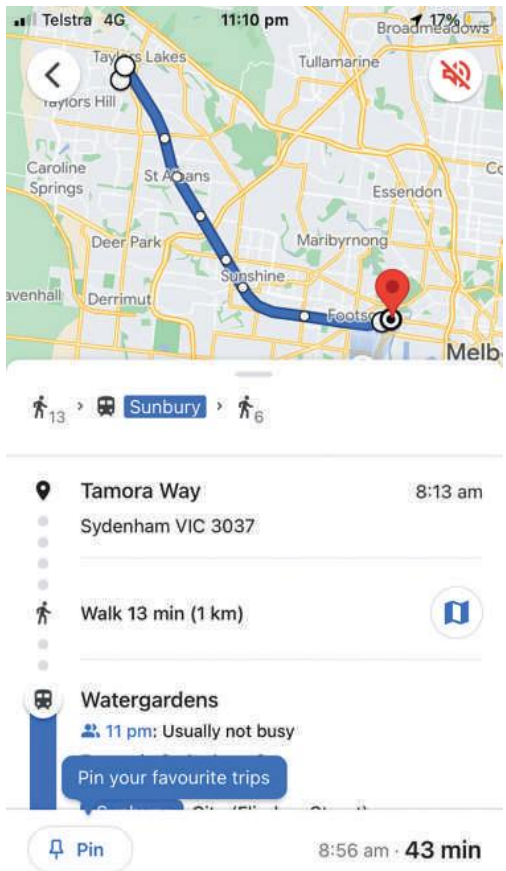
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The images below display the options for catching a train from Tamora Way near Watergardens Station to Hopkins Street near Footscray Station in the morning on a weekday. It is the same route as selected in the image above, but this time the train option has been clicked on the mobile phone screen.

Each screen shows you more detail as you select the most appropriate option. The second screen provides the information you need to know to catch that train – the departure time, arrival time and duration of the trip (you can scroll down further to see the final stages of the trip).

When you use Google Maps (or similar), the information also gives you the estimate of walking time between the different parts of the route. So, in this example, there is a 13-minute walk to get from Tamora Way to the station, and then another 6-minute walk from Footscray Station to the destination in Hopkins Street, Footscray.





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12H Tasks and questions

Thinking task

1 Taking a walk – Take 2

Previously, you did a task called **Taking a walk** where you sketched out a mud map and described a local walk from your home or school.

Find your mud map for this walk and your written directions.

Ask your teacher for permission to use your mobile phone (or borrow one or use a tablet or iPad), and use one of the free map apps (Apple Maps or Google Maps) to locate and follow the same walk, using the instructions provide by the app. Enter the same starting point and the same destination.

Compare the two sets of instructions. Think about the following questions:

a Did the app take you the same way as you went? If not, why not, and what are the differences?

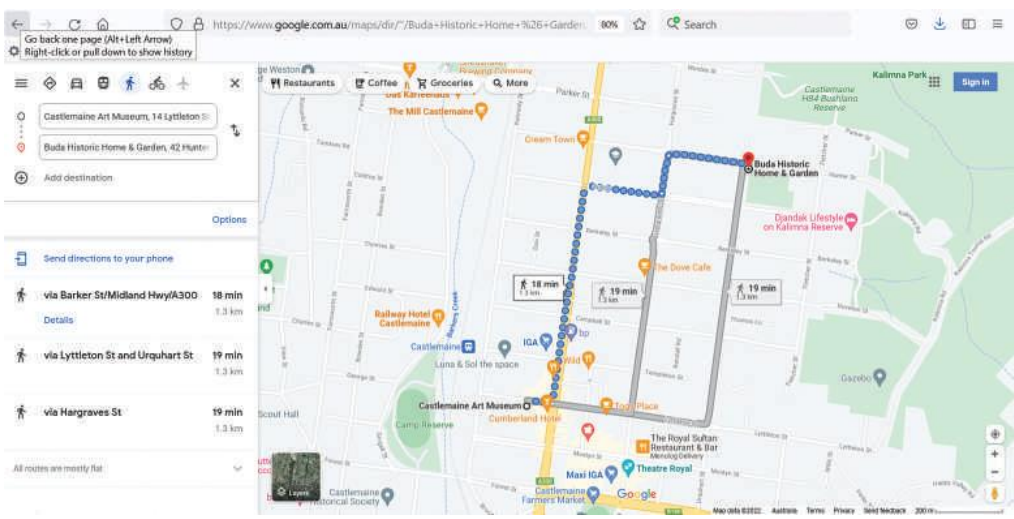
b What words and language were used for the instructions? Could you understand them all? Were there any words or terms used that you did not know?

c How did the language used by the app on your hand-held device compare with your instructions? Which was better, and why?

d Was the time taken similar or different?

Skills questions

2 Consider the following walking map in Castlemaine, and answer the following questions.



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a Walking from the Castlemaine Art Museum to the Buda Historic Home and Garden, which is the quickest route?

b Of the three routes shown, is there any difference in the distance? If not, give a possible reason why some routes may be quicker or slower than others.

c Give a fourth alternate possible route.

d For one of the routes from the Castlemaine Art Museum to the Buda Historic Home and Garden, write the directions down as if you were saying them to a friend.

3 Using the PTV Journey Planner, find out the following.

a What time does the first train after 9:00 am leave from Footscray Station to go to Watergardens Station on a Monday? How long is the train trip?

b What time does the first train after midday leave from Roxburgh Park Station to go to North Melbourne Station on a Saturday? How long is the train trip?

c What time does the first train after 5:00 pm leave from Lilydale Station to go to Richmond Station on a weekday? How long is the train trip?

4 Using the V/Line Journey Planner, find out the following.

a What time does the first train leave Bendigo Station to go to Southern Cross Station on a Sunday? How long is the train trip?

b What time does the last train leave from Traralgon Station to go to Flinders Street Station on a weekday?

c When travelling from Benalla Station to Southern Cross Station after 9:00 am on a weekday, what times do the trains depart? What times do trips involving a coach then a train depart? Where do you change from a coach to a train? How long is the total trip?

Using Google Maps on a mobile device (or laptop or PC), answer the following questions.

5 For travelling between Mildura Station and to Flinders Street Station, Melbourne:

a How many suggested options are there by car? What are the distances and times for each option?

b How many suggested options are there by public transport on a weekday (coaches and trains)? How long is each trip?

c Which trip is the quickest? How much faster is it than the second fastest route?

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6 For travelling between Wallan Station, Wallan, to Southern Cross Station, Melbourne, on a Saturday:

- **a** How many suggested options are there by car? What are the distances and times for each option?
- **b** How many suggested options are there by public transport (coaches and trains) on a Saturday? How long is each trip?
- **c** Which trip is the quickest? How much faster is it than the second fastest route?

7 Daria is planning on either walking or riding her bike from Merri Merri Park, Northcote, to Docklands Drive, Docklands, in Melbourne.

- **a** How many suggested options are there by bike? What are the distances and times for each option?
- **b** How many suggested options are there to walk? What are the distances and times for each option?
- **c** Which trip is the quickest? How much faster is it than the second fastest route?

Mathematical literacy

8 Another walk

Think about a new walk from the one you sketched out earlier – one that you could still make from your home or from school. This walk could be to a park, a shop, a friend's place, a bus stop or work.

Use a maps app on your mobile device to plan your route.

You need to plan the following and enter the information on your maps app:

- Your starting point.
- Your destination.
- Make sure you select that you are walking.
- Check the provided routes and the estimated time.
- Choose the route you want to follow.
- Hit start and follow the directions. Note the time you departed and then check your arrival time. Listen to the directions and instructions carefully.

After you have finished the walk, answer the following questions.

- **a** What words and language were used for the instructions? Could you understand them all? Were there any words or terms used that you did not know?

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b Was it easy to follow? If not, why not?

c Draw a mud map of the walk, and write out the instructions for following the route. Use your own terms and language, and don't copy the language used by your mobile device.

d How long did it take? Was the time taken similar to the original estimate provided by the app, or different?

9 A drive

Think about a longer trip you might like to make by car. Restrict it to within 150 km from home. You need to also include returning back to your stating point.

Use a maps app on a PC or laptop (or tablet if you can print from it) to plan your route in a similar way to the task above.

After you have finished planning the trip, answer the following questions.

a What was your starting point?

b What was your destination?

c What were the different routes that were offered? Write down the different distances and estimated times.

d Which route did you choose to follow and why did you choose that one?

e Did you come back to the starting point by the same route?

f Print out a copy of the map of the drive and write out the instructions for following the route, using your own terms and language.

Application tasks

10 Use the *PTV Journey Planner* to plan a shopping day in the city of Melbourne on a Sunday from Pakenham. You decide to go by train from Pakenham Station and get off the train at Melbourne Central Station, and you want to travel between 09:30 and be back in Pakenham by 17:00. Plan your travel for the day and include the following.

a Your departure time from Pakenham Station.

b Your arrival time at Melbourne Central Station.

c Your return departure time from Melbourne Central Station.

d Your arrival time back at Pakenham Station.

e How long will you spend on the train over the whole trip?

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11 Use the *PTV Journey Planner* to plan a trip from Carnegie/Truganini Rd (Stop #68 on the Route 67 tram) to Flinders Street Station on the corner of Flinders Street and Swanston Street. You have an appointment at Federation Square opposite Flinders Street Station at 11:30 am. You live very close to the tram stop. You plan on having lunch in Federation Square afterwards. Plan your travel into the city and include the following.

- Your departure time from Stop #68 on Route 67.
- Your arrival time at the corner of Flinders Street and Swanston Street.
- Your return departure time from the corner of Flinders Street and Swanston Street.
- Your arrival time back at Stop #68 on Route 67.
- How long will you spend on public transport over the whole trip?
- Did your trip include both tram and train travel? If so, can you work out your itinerary for doing the trip by going all the way there and back on Route 67?

12 Maria lives in Maryborough and needs to regularly travel to Ballarat to visit family and friends. Use the *V/Line Journey Planner* to decide on the best public transport route that meets the following requirements.

a Maria prefers to travel on weekdays.

b Maria prefers not to catch a train before 7:30 am and wants to be back in Maryborough by 5:00 pm.

c She does not want either trip to take more than 90 minutes each.

d She wants to have at least 2 hours in Ballarat.



e What times can she catch a coach or train in order to spend the day in Ballarat? Give her departure and arrival times and the durations of each trip from Maryborough to Ballarat and return.

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13 Taro needs to go from Port Fairy to Geelong to work for two days near the centre of Geelong. He must travel up to Geelong on Wednesday morning to be there for the first meeting at 10:00 am and travel back on Thursday evening after he finishes work at 4:00 pm. Use the *V/Line Journey Planner* to find out what his public transport options are to get from Port Fairy to Geelong. Write up the following information.

- **a** What options are available that suit his requirements?
- **b** Write up his itinerary with his departure and arrival times.
- **c** How long will he spend on public transport over the two days?

14 Use Google Maps or an alternative digital map application and the *V/Line Journey Planner* to compare the travel times that are suggested by car, coach and train to get from Maryborough to Bendigo (take the train stations in both places as the starting and finishing points). Write up the following information in your comparison.

- **a** How many times during a weekday are there different coach and train options suggested by the *V/Line Journey Planner*?
- **b** What is the difference in travel time between the V/Line coach and driving by car?
- **c** Which method of travel would you choose to use, and why?

15 Use the *V/Line Journey Planner* to compare the travel modes and travel times that are suggested by coach and train to get from Southern Cross Station to Echuca. There should be at least four different ways to travel – via coach or train and via different towns. Write up the following information in your comparison.

- **a** How many times during a weekday are there different options suggested by the *V/Line Journey Planner*?
- **b** Document the different routes that are suggested and show these on a map – this could be a rough mud map.
- **c** What is the difference in travel times for each route?
- **d** Estimate the average speeds of travel for each method of travel. Show how you worked each one out.
- **e** Which method of travel would you choose to use, and why?

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16 Daria is a food delivery person who rides a motorbike for her deliveries around Geelong. Use Google Maps or an alternative digital map app to work out the best way for Daria to make two food deliveries from the same restaurant.

The details of the job are as follows.

- The restaurant is in Downes Lane, Geelong.
- One delivery is to Roger Street in Belmont.
- The other delivery is to Ella Close in Newtown.
- Daria can choose which order to deliver first.

Write up your decision about the route to follow including the following information.

a How many different routes were available – including for swapping the order in which Daria delivered the food?

b What was the difference in travel times?

c What was the difference in distances travelled?

d Which route would you choose to use, and why?

e Include a sketch map or a printout of the map routes.

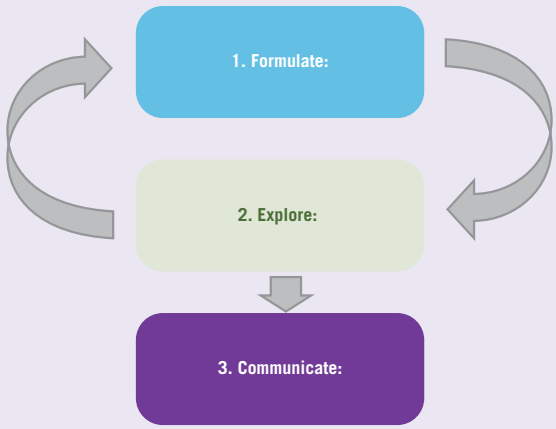


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Investigations

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 A day trip

In this investigation, plan a trip and write up an itinerary for a trip from your home to a destination that you can access easily by public transport.

Your trip needs to meet the following requirements.

- It needs to be between the hours of 8:00 am and 6:30 pm.
- The minimum time you should plan to be away from home is 5 hours.
- It needs to include the use of at least one form of public transport.
- You need to plan for breaks and meals.
- You can use car travel as part of your trip if you need to get to and from home by car to your mode of public transport.

Your itinerary needs to include the following aspects. (Remember the problem-solving cycle of Formulate, Explore and Communicate.)

- What your destination is, why you chose this destination, and what you will be doing.
- Your modes of transport for the journey.

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- Your times for each part of the journey and the location of each of the starting points, starting from and ending back at your home.
- The timetable and schedule for the public transport you use and your method for accessing the timetables (for example, via a transport app or a printed timetable).
- A map (which can be a mud map) of your trip. The map should indicate directions and distances.
- The approximate costs for the trip.
- The time you will spend travelling and the time you will be undertaking your visit or activity.

2 Taking a walk or ride

Your task is to create a detailed plan of a walk or bike ride of between 2 and 4 hours' duration.

a Explain where you are going, and why you chose this journey.

b Create a map of this journey that includes a compass, direction of travel, and a scale.

c Indicate where you will take rest breaks, and the actual distances between these.

d Research the average walking and riding distances per hour.

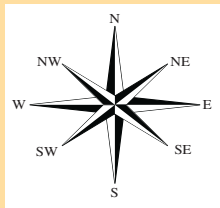
e Use these averages, and the terrain, to estimate how long this journey is in both distance and time.

f Test your detailed plan by sharing it with your classmates. Do they end up where you intended?



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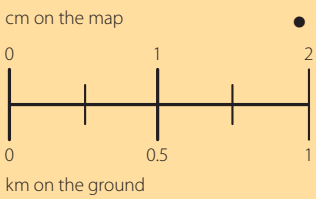
Key concepts



- **Compasses** have four main directions: **North, South, East** and **West**. We call the directions halfway between these **North East (NE), South East (SE), South West (SW)** and **North West (NW)**
- **Grid references** can be useful when interpreting local maps. One axis of the map has letters, and the other has numbers. This allows us to pinpoint particular squares (e.g. C1).

	A	B	C
1	A1	B1	C1
2	A2	B2	C2
3	A3	B3	C3

- We can calculate speed, distance and time.
  - **Speed** is how fast you travel. It calculated by dividing the distance by the time. $s = \frac{d}{t}$
  - **Distance** is how far you travel. Distance is calculated by multiplying the speed by the time. $d = s \times t$
  - **Time** is how long you travel. Time is calculated by dividing the distance by the speed. $t = \frac{d}{s}$
- The **scale** translates the lengths on the map to real-world distances. tells you what the real distance is for a specific length or unit on the map.



- Scales can be represented as ratios. For instance, the scale on the left can be represented as the ratio 1:50 000, since 1 cm on the map is equivalent to 0.5 km = 50 000 cm in real life.
- We can calculate **travel times** using a "counting on" strategy. If you're trying to calculate what the time will be in so many hours and so many minutes, start by adding the whole hours first to the current time, then the minutes.
- To read a **public transport** timetable, recall that the first column has a list of the stations or stops. As you read along the row, you can see the departure times from that location. As you read along the column, you see the departure times from each place for a particular journey.
- Digital maps and apps can be very useful for planning your journey.

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Chapter 12 review questions

☐ I can use map directions.

1 Use the internet to find a map of the central business district (CBD) of Melbourne.

- **i** State the compass direction of one landmark in relation to another. Use general terms and directions, such as South-East.
- **ii** Give written directions to get from one landmark to the other.
  - **a** The State Library is _____ of Flinders Street Station.
  - **b** The Melbourne Cricket Ground (MCG) is _____ of the Immigration Museum.
  - **c** The Atheneum theatre is _____ of Treasury Gardens.
  - **d** Flagstaff Gardens is _____ of Parliament Station.
  - **e** Melbourne Central is _____ of Southgate.
  - **f** Federation Square is _____ of Southern Cross Station.
  - **g** Docklands Stadium is _____ of the Royal Botanic Gardens.
  - **h** The Royal Children's Hospital is _____ of Parliament Station.

2 Using the same map, pick four different landmarks and describe where each landmark is in relation to Flinders Street Station, using compass directions.

☐ I can read map scales and grid references.

3 Source a map online and use the scale to find out the actual distances between the following places.

- **a** Melbourne CBD to Warragul
- **b** Warragul to Orbost
- **c** Shepparton to Echuca
- **d** Nhill to Warracknabeal
- **e** Heyward to Warrnambool
- **f** Port Campbell to Ballarat
- **g** Wangaratta to Wodonga

☐ I can use a mobile map app.

4 Using a web or app-based map, find the directions from your school to the places shown below, and complete the following tasks.

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i Write the directions out as if you were telling a friend how to get there.
ii Note down the time the app says it will take by car.
iii Note down the time the app says it will take by public transport.
iv Note down the time the app says it will take to walk.
v Note down the distance of the route.
  a The local sports oval
  b The nearest beach
  c The nearest mountain
  d The nearest lake
  e The nearest train station
  f The nearest public swimming pool
  g The nearest fire station
  h The nearest hospital

☐ I can calculate speed, time and distance using the formula.

5 Calculate the following times. Give your answers in hours and minutes.
  a How long it would take a person to travel 18 km at an average speed of 80 km/h.
  b How long it would take a car to travel 25 km at an average speed of 90 km/h.
  c How long it would take a plane to travel 150 km at an average speed of 100 km/h.

6 Calculate the following distances. Give your answers in kilometres (km) correct to one decimal place.
  a How far someone could drive in 2 hours at an average speed of 80 km/h.
  b How far someone could drive in 10 minutes at an average speed of 50 km/h.
  c How far someone could drive in 1 hours 50 minutes at an average speed of 100 km/h.

7 Calculate the following average speeds in m/s (give your answer correct to one decimal place).
  a A car that travels 95 km in 60 mins.
  b A car that travels 9000 m in 10 mins.
  c A car that travels 45 000 m in 40 mins.

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I can read timetables for travel.

8 Look at the bus timetable from Southern Cross Station to Wonthaggi and answer the following questions.

Cowes, Inverloch

Effective 13/02/2022

Melbourne to Inverloch/Cowes via Dandenong and Koo Wee Rup

		Monday to Friday											
Service		METRO	COACH	METRO	COACH	METRO	COACH	METRO	COACH	METRO	COACH	METRO	COACH
Service Information			♿		♿		♿		♿		♿		♿
SOUTHERN CROSS	*dep*	05.23	06.16	08.17	09.02	09.58	10.50	12.12	12.57	13.42	14.25	16.35	16.40
Flinders Street		05.36	–	08.23	–	10.08	–	12.21	–	13.51	–	16.41	–
Caulfield		05.50	–	08.38	–	10.23	–	12.37	–	14.07	–	16.56	–
DANDENONG	*arr*	06.18	–	09.07	–	10.52	–	13.06	–	14.36	–	17.26	–
Change Service		COACH		COACH		COACH		COACH		COACH		COACH	
Service Information		♿		♿		♿		♿		♿		♿	
DANDENONG	*dep*	06.25	–	09.18	–	11.07	–	13.18	–	14.44	–	17.31	–
Cranbourne (1)		06.48u	–	09.41u	–	11.30u	–	13.41u	–	15.29u	–	17.54u	–
Cranbourne (2)		06.52u	–	09.46u	–	11.34u	–	13.46u	–	15.33u	–	17.59u	–
Five Ways		06.57u	–	09.51u	–	11.39u	–	13.51u	–	15.38u	–	18.04u	–
Tooradin		07.04	–	09.57	–	11.46	–	13.57	–	15.45	–	18.10	–
KOO WEE RUP	*arr*	07.13	07.13	10.07	10.07	11.55	11.55	14.07	14.07	15.55	15.55	18.20	18.20
Change Service			COACH		COACH		COACH		COACH		COACH		COACH
Service Information			♿		♿		♿		♿		♿		♿
KOO WEE RUP	*dep*	07.18	07.18	10.12	10.12	12.00	12.00	14.12	14.12	16.00	16.00	18.25	18.25
Lang Lang		07.28	07.28	10.22	10.22	12.10	12.10	14.22	14.22	16.10	16.10	18.35	18.35
Jam Jerrup		07.35	07.35	10.29	10.29	12.17	12.17	14.29	14.29	16.17	16.17	18.42	18.42
The Gurdies		07.39	07.39	10.33	10.33	12.21	12.21	14.33	14.33	16.21	16.21	18.46	18.46
Pioneer Bay		07.41	07.41	10.35	10.35	12.23	12.23	14.35	14.35	16.23	16.23	18.48	18.48
Deep Creek Street		–	–	10.37	10.37	–	–	14.37	14.37	–	–	18.50	18.50
Grantville		07.47	07.47	10.41	10.41	12.29	12.29	14.41	14.41	16.29	16.29	18.54	18.54
Queensferry Road		07.49	07.49	10.43	10.43	12.31	12.31	14.43	14.43	16.31	16.31	18.56	18.56
Corinella Turn Off		07.51	07.51	10.45	10.45	12.33	12.33	14.45	14.45	16.33	16.33	18.58	18.58
Bass		07.58	07.58	10.52	10.52	12.40	12.40	14.52	14.52	16.40	16.40	19.05	19.05
ANDERSON	*arr*	08.04	08.04	10.58	10.58	12.46	12.46	14.58	14.58	16.46	16.46	19.11	19.11
ANDERSON	*dep*	08.09	08.09	10.58	10.58	12.46	12.46	14.58	14.58	16.46	16.46	19.11	19.11
Kilcunda		–	–	11.02	11.02	–	–	15.02	15.02	–	–	19.15	19.15
Dalyston		–	–	11.07	11.07	–	–	15.07	15.07	–	–	19.20	19.20
Dudley		–	–	11.12	11.12	–	–	15.12	15.12	–	–	19.25	19.25
Wonthaggi North		–	–	11.13	11.13	–	–	15.13	15.13	–	–	19.26	19.26
WONTHAGGI	*arr*	–	–	11.15	11.15	–	–	15.15	15.15	–	–	19.28	19.28
WONTHAGGI	*dep*	–	–	11.17	11.17	–	–	15.17	15.17	–	–	19.30	19.30
Cape Paterson		–	–	–	–	–	–	–	–	–	–	19.38	19.38
Inverloch (2)		–	–	11.31	11.31	–	–	15.31	15.31	–	–	19.56	19.56
Inverloch (1)		–	–	11.32	11.32	–	–	15.32	15.32	–	–	19.57	19.57
San Remo		08.19	08.19			12.56	12.56			16.56	16.56		
Newhaven Turn Off		08.24	08.24			12.58	12.58			16.58	16.58		
Cape Woolamai		08.26	08.26			13.03	13.03			17.00	17.00		
Surf Beach		08.29	08.29			13.06	13.06			17.03	17.03		
Rhyll Turn Off		08.30	08.30			13.07	13.07			17.04	17.04		
Sunset Strip		08.33	08.33			13.10	13.10			17.08	17.08		
Smiths Beach		08.34	08.34			13.11	13.11			17.09	17.09		
Wimbeldon Heights		08.38	08.38			13.15	13.15			17.13	17.13		
Cowes (2)		08.41	08.41			13.18	13.18			17.18	17.18		
COWES TRANSIT CENTRE	*arr*	08.46	08.46			13.23	13.23			17.23	17.23		

Source V/Line website

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a How long does it take to travel between Southern Cross Station and Koo Wee Rup, leaving on the first service of the day?

b Leaving at 12.00 pm from Koo Wee Rup, what time does the bus get into San Remo?

c Leaving at 10:45 am from the Corinella turn-off, what time does the bus get into Inverloch (2)?

d How long does it take to travel between Southern Cross Station and Inverloch, leaving on the last service of the day?

e Which is the quickest bus to take from Southern Cross Station to Koo Wee Rup?

f If you need to be in Cowes at 3:00 pm, which bus should you take from Southern Cross Station?

g Using an online map, determine the distance from Southern Cross Station to Cowes.



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Key vocabulary

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

Term	Meaning
Adjacent	Next to each other.
Anticlockwise	The opposite direction to the way the hands of a clock move.
As the crow flies	The distance measured in a straight line – the shortest path between two points.
Behind	In or to a place at the back of, or to the rear of, something or someone.
Between	In or along the space separating two objects or regions.
Bird's-eye view	A bird's-eye view is a view from a high angle as if seen by a bird in flight.
Clockwise	Moving in the direction of the hands on a clock.
Compass	An instrument that shows us direction (such as North, South, East and West) by a small magnetic needle that points North/South.
Departure point	The place where you are leaving from.
Destination	The place where someone is going, or where something is being sent or taken.
Direction	The line or course on which something is going – where something is pointing. The main compass directions are North, South, East and West. (The exception is wind direction, where a North wind is coming *from* the North.)
East	Situated in or facing or moving toward the East – the direction where the sun rises in the morning – opposite to West.
ETA	Estimated Time of Arrival.
GPS	Global Positioning System.
Grid reference	A number of horizontal and vertical lines which form a set of **grid squares** over a map. These provide a numerical grid reference for places on the map.
In front	In a position just ahead of or at the front part of someone or something else.

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Term	Meaning
Itinerary	A detailed travel plan for a trip or route which details where you will go and when you will be there.
Key	The key or legend on a map tells you where the main places of interest are located, for example, toilets or bus stops.
Left	The left-hand part, side or direction.
Legend	See *Key*
Location	The place or position where something is or where something is occurring.
Map	A diagram of a place or geographical area, showing features like roads, rivers and cities.
Mud map	A roughly drawn map (Australian term based on the idea of a map drawn on the ground.)
North	Situated in or facing or moving toward the North. The direction of the North Pole from any other point on the Earth's surface.
Opposite	In a position facing someone or something, on the other or further side.
Ratio	A comparison between two variables, using a colon ':', for example, if a class has 12 female and 10 male students, the ratio of females : males is 12 : 10, which simplifies to 6 : 5.
Right	The right-hand part, side or direction.
Scale	The ratio of the length in a drawing (or model) to the length of the real thing.
South	Situated in or facing or moving toward the South. The direction of the South Pole from any other point on the Earth's surface.
Speed	How fast something is moving, measured as distance travelled per unit of time, such as km/h or m/s.
West	Situated in or facing or moving toward the West. The direction where the sun sets in the evening that is opposite to East.

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Answers

Chapter 1

1B Practice questions

1 Answers will vary
2 Answers will vary
3 Answers will vary
4 Answers will vary
5 Answers will vary

1C Tasks and questions

1 Answers will vary
2 Answers will vary
3 Answers will vary
4 a Addition
b Counting
c Problem solving
d Ratios
e Budgeting
f Problem solving
g Problem solving
5 Answers will vary

1D Tasks and questions

1 Answers will vary
2 a i One of the tyres has been popped.
ii Pulling over and changing the tyre to a spare.
iii Then, there will be four functioning tyres.
b i Without fuel, the car will not drive.
ii Fill up the car with fuel.
iii Now that the car has fuel, you can drive it.
c i You cannot get home via Uber or train.
ii Call a friend or taxi, asking if they can help.
iii Now you have a way home.
d i The safety switch for the power box has flipped.
ii First turn off all devices, then go flip the switch back on.
iii This safely allows you to restart the power.
e i You aren't available to work on such short notice.
ii Inform your boss that you've already made plans and won't be available.
iii Telling the truth, and being upfront avoids any further issues down the line.
f i You have an infestation of bugs in your pantry.
ii Clean out the entire pantry.
iii You no longer have bugs in your pantry.
g i Your parcel has gone missing during the delivery process.
ii Contact the seller to ensure the parcel is shipped, then the postage company.
iii Find where the issue lies first, then have it sorted with whomever was responsible.
3 Answers will vary
4 a Divide the total by four
b Bank apps and calculator app
c Bank apps to transfer money to the person paying
d Ask the friend paying
e The friends bank will notify him, or you can provide evidence
f

Formulate the problem	Explore solutions	Communicate the solution
Question b, Question d, Question e	Question a, Question c, Answer b, Answer d, Answer e	Answer a, Answer c

5 Answers will vary

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1E Tasks and questions

1 **a** 12 **b** No
c A, B, C, D, E
d No. For additional content.
e Answers will vary
2 Answers will vary
3 **a** Between 0°C and 4°C
b Between 30 and 60 minutes
c Procedure ID 5-09-17
d Weight of the 7 slices added together
e Total weight is between 100 g and 105 g
f The scales are within 0.00 1kg = 1 g of the true weight
4 Answers will vary
5 Answers will vary

Chapter review questions

1 Answers will vary
2 Answers will vary
3 **a** Correct **b** Correct
c Incorrect **d** Correct
e Incorrect **f** Correct
4 **a** Less **b** Plus
c Take away **d** Extra
5 Answers will vary

Chapter 2

2A Practice question

1 Answers will vary

2B Practice questions

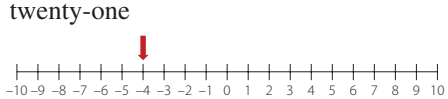
1 **a** The saving is 50c, not $1.
b There is no discount when buying 4 since 4 × $3 = $12.
c 10% of the retail price is $59.9, not $160.89.
d The percentages don't add up to 100%.
e The discount cannot be more than 100%.
f The old price is lower than the new price.

2C Tasks and questions

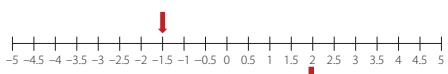
1 Answers will vary

2 **a** $\frac{1}{2}$ **b** $\frac{1}{4}$
c $\frac{2}{4}$ **d** $\frac{1}{3}$
e $\frac{2}{3}$ **f** $\frac{3}{4}$
g $\frac{1}{5}$ **h** $\frac{3}{5}$

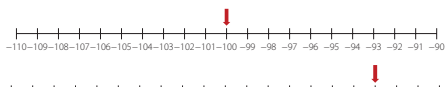
3 **a** 12345899 **b** 99854321
c 99854321, 99854312, 99853421, 99584321, 98954321
d Ninety-nine million eight hundred and fifty-four thousand three hundred twenty-one,
Ninety-nine million eight hundred and fifty-four thousand three hundred twelve,
Ninety-nine million eight hundred and fifty-three thousand four hundred twenty-one,
Ninety-nine million five hundred and eighty-four thousand three hundred twenty-one,
Ninety-eight million nine hundred and fifty-four thousand three hundred twenty-one

4 **a**


b


c


d


e


f


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5 Answers will vary

6 90 mph, 145 km/h, 1.6 km, 397 feet, 121 meters, 18%, 16 curves, 80 mph, 129 km/h, 1.6 km, 2018, 0.026 seconds, five, four, 2022

2D Tasks and questions

1 Answers will vary

2 a Six hundred and fifty-seven
b Eight hundred thousand seven hundred and twenty-three
c Five hundred and seventy-six thousand and two
d Three million five hundred and seventy-six thousand nine hundred and twelve
e Fifty-six million three hundred and seventy-six thousand two hundred and thirteen
f Nine hundred and eighty-seven million four hundred and fifty-five thousand three hundred and twenty-two

3 a One point five
b Six point seven five
c Nine point three two
d Eight point nine three five
e One thousand ninety-nine dollars and thirty-four cents
f Six hundred seventy-five dollars and forty-two cents

4

1,000s	100s	10s	1s	•	$\frac{1}{10}$ ths	$\frac{1}{100}$ ths	Number in words
	1	4	5	•	7		one hundred and forty-five point seven
5	7	8	2	•	6	1	five thousand, seven hundred and eighty-two and sixty-one hundredths
	2	5	7	•	7	5	two hundred and fifty-seven and seventy-five hundredths
	7	3	1	•	5	8	seven hundred and thirty-one point five eight
9	3	7	3	•	9	9	nine thousand, three hundred and seventy-three and ninety-nine hundredths
7	4	2	6	•	5		seven thousand, four hundred and twenty-six and five tenths
4	3	4	5	•	6	7	four thousand, three hundred and forty-five and sixty-seven hundredths
9	0	4	0	•	8	7	nine thousand and forty point eight seven
2	2	1	2	•	0	5	two thousand, two hundred and twelve and five hundredths

5 a 24.5 b 5.049

6 Answers will vary

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2E Tasks and questions

1 Answers will vary

2

Fraction	As a fraction out of 10 or 100	As a decimal	As a percentage
$\frac{1}{2}$	5 out of 10 $= \frac{5}{10}$ or 50 out of 100 $= \frac{50}{100}$	0.5	50%
$\frac{1}{4}$	25 out of 100 $= \frac{25}{100}$	0.25	25%
$\frac{3}{4}$	75 out of 100 $= \frac{75}{100}$	0.75	75%
$\frac{1}{5}$	2 out of 10 $= \frac{2}{10}$ or 20 out of 100 $= \frac{20}{100}$	0.2	20%
$\frac{1}{10}$	1 out of 10 $= \frac{1}{10}$ or 10 out of 100 $= \frac{10}{100}$	0.1	10%
$\frac{2}{5}$	4 out of 10 $= \frac{4}{10}$ or 40 out of 100 $= \frac{40}{100}$	0.4	40%
$\frac{3}{10}$	3 out of 10 $= \frac{3}{10}$ or 30 out of 100 $= \frac{30}{100}$	0.3	30%
$\frac{7}{10}$	7 out of 10 $= \frac{7}{10}$ or 70 out of 100 $= \frac{70}{100}$	0.7	70%

3 Answers will vary

4 **a** Blue: $\frac{7}{10}$, purple: $\frac{1}{2}$, red: $\frac{1}{5}$

b Blue and purple

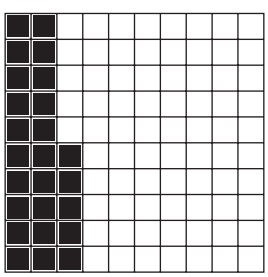
5 **a** $\frac{2}{5}$, 0.4, 40%

b $\frac{3}{8}$, 0.375, 37.5%

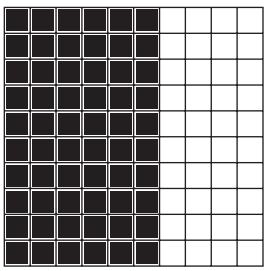
c $\frac{4}{6}$, 0.667, 66.7% to 3 decimal places

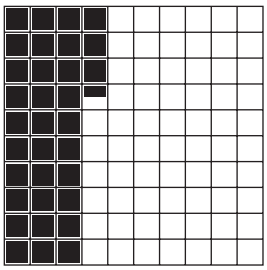
d $\frac{4}{5}$, 0.8, 80%

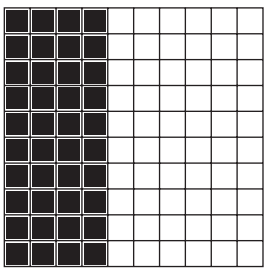
6

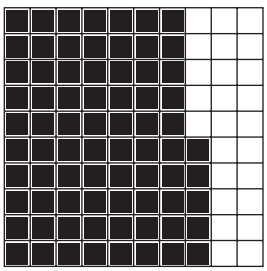
a  $\frac{1}{4}$, 0.25

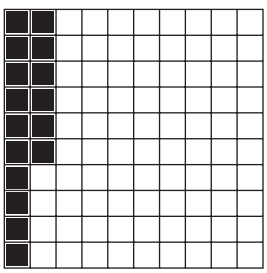
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b  $\frac{6}{10}, 0.6$

c  $\frac{3333}{10000}, 0.3333$

d  $\frac{2}{5}, 0.4$

e  $\frac{3}{4}, 0.75$

f  $\frac{4}{25}, 0.16$

7 a Sun Sep 26, Mon Sep 27, Wed Sep 22, Sat Sep 25, Thu Sep 23, Tue Sep 21, Fri Sep 24

b Fri Sep 24

c Sat Sep 25

d Sat Sep 25

8 a 48% were born overseas.
45% identified as female, 47% as male and 8% as non-binary.
40% were younger than 21, 45% were aged over 21 and 15% were older than 50.
65% had completed Year 12 and 35% had a university degree.
26% of them do not have a job.

b Answers will vary

2F Tasks and questions

Possible answers include:

1 (5 + 5) × 10 – 17, (200 ÷ 4) + (40 – 7), (5 × (86 + 80)) ÷ 10, (15 × 12) + 3 – 100, (40 – 6.8) ÷ 4 × 10

2

Mathematical operation	Spreadsheet symbol or term	Excel formula	Solution
Addition	+	=819+327	1146
Subtraction	–	=1902–785	1117
Multiplication	*	=323*5	1615
Division	/	=774/43	18
Square	^	=12^2	144
Square Root	Sqrt	=SQRT (196)	14
Powers or Exponents	^	=8^3	512
Brackets	()	=(14+31)/3	15

3 Answers will vary

4 a $31 and operation i

b $45 and operation iii

c Answers will vary

d Answers will vary

e Answers will vary

f Answers will vary

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Chapter review questions

1 a 3659, 03 5792 2155
b 400, 231

2 a $\frac{1}{2}$ b $\frac{1}{4}$
c $\frac{1}{3}$ d $\frac{1}{5}$
e $\frac{3}{5}$ f $\frac{2}{3}$

3 a 1.5 b 5.75
c 6.75 d 823.4
e 0.4 f 1.75

4 Student answers will vary

5 Student answers will vary

6 a Twenty-three dollars
b Sixty-three dollars and ninety-nine cents
c Two hundred and eighty-nine thousand, seven hundred and sixty-five
d Three hundred and sixty-seven thousand, eight hundred and ninety-nine dollars
e Five hundred and sixty-seven million, six hundred and fifty-four thousand, two hundred and thirty-two
f One hundred and ninety-eight million, five hundred and forty-six thousand, seven hundred and eighty-nine
g One million, two thousand, nine hundred and eighty-nine dollars
h Nine hundred and twenty-five thousand dollars
i Six hundred and seventy-five thousand dollars

7 a 0.5 b $0.\overline{3}$
c 0.75 d 0.2
e 0.8 f 0.1

8 a $\frac{1}{4}$ b $\frac{1}{2}$
c $\frac{3}{4}$ d $\frac{2}{3}$
e $\frac{1}{5}$ f $\frac{2}{5}$
g $\frac{3}{5}$

9 a Four dollars per kilogram
b Kilometres per hour
c Metres per second
d Litres per kilometre

10 a 33 b 189
c 13 d 13
e 64 f 12

11 a 65 b 109
c 73 d 135
e 32

Chapter 3

3A Starting activities

Answers will vary

3B Practice questions

1 A

2 1.35 mL

3 Answers will vary

4 a About three times faster
b Answers will vary

3C Tasks and questions

1 Answers will vary

2 No, this is too high. The unit price is closest to $1.67.

3 This is too low, he should be having 600 g.

4 This is a fair estimate. The range is $570-$665.

5 Answers will vary

6 a $12 b $129
c $223 d $77
e $785 f $2343

7 a $56.17
b $128.86
c $221.46
d $7.21
e $874.77
f $1333.20

8 a 34.56 b 123.2 c 0.034

9 a 0.00003 b 0.0003
c 0.000054

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10 **a** $4.10
b $9.85
c $35.50
d $43.20
e $234.75
f $333.20

11 **a** $160 **b** $40

12 Answers will vary

13

Employee	Personal Income	Rounded Income
JD	$23 654.98	$23 655
MB	$78 345.23	$78 345
FT	$102 456.38	$102 456
RC	$99 456.54	$99 457

14

Element	Atomic Weight	Rounded Value
Aluminium	26.981538	27.0
Bromine	79.904	79.9
Chlorine	35.453	35.5
Oxygen	15.9994	16.0
Potassium	39.0983	39.1
Silicon	28.0855	28.1
Zinc	65.39	65.4

3D Tasks and questions

1 20% would be taking a 5th or dividing by 5. 5% would be taking a 20th, dividing by 20.

2 **a** $18.30 **b** $6.80

3

Shelf	Timber Length (m)	Quantity	Total Length (m)
1	12.5	24	300
2	15	13	195
3	18.5	8	148

4 5.33 m = 5 m and 33 cm

5 1.875 km = 1 km and 875 m

6 $95 550

7 The word ‘percent’ is derived from the Latin word ‘Centum’ meaning 100. That is, per-100.

8 Answers will vary

9 Answers will vary

10

TIME (days)	FIXED growth per day	PERCENTAGE growth per day
start	5000	5000
1	5500	5500
2	6000	6050
3	6500	6655
4	7000	7321
5	7500	8053

3E Tasks and questions

1 Answers will vary

2 **a** 8
b 5
c 40
d 68
e 31

3 **a** 53 and 80 respectively, yes
b 1 and 8 respectively, yes
c 3 and 7 respectively, yes
d 23 and 23 respectively, no
e 27 and 27 respectively, no
f 19 and 27 respectively, yes

4 Answers will vary

5 Answers will vary

3F Tasks and questions

1 Answers will vary

2 **a** 4 **b** 7
c 11 **d** 3

3 **a** 1 mL **b** 400 mL
c 10 balls **d** 4 kg
e 5 L **f** 1 tonne

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4 **a** $\frac{1}{4}$ and $\frac{3}{4}$ **b** $\frac{2}{7}$ and $\frac{5}{7}$
c $\frac{7}{8}$ and $\frac{1}{8}$ **d** $\frac{2}{5}$ and $\frac{3}{5}$
e $\frac{5}{7}$ and $\frac{2}{7}$ **f** $\frac{1}{6}$ and $\frac{5}{6}$

5 **a** 6 lawns/day **b** 100 km/h
c 50 km/h **d** 120 rolls/hr
e 10 potatoes/kg **f** $16/hr
g $1.20/L **h** 125 sausages/hr
i Answers will vary

6 Answers will vary

7 **a** $0.90 per kg **b** $22.67 per kg

8 **a** 2 kg for $6.30 **b** 250 mL for $4.40
c 250 mL for $5.25

9 **a** 7 kg **b** 3.5 kg
c 8 kg crushed rocks + 4 kg sand + 2 kg cement
d 12 kg crushed rocks + 6 kg sand + 3 kg cement
e 1.829 kg crushed rocks + 0.914 kg sand + 0.457 kg cement

10 **a** 1kg dried chickpeas
4 tbsp bicarbonate of soda
1 cup tahini
2 large lemons, juiced
4 garlic cloves
4 tsp salt
2 tsp ground cumin
2 tbsp extra virgin olive oil
2 tsp paprika
1 cup finely chopped flat-leaf parsley

b 250g dried chickpeas
1 tbsp bicarbonate of soda
$\frac{1}{4}$ cup tahini
$\frac{1}{2}$ large lemon, juiced
1 garlic clove
1 tsp salt
$\frac{1}{2}$ tsp ground cumin
$\frac{1}{2}$ tbsp extra virgin olive oil
$\frac{1}{2}$ tsp paprika
$\frac{1}{4}$ cup finely chopped flat-leaf parsley

c 1.25kg dried chickpeas
5 tbsp bicarbonate of soda
$1\frac{1}{4}$ cup tahini
$2\frac{1}{2}$ large lemons, juiced
5 garlic cloves
5 tsp salt
$2\frac{1}{2}$ tsp ground cumin
$2\frac{1}{2}$ tbsp extra virgin olive oil
$2\frac{1}{2}$ tsp paprika
$1\frac{1}{4}$ cup finely chopped flat-leaf parsley

11 11 mL of antiseptic

12 45 minutes

3G Tasks and questions

1 Answers will vary. It is understood that Google derived its name from the word 'googol', a term reportedly named by the then nine-year-old Milton Sirotta, nephew of the American mathematician Edward Kasner. A googol is ten to the power of one hundred.

2

Full number	Power of 10 notation
4 300	4.3×10^3
430 000	4.3×10^5
5 146 000	5.146×10^6
26 600 000	2.66×10^7
8 031 800 000	8.0318×10^9
602 200 000 000 000 000 000 000	6.022×10^{23}

3 **a** 32 **b** 0.00032
c $0.00032 = 2^5 \times 10^{-5}$
d 1 000 000 **e** 1.96715135729

4 Cubed and tesseracted

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Chapter review questions

1 **a** $23 567 **b** $655
c $356.78 **d** $20.55
e $15.70 **f** $235.25
2 32.45
3 0.000005
4 $289
5 No. At most it will cost 8 × 0.7 = $5.60. And this is without any discounts.
6 **a** $23.50 **b** $18
7 $7 500
8 600 m^2
9 $1.20 each
10 **a** 40 **b** 11 **c** 4
11 (14 – 12) ÷ 2
12 **a** 600 g flour + 200 g lemonade + 200 g cream
b $\frac{3}{5}$, $\frac{1}{5}$ and $\frac{1}{5}$ of the whole amount
13 312.5 rolls/hour
14 125
15 3.3473×10^8 km
16 602 252 000 000 000 000 000 000
17 **a** $1 500 000 **b** $1 000 000
18 **a** $438.75
b

Item	RRP (Recommended retail price)	Number of items	Total value
Asics Gel 7 Running Shoe	$79.99	22	$1759.78
Mizuno Wave Netball Shoe	$189.99	5	$949.95
Adidas Men's Grand Court	$120	18	$2160
Nike Zoom Waffle Shoes	$99.99	2	$199.98

c

Item	RRP (Recommended retail price)	10% of RRP	Sale Price
Asics Gel 7 Running Shoe	$79.99	$8	$71.99
Mizuno Wave Netball Shoe	$189.99	$19	$170.99
Adidas Men's Grand Court	$120	$12	$108
Nike Zoom Waffle Shoes	$99.99	$10	$89.99

d 454.55 mL of cleaning fluid concentrate

Chapter 4

4A Starting activities

Answers will vary

4B Practice questions

1 **a** 6 cups
b 8 cups
2 **a** 19 cakes
b 24 cakes
3 **a** Ace Electricals cost = $470, Betta Electricals = $475
b Betta Electricals
c Ace Electricals

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4C Tasks and questions

1 Answers will vary
2 Answers will vary
3 Answers will vary
4 Answers will vary

4D Tasks and questions

1 a Rugby = 5 × trys + 3 × field goals + 3 × penalty goals + 2 × conversion goals
b Basketball = 3 × 3-pointers + 2 × baskets + 1 × foul scores
c Each and every goal is worth exactly 1 point

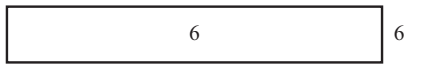
2 a $5 \times 8 + 64$
b $42 \div 7 + 5 \times 15$
c $2 \times \$4.99 + 5 \times \$3.75$
d $12 + 32 - 18 \times 3$
e $5 \times \$15 + 6 \times \$45$
f $\$75 + 30 \times \$24$

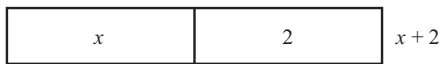
3 a i Four lots of \$6.50 and two lots of \$5.25
ii $4 \times 6.5 + 2 \times 5.25$
b i 2 for each friend at \$1.75
ii $2 \times 1.75 \times$ friends
c i Four tickets at \$19.95 each and two popcorns at \$11.35 each.
ii $4 \times 19.95 + 2 \times 11.35$
d i 8 lots of \$16 plus \$224
ii $8 \times 16 + 224$
e i \$130 for a hutch, twelve months of hay at \$12 a per month and 26 fortnights of food at \$20 per fortnight.
ii $130 + 12 \times 12 + 20 \times 26$
f i \$50 meal allowance plus 55 cents per kilometre.
ii $50 + 0.55 \times$ kilometres

4 Answers will vary
5 D $5n - (2n + 70)$
6 C $120h + 75$

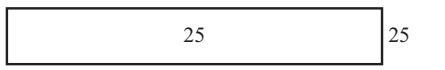
4E Tasks and questions

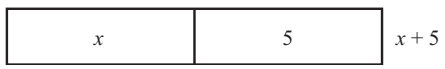
1 a



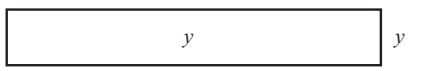


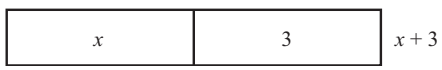
b



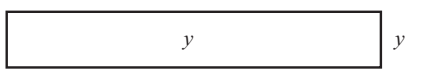


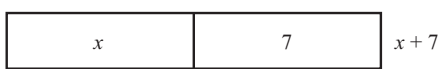
c



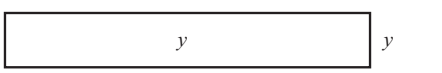


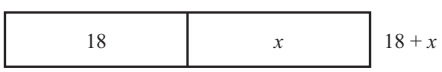
d



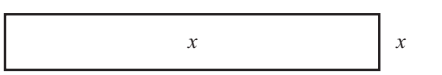


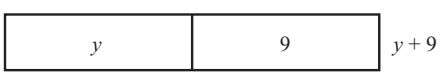
e





f





2 a *C* and *D*
b time, drops per minute, volume
c dose ordered, solution concentration, volume per hour
d floor area percentage, total floor area, total site area

3 a *A* **b** *A*
c *D* (dose) **d** Interest

4 a discount, marked price
b opening stock, closing stock
c sum of data points, number of data points
d *l, w, h*

5 B
6 A
7 B

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8 **a** V, r, h **b** Area
c F **d** π

9

Word	Meaning(s) in an everyday life or are they not used outside maths?
Pronumeral	Not used outside mathematics
Subject	A topic or talking point
Variable	Can be changed
Dependent	In everyday life this can mean you rely on someone or something else for assistance or support.
Independent	Acts on its own
Constant	Does not change

10 **a** Profit is the money earnt, Selling price is the price the object is sold for, and the Cost price is the price the object originally cost.
b A is the area of a circle, π is ~3.14, and r^2 is the circle's radius, squared.
c C is the circumference of a circle, π is ~3.14, and r is the circle's radius.
d V is volume, A is base-area and h is the height.
e V is volume of a sphere, π is ~3.14, and r^3 is the sphere's radius, cubed.
f l is arc length, θ is the angle of the sector, π is ~3.14, and r is the circle's radius.

4F Tasks and questions

1 **a** Answers will vary
b Dollars, minutes and km
c The rate calculated would be drastically cheaper
2 **a** 112
b 1.37, 0.88, 1.24, 0.81, 1 respectively
3 **a** \$800 **b** \$425
c \$162.50
4 **a** \$250 **b** \$455
c $100 \times days + 0.75 \times km$
5 Answers will vary
6 **a** **i** 432 cm^2
ii 19.5 cm^2
iii cm^2
iv Answers will vary
b **i** 5 181 750 mm^3
ii 5181.75 cm^3
iii mm^3 and cm^3
iv Answers will vary
c **i** 50.27 cm^2
ii 5.73 m^2
iii cm^2 and m^2
iv Answers will vary
7 **a** \$23.30 **b** \$90.85
c \$55.45 **d** \$66.95
8 Answers will vary

4G Tasks and questions

1 Answers will vary
2 **a** 15 **b** 3
c 140 **d** 99.25
e −2201
3 **a** 18 **b** 57
c 162 **d** 0.056
e 1
4 **b** 601 **c** 601
d 50.08 **e** 94
f 5
5 Answers will vary
6 **a** 9, 9, 0, 27, 18, 9, 9
b 60, 42, 126, 108, 42, 150, 114
c 5, 8, 13, 11, 15, 9, 10
d 74, 59, 139, 146, 75, 168, 133
e 74, 59, 139, 146, 75, 168, 133
f 794

4H Tasks and questions

1 Answers will vary
2 **a** $y = 5$
b $y = x - 2$
c $y = x - 2$

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d $y = x - 2$
e $y = z + 2$
f $y = 6 - q + x$
g $y = 6 - a$
h $y = g + 3 - x$

3 a $A = 4$
b $A = \frac{x}{2}$
c $A = 48$
d $A = 2x$
e $A = \frac{y}{16}$
f $A = lw$
g $A = \frac{b \times h}{2}$
h $A = \frac{h}{2} \times (a + b)$

4 a $F = ma$
b $r = \frac{c}{2\pi}$
c $l = \frac{A}{w}$
d $h = \frac{V}{lw}$
e $b = 2A - h$
f $u = v - at$

5 Answers will vary

6 a $25 \times photos - 100$
b $150
c $500
d 4
e 12

7 a $40 + 90h$
b $400
c $265
d $107.50
e 4 hours
f 10 hours 40 minutes

Chapter review questions

1 Answers will vary
2 Answers will vary
3 Answers will vary
4 a $5 \times 16 + 23$
b $28 \div 4 + 9 \times 12$
c $(5 + 3) \times 8$
d $14 - 8 + 2 \times 6$
e $3 \times 27 - 9 \times 5$

5 a $5 \times 12 \times 30$ (could also be $\times$ 28, 29 or 31)
b $18 \times (43 + 12) + 24$
c $(8 \times 25.99 + 86) \div 8$
d $(58 + 199) \div 11$
e $(80 + 165 + 65 + 210 \times 3) \div 4$

6 a i C
ii D
b i V
ii b,h,l
c i Density
ii mass, volume
d i Food cost
ii opening inventory, purchases, closing inventory, food sales

7 a Pronumeral
b Expression
c Equation
d Variable
e Constant
f Term

8 a $y = -x - 13$
b $x = \frac{y - 2}{4}$
c $r = \frac{A}{2\pi h}$
d $P = \frac{100I}{RT}$
e $t = \frac{C - \$120}{5}$
f $q = yx - 7$

9 a $C = 110 + 75h$
b $185
c $372.5
d $h = \frac{C - 110}{75}$
e 4 hours

10 a $C = 300 + 18p + 150h$
b $1650
c $2250

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d $h = \dfrac{C - 300 - 18p}{150}$

e $h = \dfrac{1170 - 18p}{150}$

11 **a** $t = 30 + 30w$

b 3.5 hours

c 2.8 hours

d $w = \dfrac{t - 30}{30}$

e 2.5 kg

Chapter 5

5B Practice questions

1 Answers will vary

2 Answers will vary

3 Answers will vary

4 Answers will vary

5 Answers will vary

5C Tasks and questions

1 **a** Numerical **b** Categorical
c Numerical **d** Categorical

2 **a** Numerical **b** Categorical
c Numerical **d** Numerical
e Categorical **f** Categorical
g Numerical **h** Numerical
i Categorical **j** Categorical

3 Answers will vary

4 Answers will vary

5D Tasks and questions

1 Answers will vary

2

What is your favourite animal?	1
Which do you prefer: rice or beans?	2
How do you like your steak done?	3
How tall are you?	4
What is the length of your handspan?	5

2	Rice, Rice, Beans, Beans, Beans, Rice
3	Cooked, Rare, Medium, Medium, Burnt, Well-done
5	19 cm, 20 cm, 20.5 cm, 198 mm, 18.7 cm
1	Koala, Dog, Cat, Guinea Pig, Wombat, Platypus
4	156 cm, 174 cm, 1.67 m, 173 cm, 1.59 m

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3 a Open
b Closed
c Open
d Closed
e Open

4
- Ringing household landlines to gather information on political opinions.
- The Australian Bureau of Statistics.
- A website that claims to present opinions on current topics.
- An organisation that conducts surveys and provides data to its clients.
- Stopping random shoppers in a shopping centre to ask for their political opinion.
- A poll that pops up on social media asking whether there is more violence in society.
- An SMS poll collected from viewers voting for the 'most valuable player'.

5 a Shows bias
b Is double-barreled
c Includes Jargon
d Shows bias
e Contains none

6 a Multiple choice
b Short answer
c Multiple choice
d Slider

7 a They are surveying obvious fans
b Selective sample group
c They are surveying obvious users
d They are surveying a bias audience
e They are surveying a bias audience

8 a 'monstrosity'
b 'ridiculously late'
c Phrasing it as a question
d Implying it does

9 a No option for 'none' or 'other'
b Too many options and doesn't include less than 1 hour or more than 15
c Doesn't cover 4–5 hours or less than 1 hour
d The age ranges overlap

10 a Doesn't cover all possibility
b Overwhelming
c Answers will vary

5E Tasks and questions

1 Answers will vary

2 a Time based
b Attendance status
c Descending order
d Answers will vary
e Descending order
f By date
g By site

3 Answers will vary

4 Answers will vary

5 Answers will vary

5F Tasks and questions

1 Answers will vary

2 a Country Fire Authority
b Minor facility improvements, operational equation
c Alexandra
d Almonds
e Anakie
f $12 212.28
g $82 525.19
h $70 312.91

3 a 3 794
b 2 142
c 2 854
d Administrative and Support Services
e Manufacturing
f Unknown
g Health Care and Social Assistance

4 a Tarago and O'Shannassy
b Cardinia, Upper Yarra, Silvan, Maroondah
c O'Shannassy, Tarago, Yan Yean, Greenvale, Sugarloaf, Thomson, Silvan, Maroondah, Carinda, Upper Yarra
d 91.4
e 89.56
f Answers will vary

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5 b Feb c Jan
d 7 e 5
f Feb, April, May, Jun, Aug, Sep

6 a Percentage of smokers in Victoria, male vs female
b Downwards c 16%
d 12% e 4%
f 2016–2017 g 5%
h Answers will vary

7 Answers will vary

8 a Not Available b 1.8 m
c 4.8 m d 11 m
e Latrobe River f 83 m
g Multiple lanes
h Devilbend Creek, Murray River Rd, Floodway Culvert

9 a Milk chocolate b 43.6 mg
c 2.7 espressos d 4 cups of tea
e 1.8 Energy drinks f 4
g 1 espresso

5G Tasks and questions

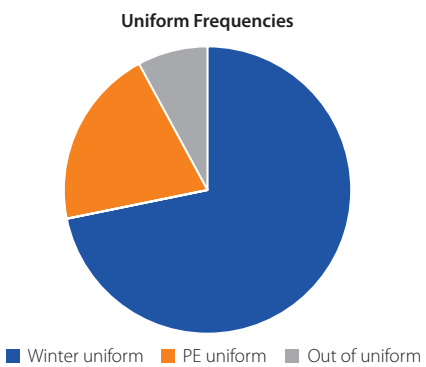
1 Answers will vary

2 a Answers will vary
b Match them in ascending order. The smallest piece is Brooks the largest piece is Fila
c The bar graph

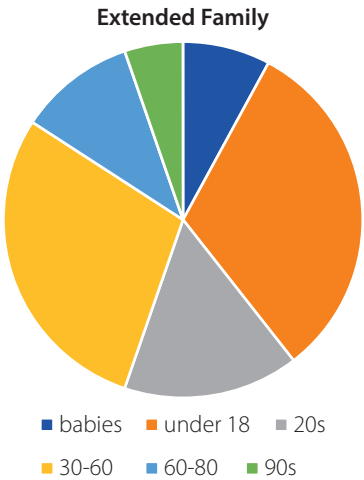
3 Answers will vary

4 Answers will vary

5 a



b



6 Answers will vary

7 Answers will vary

5H Tasks and questions

1 a Gambling losses across countries
b Favourite super heroes amongst kids
c Money spent on various types of gambling
d Number of Australian artists to hit number 1 on the ARIA charts
e Facilities that played Eminem's 'Lose Yourself'

2 a Salary and the year
b Working days lost/1000 and the year
c Mass and the year
d Mass and the year
e Shows, events and value of prize

3 Answers will vary

4 Answers will vary

5 Answers will vary

6 Answers will vary

5I Tasks and questions

1 Answers will vary

2 Answers will vary

3 Answers will vary

4 Answers will vary

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Chapter review questions

1 a n
b c
c c
d n
e n
f n
2 Categorical
3 Answers will vary
4 Answers will vary
5 a Secondary
b Answers will vary
6 Answers will vary
7 b
8 a April
b April
c No
d 5
9 a Food and non-alcoholic beverages
b Current housing costs
c Clothing and footwear, Household furnishings and equipment, Food and non-alcoholic beverages
d Education, Communication, Current housing costs
10 a 2014
b 2014
c Answers will vary
11 a Bar graph
b Bar graph
c Pie chart
12 Answers will vary
13 Answers will vary

Chapter 6

6B Practice questions

1 Answers will vary
2 Answers will vary
3 Answers will vary
4 Answers will vary

6C Tasks and questions

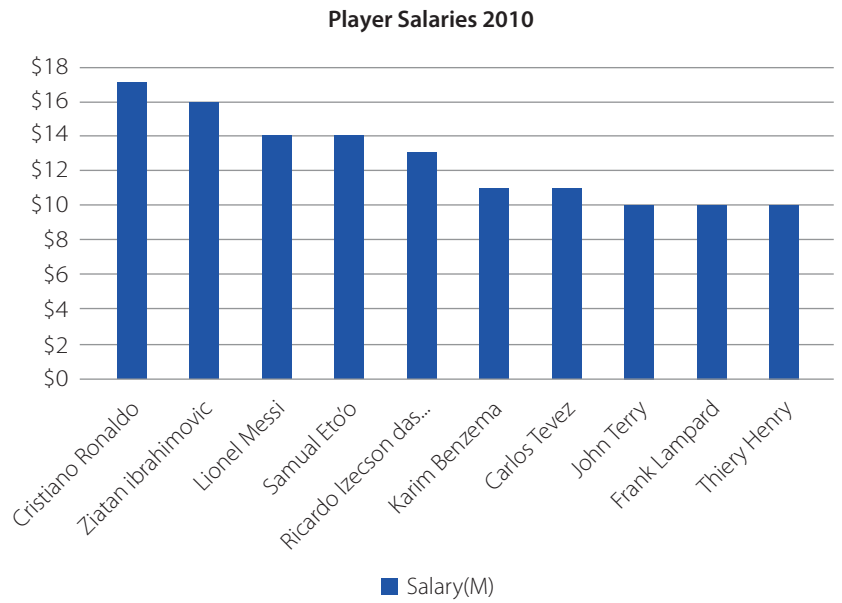
1 a One graph is based on the year 1900 while the other is based on 2019. Populations are much larger in 2019 and ordering of countries has changed.
b Understanding how populations have changed over time across different countries.
c Answers will vary
2 a Predicting weather changes
b Planning classes and teaching schedules
c Understanding consumer preferences
d Measuring popularity of a radio show
e Climate change research
f Purchasing uniforms of correct sizes
3 a Understanding population trends
b Understanding car crash trends
c Scientific research
d Staying logged in to a website
e Keeping medical records for future treatment
f Using map applications
4 a Measuring inflation
b Popularity measure
c Measuring diversity
d Measuring diversity
e Climate change
f Severity and population of asthma
5 a no
b yes
c Answers will vary
d Answers will vary
e Answers will vary
6 Answers will vary
7 Answers will vary
8 Answers will vary

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9 a





b Allows the reader to more accurately investigate the data.

c To see how salaries have changed over the last decade.

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6D Tasks and questions

1 Answers will vary

2 **a** List

b Two sided bar graph

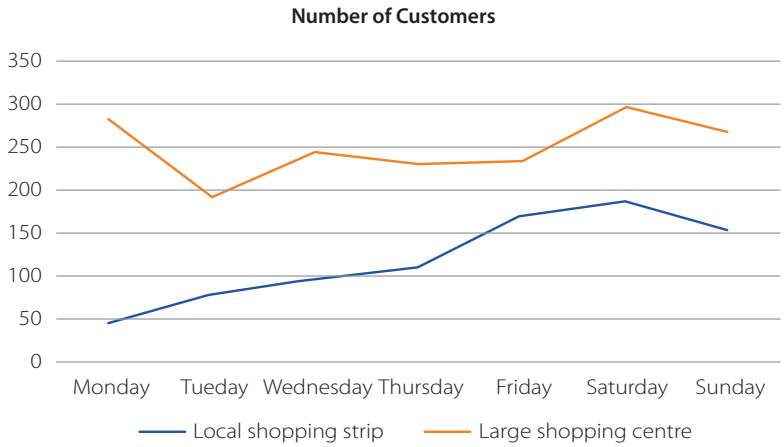
c Column graph

d Line graph

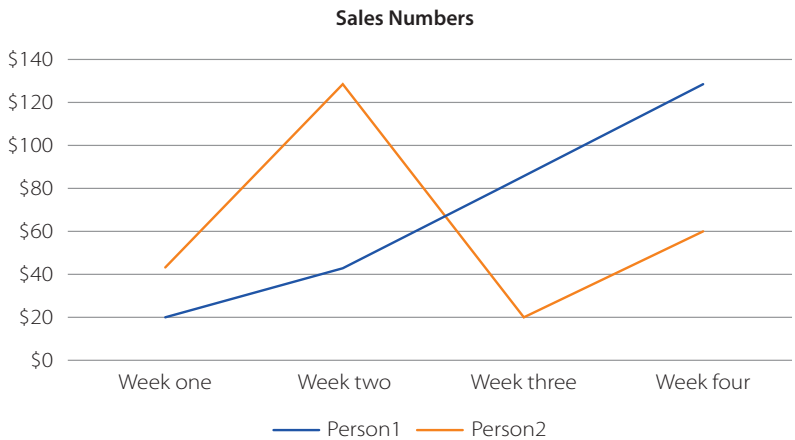
e Table

f Stem and leaf plot

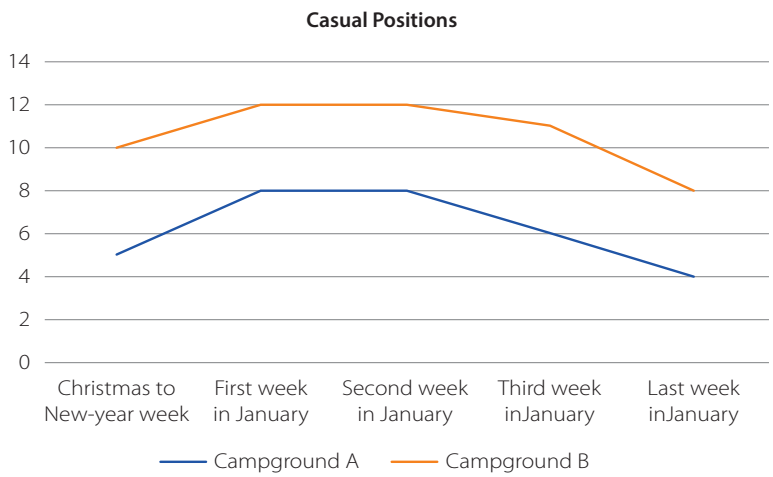
3 **a**



b



c



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4 Answers will vary
5 Answers will vary
6 Answers will vary

6E Tasks and questions

1 a 3 b 3
c 4 d 4
2 a 4 b 3
c B d Investment scams
e Brimbank
3 a 7 b 4
c 54 d 48 and 39
e 577.5 f 10
4 a 64 b 5
c 535.36
d i 55.25
ii 30.15
iii 23.8
iv 1.3
5 a Mean 4.3, median 5, mode 8
b Mean 29.1, median 28, mode 28
c Mean 7 962.2, median 6 499, no mode
d Mean 22.3°C, median 21°C, mode 20°C
6 Answers will vary
7 a 58.4, 77.7
b The median gives the best understanding since there are outliers skewing the mean
8 Answers will vary

6F Tasks and questions

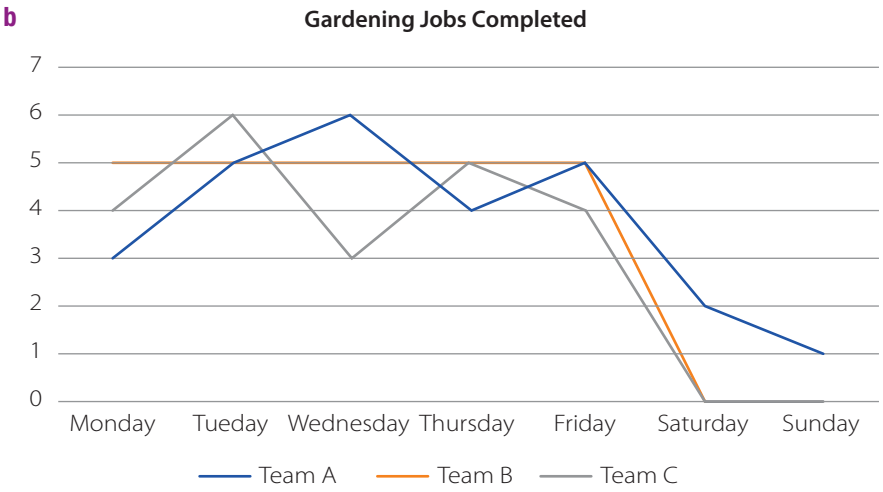
1 Answers will vary
2 a i 21 – 1 = 20
ii Q1 = 3.5, Q3 = 10.5
iii IQR = 7
iv The IQR gives a better indication of how the data is spread
b i 3024 – 198 = 2826
ii Q1 = 1170,Q3 = 2558.5
iii IQR = 1388.5
iv The IQR gives a better indication of how the data is spread
c i 68 – 27 = 41
ii Q1 = 35, Q3 = 65
iii IQR = 30
iv The IQR
d i 32 – 8 = 24
ii Q1 = 8, Q3 = 20
iii IQR = 12
iv The range since it shoes how different the values are with such a small sample
e i 89 – 2 = 87
ii Q1 = 3, Q 3 = 72
iii IQR = 69
iv The IQR since it is less influenced by the outliers
3 Answers will vary
4 a Phishing
b Ransom and Malware
c 7386
d Q1 = 928, Q2 = 1673, Q3 = 1928, IQR = 1000
e 21,706
f The most reported scam
5 Answers will vary
6 Answers will vary

Chapter review questions

1 a Which stock is selling, which isn't and which needs replenishing
b Which roads are consistently congested
2 a Number of patients, arrival times, departure times, symptoms
b To better manage and understand the flow of patients in the ER
c Excel, spreadsheets, online databases
d Answers will vary
3 To better understand and compare different health risks to Australians by sex
4 a Line graph

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b



5 **a** Mean = 18.5, median = 19.5, mode = 18 & 25

b Mean = 2.67, median = 2, mode = 2

6

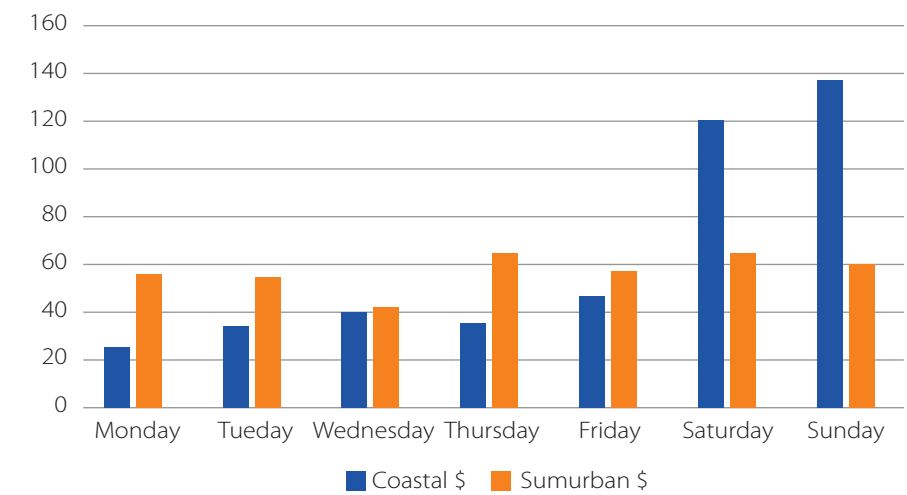
	Year 10	Year 11	Year 12
Mean	22.75	18.625	16.25
Median	23	18.5	16

	Year 10	Year 11	Year 12
Mode	23	18	15

7 For Maths the range = 58 and IQR = 31
For Science the range = 60 and the IQR = 31
For English the range = 54 and the IQR = 20

8 **a** Answers will vary

b



c The suburban store sells more on weekdays but significantly less on weekends

d Coastal: mean = 62.57, median = 42, no mode
Suburban: mean = 56.14, median = 57, no mode
Answers will vary

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Chapter 7

7B Practice questions

1 See Key vocabulary in Chapter 7
2 Answers will vary
3 Answers will vary
4 Answers will vary
5 Answers will vary
6 Answers will vary
7 $2538
8 $99.50

7C Tasks and questions

1 The money belongs to Sam's employer, and it's Sam's responsibility to report the error so that his employer can have it fixed.
2 a $199.50 b $344.25
c $136 d $189
e $82.13 f $160.88
3 a 185.25 b $156
c $168.25 d $246.43
e $210 f $403.25
4 a $42.85 b $22.60
c $32.69 d $11.06
e $8.95 f $18.84
5 a $2000 b $2846.15
c $2423.08 d $961.54
6 a $39197.60 b $86000.20
c $61854 d $43570.80
e $39 197.60 f $93 999.88
g $75 159.50 h $51 656.28
7 a $178.13 b $1307.69
c $44278 d $147.50
e $24.52
8 a $438 b $569.80
c $629 d $731.60
9 A form of commission, paid per item (piece) collected
10 $4356.79

7D Tasks and questions

1 Answers will vary
2 Answers will vary
3 a $14.40 b $547.25
c $24.88 d $796.00
e $10.48 f 80%
4 See Key vocabulary in Chapter 7
5 Answers will vary

7E Tasks and questions

1 The accountants and bookkeepers are responsible. To ensure this does not happen the company could implement a more rigorous bookkeeping scheme.
2 Answers will vary
3 a Total = unit × rate
b Their annual income is too low
c They broke workplace equipment
d $60.85
4 Answers will vary
5 a Net = gross – tax
b 14 days
c Super = 0.105 × pay
d 18.95 × 42 = $795.90
e No
6 Answers will vary
7 Answers will vary

7F Tasks and questions

1 Answers will vary
2 a Part-time contract
b $15.71 c 16 hrs
d $15.71 × 16 e $10 119
f $1113.11 g $335.04
h $44.05/hr and $44.05 × hrs worked each fortnight
3 a i $21.59
ii $37.78
b $16.19. Because of job security and not being entitled to leave

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c $855.83 **d** $1069.70
e $0, they are not entitled to leave
f **i** $712.48
ii $858.26
iii $145.78
g **i** $712.48
ii $813.26
iii $118.78

4 Answers will vary

5 **a** $2472
b $12096
c $8000
d $10230.77
e $7393.85

7G Tasks and questions

1 Answers will vary

2

Date	Description	Debits	Credits	Balance
16 Sept	M transfer – Wages		314.00	642.40
17 Sept	Banh Mi	17.50		624.90
18 Sept	Haircut	60.00		564.90
19 Sept	Spotify	5.00		559.90
19 Sept	Petrol	56.51		503.39
20 Sept	ColesWorths	11.00		492.39
22 Sept	Parking	2.00		490.39
23 Sept	M transfer – Wages		413.00	903.39
24 Sept	Ice-cream	5.00		898.39
24 Sept	Clothes	149.00		749.39
24 Sept	ColesWorths	18.00		731.39

3

Date	Description	Debits	Credits	Balance
3 July	IGA	18.00		196.00
3 July	M transfer – Bank of Mum and Dad		50.00	246
3 July	Birthday money Yia		120.00	366.00
3 July	Spotify	5.00		361.00
3 July	YouTube	11.99		349.01
3 July	Sushi	3.6		345.41
3 July	IGA	21.00		324.41
3 July	Movies	17.50		306.91
3 July	Grilled	23.00		283.91
3 July	Myki top-up	30.00		253.91
3 July	TimeOut	14.00		239.91
3 July	Beverages	140.00		99.91
3 July	Souvlaki	8.99		90.92
3 July	Ice-cream	4.50		86.42
3 July	M transfer – Wages		80.00	166.42

4 Answers will vary

5 Answers will vary

6 **a** $823 **b** $13
c Video games, shoes, jewellery and clothes
d $32 **e** $373
f Balance = +0.37 × gross – 0.64 × gross
g Margin = spend – savings
h Answers will vary

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Chapter review questions

1 **a** 30/10/2023 **b** $57.22068
c 74675475465 **d** $4566.21
e $3251.42 **f** $871
g $433.79

2 **a** $161.40 **b** $145.93

3 Jax's gross pay is $2480.77 and Sid's gross pay is $2898.

4 $1671.90

5 **a** $65415 **b** $70332
c $25223

6 **a** $768.30 **b** $1172.80
c $404.50. Casuals are paid more because they have less benefits
d $194.73

7

Date	Description	Debits	Credits	Balance
12 May	Optus	45.00		1123.20
12 May	Wage		850.45	1973.65
13 May	Soopermart	85.32		1888.33
13 May	Bakery	4.50		1883.83
13 May	Nics and nacks	22.50		1861.33
14 May	Family allowance		85.88	1947.21
15 May	Florist	66.00		1881.21

8 **a** Yes, 7.5 ordinary hours and 5 penalty hours
b No, his Saturday rate should be $26.43.
c Harvey hasn't met the tax free threshold
d $391.15

Chapter 8

8B Practice questions

1 **a** $10 **b** $16
c $237.50 **d** $96
e $18.99 **f** $471.80

2 **a** $I = \frac{5000 \times 10}{100}$

b $I = \frac{50000 \times 8}{100}$

c $80 = \frac{4000 \times R}{100}$

d $193 = \frac{P \times 3}{100}$

8C Tasks and questions

1 Answers will vary

2 **a** Goods **b** Services
c Services **d** Goods
e Services

3 **a** GST free **b** GST
c GST **d** GST
e GST **f** GST free
g GST **h** GST free
i GST **j** GST free

4 **a** $42 and 30 c **b** $76 and 60 c
c $457 and 30 c **d** $607 and 80 c
e $1059 **f** $2500
g $3 and 58 c **h** $2 and 35 c
i 83 c **j** 50 c

5 **a** $8.36 **b** $95.64
c $306.70 **d** $1507
e $5749.90

6 **a** do not **b** 10%
c 11 **d** with
e is

7 **a** **i** Goods
ii Water
iii GST Free
b **i** Goods
ii Office supplies
iii GST
iv $5.03
c **i** Goods
ii Food
iii GST
iv $1.09

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d i Goods
ii Fuel
iii GST
iv $5.64
e i Service
ii Phone bill
iii GST
iv $5.91

8 a $2400 + $240 = $2640
b 2 × $6.50 + $3.90 + $4.35 + 5.99* = $27.24 (incl. G.S.T: $ 0.54)
c $65 × 6 + $6.5 × 6 = $429

8D Tasks and questions

1 Answers will vary
2 a B **b** A
c D **d** B
e C
3 a 2023/2024 **b** 2024/2025
c 2022/2023 **d** 2023/2024
4 a Non-assessable **b** Assessable
c Non-assessable **d** Assessable
e Non-assessable
5 a $6050.75 **b** $76417
c $0 **d** $978.50
6 a $247 **b** $0
c $7558.73
7 a $3425.60 **b** $86.33
c $120.94 **d** $745.42
e $172.00 **f** $4082.78
8 $18 201-$45 000
9 $29 467
10 Answers will vary
11 a Money from part-time job is assessable and the money from family is non-assessable
b Yes **c** $14 401
d 0 – $18 200 **e** $0

12 a

Day	Hours worked	Rate	Pay
Friday	3	$15.27	$45.81
Saturday	4	$15.27	$61.08
Sunday	5	$21.63	$108.15
		Total	

b

Day	Hours worked	Rate	Pay
Friday	3	$15.27	$45.81
Saturday	4	$15.27	$61.08
Sunday	5	$21.63	$108.15
		Total	$215.04

c $0
d No, Sharon is under 18
13 a Brandon Parker **b** 123456789
c 2020/21 **d** $21 759
e No, the correct amount is $676.21
f Brandon's employer has most likely made an error calculating his annual income
g $2067.12
h His gross pay
i 9.5% **j** Yes
k The status

8E Tasks and questions

1 Answers will vary
2 a i $120
ii $1120
b i $1200
ii $11200
c i $160
ii $2160
d i $100
ii $2100
e i $400
ii $2400

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f i $320
ii $4320
3 a i $720
ii $3720
b i $600
ii $6600
c i $440
ii $2440
d i $400
ii $1400
e i $720
ii $5220
f i $5040
ii $14 040
4 a i $4160
ii $160
b i $6240
ii $240
c i $12 600
ii $600
d i $20 600
ii $600
e i $1040
ii $40
f i $5200
ii $200
5 a i $89 989.12
ii $9989.12
b i $876 449.26
ii $476 449.26
c i $1 33 2918.17
ii $832 918.17
d i $118 522.42
ii $83 522.42
e i $479 311.64
ii $279 311.64
f i $2 709 083.95
ii $1 909 083.95
6 a i $610
ii $110
b i $541 833.37
ii $241 833.37
c i $100 800
ii $10800
d i $101 295.79
ii $11 295.79
e i $2300
ii $300
f i $3 987 161.03
ii $3 187 161.03
7 Answers will vary
8 Answers will vary
9 Answers will vary

8F Tasks and questions

1 Answers will vary
2 a 20 instalments
b 10 instalments
c 8 instalments
d 11 instalments
e 10 instalments
f 134 instalments
g 400 instalments
h 80 instalments
3 a $30
b $62.5
c $541.67
d $333.33
e $166.67
f $83.33
g $333.33
h $1041.67
i $1666.67
j $3000
4 a i $7200
ii $17200
iii $358.33
b i $1400
ii $6400
iii $266.67
c i $19 500
ii $84 500
iii $1173.61
d i $13 440
ii $21 440
iii $148.89
e i $250 000
ii $500 000
iii $2083.33
f i $3240
ii $9240
iii $256.67

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5 **a** $120 **b** $240
c $400 **d** $140
e $280 **f** $160
g $320

6 **a** **i** $480
ii $4480
iii $186.67
b **i** $1520
ii $20520
iii $427.50
c **i** $6080
ii $25 080
iii $522.50
d **i** $10 640
ii $29 640
iii $617.50
e **i** $1275
ii $9775
iii $271.53

7 **a** 115 instalments **b** $216.67
c $305.56 **d** 25 instalments
e $670.56 **f** 18 instalments
g $153.33 **h** $287.50

8 Answers will vary

9 **a** $151 **b** $116
c $1861 **d** $2649
e 10 years **f** 5 years

10

Loan term	Monthly repayment	Monthly interest	Weekly repayment (assume /4)	Yearly repayment	Total repayment over life of loan (Principal + interest)	Total interest over life of loan (Total – principal $250,000)
15 years	$1849	$460.11	$462.25	$22 188	$332 820	$82 820
20 years	$1515	$473.33	$378.75	$18 180	$363 600	$113 600
25 years	$1320	$486.67	$330	$15 840	$396 000	$146 000
30 years	$1194	$499.56	$298.50	$14 328	$429 840	$179 840

11

Loan term	Monthly repayment	Monthly interest	Weekly repayment (assume /4)	Yearly repayment	Total repayment over life of loan (Principal + interest)	Total interest over life of loan (Total – principal)
15 years	$3329	$829	$832.25	$39 948	$599 220	$149 220
20 years	$2727	$852	$681.75	$32 724	$654 480	$204 480
25 years	$2375	$875	$593.75	$28 500	$712 500	$262 500
30 years	$2148	$898	$537	$25 776	$773 280	$323 280

12

Loan term	Monthly repayment	Monthly interest	Weekly repayment (assume /4)	Yearly repayment	Total repayment over life of loan (Principal + interest)	Total interest over life of loan (Total – principal)
15 years	$4808	$1196.89	$1202	$57 696	$865 440	$215 440
20 years	$3939	$1230.67	$984.75	$47 268	$945 360	$295 360
25 years	$3431	$1264.33	$857.75	$41 172	$1 029 300	$379 300
30 years	$3103	$1297.44	$775.75	$37 236	$1 117 080	$467 080

13 Answers will vary

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8G Tasks and questions

1 Answers will vary

2 a 0% b 6.5%
c 0% d 10%

3 a $75 141 – $79 649
b $119 765 – $126 950
c $89 495 – $94 865
d This applies to no-one
e Below $51 550

4 a No b Yes, $3054
c Yes. $14 082.42 d No
e Yes, $18 922.10

5 Answers will vary

6 Not being an Australian citizen, permanent resident or having an insufficient HELP balance

7 Answers will vary

8H Tasks and questions

1 Answers will vary

2 a June 14, June 21, June 28, July 5, July 12
b June 3, June 17, July 1, July 15
c May 16, June 16, July 16, August 16
d June 18, July 2, July 16, July 30
e May 1, May 15, May 29, June 12, June 26, July 10, July 24, August 7, August 21, September 4

3 a $24 b $25
c $81.25 d $125
e $2058.17

4 a A b $1194.38
c 15 Nov 2021 d 25
e AutoPay f $25.00
g 8 years and 11 months
h No additional charges on the card
i $1467.86 j $7500
k $6305.62
l No, it shows they've already repaid some of debt in the last month

5 a 6 b 6
c 12 d Jan 20
e Late fees may occur

6

	Amount needed to set up an account	Repayment schedule	Fee charged for an overdue payment	Other account-keeping fees
Account a	$0	Once every fortnight for 4 payments	$10	None
Account b	$0	5 fortnightly payments or 10 fortnightly payments	$6	An additional $8 for 10 payments over 5
Account c	$0	Over $100: four fortnightly payments. Under $100 one immediate payment	$10	None
Account d	$0	Choose between weekly, fortnightly or monthly payments	$8	None

7 Minimum payment: The minimum amount allowed to be repaid in one instalment
Minimum purchase: The smallest purchase allowed to apply to BNPL
Capped: An upper limit on fees
Credit Limit: The maximum debt a card can accumulate
Credit Rating: A score which represents an individual's creditworthiness.

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8 a

Trx #	Instalment 1		Instalment 2		Instalment 3		Instalment 4	
	Due date	Amount	Due date	Amount	Due date	Amount	Due date	Amount
1	Jun 12	$20.00	Jun 26	$20.00	Jul 10	$20.00	Jul 24	$20.00
2	Jun 12	$34.50	Jun 26	$34.50	Jul 10	$34.50	Jul 24	$34.50
3	Jun 16	$40.00	Jun 30	$40.00	Jul 14	$40.00	Jul 28	$40.00
4	Jun 21	$55.00	Jul 5	$55.00	Jul 19	$55.00	Aug 2	$55.00
5	Jun 22	$8.00	Jul 6	$8.00	Jul 20	$8.00	Aug 3	$8.00
5	Jun 26	$15.00	Jul 10	$15.00	Jul 24	$15.00	Aug 7	$15.00
7	Jun 30	$18.75	Jul 14	$18.75	Jul 28	$18.75	Aug 11	$18.75
8	Jul 4	$40.00	Jul 18	$40.00	Aug 1	$40.00	Aug 15	$40.00

b

	Week beginning								
Trx #	Jun 12	Jun 19	Jun 26	Jul 3	Jul 10	Jul 17	Jul 24	Jul 31	Aug 7
1	$20.00		$20.00		$20.00		$20.00		
2	$34.50		$34.50		$34.50		$34.50		
3	$40.00		$40.00		$40.00		$40.00		
4		$55.00		$55.00		$55.00		$55.00	
5		$8.00		$8.00		$8.00		$8.00	
6			$15.00		$15.00		$15.00		$15.00
7			$18.75		$18.75		$18.75		$18.75
8				$40.00		$40.00		$40.00	
Total	$94.50	$63.00	$128.25	$103.00	$128.25	$103.00	$128.25	$103.00	$33.75

c Yes. After house expenses Rory makes $330 a week, which is enough

d $32, no it does not

e 450 – 120 – 75 – 150 = 105. No, they cannot afford it

f 450 – 120 – 1400/4 = –20. No, they cannot afford it

9 a Trx 1 - $80, Trx 2 - $138, Trx 3 - $120, Trx 4 - $220

b They will be included in next month's statement.

c $80 + $138 + $120 + $220 = 558

d Rory will not be able to pay from one week's pay. Answer will vary.

e They will be included in next month's statement.

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8I Tasks and questions

1 Answers will vary
2 a $588
b $1068
c $1368
3 a $130.50
b i $250
ii $200
iii $150
c i $310.50
ii $276
iii $34.50
4 a $126
b $196.38
c $242.50
5 a $1737
b $2496
c $1768.80
d b
6 Answers will vary
7 a They are all lock in contracts as they all have a time frame of 12 or 24 months.
b 12, 12 and 24 months
8 a Charge = fee × (months+part months)/2+(voucher value/12) × (months+part months)
b i $238
ii $790
c i $196
ii $392
9 a $960, $1080, $1260
b 80 + 9 × 24=first month + 9 × 24 months
10 Answers will vary

Chapter review questions

1 a Good, GST-free
b Service, GST-free
c Good, GST
2 a $34.50, $379.50
b $112.05, $1232.55
c $83.29, $916.19
3 $1.07
4 a $31 312.19
b $12 498.70
5 a 2021/22
b $3047.98
c $3424.20
6 No, it is non-assessable
7 a $749.18
b $6749.18
8 i $2 629 755.15, $2 678 728.25, $1 992 335.31 respectively
ii $1 754 755.15, $1 803 728.25, $1 117 335.31 respectively
9 a $16 200
b $270
10 a $420
b $3920
c $108.89
11 Yes, $523.55
12 $2313.80
13 a i
b $2463.98
c 19 Jun 2018
d $49.00
e $20 000.00
f $17 536.02
14 $187.50 on Jan 3, Jan 17, Jan 31, Feb 14
15 a $350
b $650
c $275
16 a $10 722.63
b $6232.50
c $10 261.2?
d $1246.50
e $1232
f $79.20
g $704
h The loan has cheaper installments whereas the BNPL is interest free

Chapter 9

9B Practice questions

1 Answers will vary
2 Answers will vary
3 Answers will vary
4 Answers will vary

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9C Tasks and questions

1 Answers will vary
2 a Retailers sell electricity and gas while distributors deliver electricity and gas to consumers.
b Citipower, Jemena, Powercor Australia, AusNet Services, United Energy Distribution
c Australian Gas Networks, Multinet Gas, AusNet Services
d An NMI (National Meter Identifier) is a unique number assigned to each electricity meter.
e A MIRN (Meter Identification Reference Number) is a unique number assigned to each gas meter.
3 a Actual
b Nov1 2020-Nov28 2020
c 184.56 kWh d 0.2475$/kWh
e $1.21/day
f 23 Feb give or take 2 days
4 a $104.04 b $217.77
c $80.77 d $81.98
5 a 20 Aug 2020 – 21 Aug 2021
b Answers will vary
c It peaks during the winter
d Went away on holiday
e 15.39
f 2 people
g They use significantly more electricity than the average person
h They use significantly less electricity than the average house of four
6 a kL b 1000 L
c 11 kL = 11000 L d 0.128 kL = 128 L
e 12.8 Buckets
f Water usage and Sewage disposal
g Water ways and drainage charge as well as an annual parks charge for the state gov
h People who hold a centrelink pensioner concession and more
7 a Answers will vary
b Average water used daily, divided by the population
c A water efficiency movement encourage to use less than 155 L daily per person
d i 30 L, 27 L
ii 339 L, 336 L
e Answers will vary
8 Answers will vary
9 a Gas bill
b $120
c Amount paid on 5th of Oct
d By credit card
e 15-Sep to 15-Nov
10 a The total b The first bill
c Customer 2
d During peak period, customer 2, otherwise customer 1
e $86.46 f $99.39
g Answers will vary
11 Answers will vary
12 a Its the amount owing, which is $0 for this customer
b 0.125 kL = 125 L
c 43.1%
d i 3–4
ii 12
e i $887.88
ii $521.82-$695.76
iii Electricity

9D Tasks and questions

1 Answers will vary
2 Answers will vary
3 Answers will vary
4 Answers will vary
5 a 1 July 22–30 June 23
b Fire service levy residential fixed, fire service levy residential variable, garbage with garden waste 120L and a general rate
c Single unit, Code 120

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d Pay by installments, Pay in full, Pay by direct debit
e For accessibility
f The rates and charges
g 10%
h $131.33

6 Answers will vary

7

Comprehensive car insurance	Car insurance that covers damage to your car in the event of an accident
Discretionary spending	Spending that you can choose to do or not do
Fire and theft car insurance	Car insurance that covers the cost of your car if it is stolen or burnt
Health insurance extras	Private health care can cover you for more than just hospital cover: services such as physiotherapy, dental, chiropractic, podiatry
Insurance policy excess	The amount you pay for an insurance product
New for old replacement	An insurance policy that provides new furniture or white goods (for example) in the event of an insurance claim
Premium	The amount you must pay in the event you make a claim
Market value	The market value of your car that will be paid in the event of your car being 'written off'
Third party property car insurance	Car insurance that covers the cost of damage to another person's car or property in the event of you being in an accident
Written off	The term used by insurance companies to indicate that repairs to a car would exceed the value of the car

8 Answers will vary
9 Answers will vary

9E Tasks and questions

1 Answers will vary
2 Answers will vary
3 **a** Offer B
b Offer A for the first 608.33 kWh per month
c Offer B **d** Neither
e How much energy a house uses
4 **a** Option B **b** Option B
c Option B
5 **a** **i** $2.47
ii $1.24
iii $3.71
b **i** $30.99
ii $15.49
iii $46.48
c **i** $4.86
ii $2.43
iii $7.29
d **i** $1.21
ii $0.61
iii $1.82
6 Answers will vary
7 **a** 1.5% **b** 0%
c 0 **d** 1.25%
e $1562.50
8 Answers will vary
9 65
10 Answers will vary
11 Answers will vary
12 Answers will vary
13 Answers will vary
14 Answers will vary
15 Answers will vary

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9F Tasks and questions

1 Answers will vary

2 **a** **i** $228
ii $456
b **i** $300
ii $600
c **i** $226
ii $418
d **i** $476
ii $668
e **i** $234
ii $522
f **i** $173.94
ii $425.82
g **i** $232.50
ii $496.50
h **i** $192.75
ii $393.75

3 **a** **i** Plan A $179.94, Plan B $224.94, Plan C $269.94, Plan D $359.94
ii Plan A $419.82, Plan B $524.82, Plan C $629.82, Plan D $839.82
b **i** Plan A $230, Plan B $345
ii Plan A $470, Plan B $705
c **i** Plan A $110, Plan B $220, Plan C $330
ii Plan A $230, Plan B $460, Plan C $690

4 **a** $30
b $60
c $87
d $21.25
e $33.75
f $33.13
g $25
h $37

5 **a** In order: $0.67,$2.43,$0.44,$1.39,$0.67, $0.42,$0.68,$0.47,$0.57,$1.15,$0.41
b In order:$0.99,$4.51,$0.53,$2.43,$0.63, $0.99,$0.49,$1.01,$0.59,$0.79,$1.95, $0.47
c In order:$1.31,$6.59,$0.62,$3.47, $0.77,$1.31,$0.56,$1.34,$0.71,$1.01, $2.75,$0.53
d $9.95,$62.75,$3.05,$31.55,$4.55,$9.95, $2.45,$10.25,$3.95,$6.95,$24.35,$2.15
e Cost = flag fall + mins × rate
f $C = f + m \times r$
g **i** $0.35 + 45 \times 1.04 = \$47.15$
ii $0.35 + 45 \times 0.07 = \$3.50$
iii $0.35 + 45 \times 0.22 = \$10.25$

6 Answers will vary

7 **a** 1 month **b** 2 GB
c $40 **d** $50
e $10 **f** $50
g **i** $10
ii $30
iii $70
h **i** $20
ii $35
iii $65
i **i** $30
ii $40
iii $60
j **i** $40
ii $45
iii $55
k Answers will vary

8 **a** The charge you receive each month with no extras
b By multiplying the minimum monthly charge by 12
c Plan 1 $102, Plan 2 $132, Plan 3 $168, Plan 4 $198, Plan 5 $228, Plan 6 $270
d Plan 1 $282, Plan 2 $312, Plan 3 $348, Plan 4 $378, Plan 5 $408, Plan 6 $450
e Plan 3
f Plan 3 because it is the cheapest deal that meets all needs

9G Tasks and questions

1 Answers will vary

2 **a** The Korean War Boom

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b 1950–51 **c** Twice
d Both were during a financial crisis
e The CPI sharply decreased

3 **a** 5.88% **b** 15.79%
c 2.37% **d** –10.2%
e –33.82%

4 **a** $103 **b** $612
c $37.44 **d** $337.03
e $80.68 **f** $100.20
g $23.83

5 **a** $100 **b** $800
c $424.29 **d** $209.55
e $138.49 **f** $243.39
g $151.94 **h** $262.14

6 Answers will vary

7 **a** They are most likely renting, and this will make the cost of living increase
b They most likely own their home. It won't affect them much but there will be an increase
c They most likely are paying off a mortgage. Inflation will bring increased rates to their mortgage, and therefore increasing the cost of living

8 **a** The cost of living increases drastically
b The cost of living will increase, but it won't be too influential. It's likely a house of two who don't drive often
c The cost of living increases drastically

9H Tasks and questions

1 Answers will vary

2 Answers will vary for part **i**
a $2 **b** $4
c $1 **d** $4.90
e $2.45 **f** $1.23
g $7.80 **h** $3.90
i $1.95 **j** $0.78

3 Answers will vary for part **i**
a **ii** No
iii $169
iv $10 more
b **ii** No
iii $177
iv $10 more
c **ii** No
iii $93
iv $2 more
d **ii** No
iii $365
iv $10 more
e **ii** No
iii $26.99
iv $1 more
f **ii** No
iii $229
iv $17 more
g **ii** No
iii $59.89
iv $2 more
h **ii** No
iii $535
iv $14 more
i **ii** No
iii $230
iv $96 less

4 Answers will vary for part **i**
a **ii** No
iii $88.2
iv $1.80 more
b **ii** No
iii $49.05
iv $0.95
c **ii** No
iii $111.60
iv $0.40 more
d **ii** No
iii $45.45
iv $0.05 more
e **ii** No
iii $44.99
iv $5 less
f **ii** No
iii $28.80

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iv $0.20 more
g ii No
iii $56.68
iv $0.03 more
h ii No
iii $51.26
iv $0.70 more

5 Answers for part **i** will vary
a ii No
iii $34
iv $4 more
b ii No
iii $50
iv $2 more
c ii No
iii $512
iv $48 more
d ii Yes
e ii No
iii $86.38
iv $0.02 more
f ii No
iii $28.80
iv $0.20 more
g ii No
iii $465.60
iv $10 more
h ii No
iii $62.40
iv $2.60 more

6 a $3.50 **b** $3
c $7.10 **d** $5.00
e $1.50 **f** $0.40
g $2.20 **h** $47.35

7 Answers will vary

8 a Answers will vary **b** $2561.50
c $1554.8 **d** $1265
e C
f Knowledge of plans and payment schemes

9 a $468 **b** $840
c $2208 **d** $2428.80
e $841.40
f To be confirmed and no
g Answers will vary

9I Tasks and questions

1 Answers will vary

2 a

b

c

d

e

f

g

h


3 a i $4
ii $1
b i $5
ii $1
c i $3
ii $1
d i $6
ii $1
e i $40
ii $10
f i $50
ii $10
g i $30
ii $10
h i $60
ii $10

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4 a i $\frac{1}{2}$

ii $\frac{1}{2}$

b i $\frac{1}{4}$

ii $\frac{3}{4}$

c i $\frac{1}{5}$

ii $\frac{4}{5}$

d i $\frac{1}{6}$

ii $\frac{5}{6}$

e i $\frac{1}{8}$

ii $\frac{7}{8}$

f i $\frac{1}{10}$

ii $\frac{9}{10}$

5 a i 50%

ii 50%

b i 25%

ii 75%

c i 20%

ii 80%

d i 16.67%

ii 83.33%

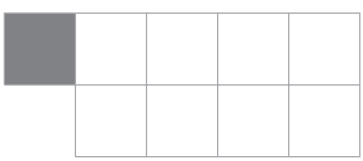
e i 12.5%

ii 87.5%

f i 10%

ii 90%

6 a



b Could win \$9 could lose \$1

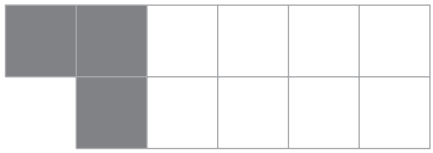
c $\frac{1}{9}$ chance of winning, $\frac{8}{9}$ chance of losing

d



e 11.1% win, 88.9% loss

f



g $\frac{1}{12}$ win, $\frac{11}{12}$ loss

h 5% win, 95% loss

i \$20 win, \$1 loss

7 Answers will vary

8 a i



ii $\frac{1}{2}$ win $\frac{1}{2}$ loss

iii 50% win, 50% loss

iv \$20 win, \$10 loss

b i

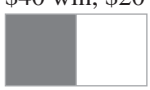


ii $\frac{1}{2}$ win $\frac{1}{2}$ loss

iii 50% win, 50% loss

iv \$40 win, \$20 loss

c i

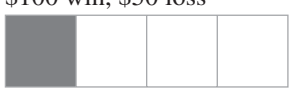


ii $\frac{1}{2}$ win $\frac{1}{2}$ loss

iii 50% win, 50% loss

iv \$100 win, \$50 loss

d i

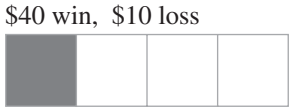


ii $\frac{1}{4}$ win $\frac{3}{4}$ loss

iii 25% win 75% loss

iv \$40 win, \$10 loss

e i

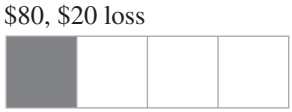


ii $\frac{1}{4}$ win $\frac{3}{4}$ loss

iii 25% win 75% loss

iv \$80, \$20 loss

f i



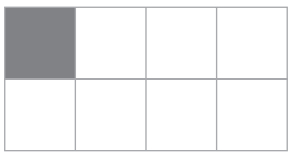
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ii $\frac{1}{4}$ win $\frac{3}{4}$ loss

iii 25% win 75% loss

iv \$200, \$50 loss

g i

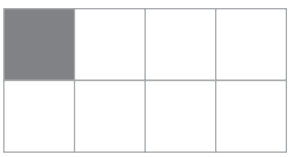


ii $\frac{1}{8}$ win $\frac{7}{8}$ loss

iii 12.5% win 87.5% loss

iv \$80 win \$10 loss

h i



ii $\frac{1}{8}$ win $\frac{7}{8}$ loss

iii 12.5% win 87.5% loss

iv \$800 win \$100 loss

9 Answers will vary

Chapter review questions

1 a \$114.69 **b** \$118.92

c 2414110, to make sure the right bill is paid

d Yes, see bottom of bill

e No, see invoice

2 a The bill is labeled "electricity account usage"

b 28 days **c** \$1.122/day

d 174.11 kWh **e** \$0.2893/kWh

f Daily charge, usage, GST, and discounts

3 a \$39.27 **b** \$20.20

c \$44.55 **d** \$29.95

e \$76.43

4 a 52 L/day **b** 6.22 kWh

c Low user of electricity and water

d 3 person household

5 a 6 **b** Answers will vary

6 Discretionary expenses are those which are chosen by the household while non-discretionary expenses must be paid or penalties are applied.

7 a Household expense

b Household expense

c Household expense

d Household expense

e Household expense

f Other

g Other

h Other

i Household expense

j Household expense

k Household expense

l Household expense

m Household expense

n Household expense

o Household expense

p Household expense

8 a,b,c,d,e,i,j,k,l,n,p are discretionary

9 a The first **b** The first

c First=\$33.79, Second=\$34.47

d First=\$46.14, Second=\$52.30

e The first

10 a i 8%

ii 40%

b 65

c i 10%

ii \$8

iii \$88

11 a 1.5% **b** 0%

c \$950

d Single Tier 2, 1.25%

e \$1650

12 Prepaid is a payment at the beginning of the month giving access to a fixed amount of service, post paid is at the end of the month base off how much service you've consumed that much

13 a i \$348

ii \$696

b i \$398

ii \$614

c i \$288

ii \$720

d i \$196.65

ii \$386.85

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14 **a** $100
b The storage, 128 GB vs 256 GB
c Answers will vary

15 **a** Plan A 3 GB, Plan B 20 GB, Plan C 40 GB, Plan D 65 GB
b Answers will vary
c Plan A $5, Plan B $1.25, Plan C $0.88, Plan D $0.69
d Plan D
e Answers will vary

16 The basket of goods from the current and previous year determine the CPI

17 The weighting indicates the importance of the goods and services being affected

18 **a** 15.5% **b** 33.86%
c 95.45% **d** 19.2%

19 **a** $102 **b** $824
c $38.33 **d** $13.43

20 Answers to part **i** will vary
a **ii** Yes
b **ii** No
iii $278
iv $10 more
c **ii** No
iii $98
iv $13 less
d **ii** No
iii $99
iv $2 Less
e **ii** No
iii $49.05
iv $0.95 more
f **ii** No
iii $205.20
iv $5.20 less
g **ii** No
iii $256
iv $26 more
h **ii** No
iii $39.99
iv $0.01 more

21 **a**

b

c

d


22 **a** **i** $5
ii $1
b **i** $3
ii $1
c **i** $8
ii $1
d **i** $40
ii $10
e **i** $20
ii $10

23 **a** **i** $\frac{1}{4}$
ii $\frac{3}{4}$
b **i** $\frac{1}{3}$
ii $\frac{2}{3}$
c **i** $\frac{1}{20}$
ii $\frac{19}{20}$

24 **a** **i** 20%
ii 80%
b **i** 16.67%
ii 83.33%
c **i** 6.67%
ii 93.33%

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Chapter 10

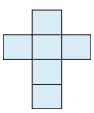
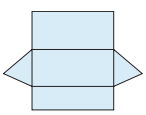
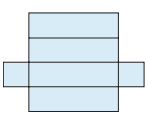
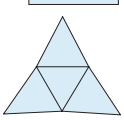
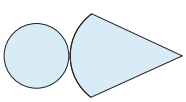
10B Practice questions

1 Answers will vary
2 Answers will vary
3 Answers will vary

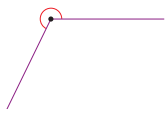
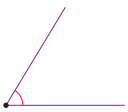
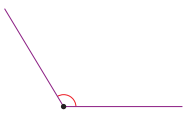
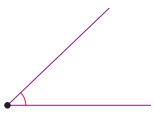
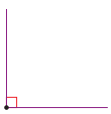
10C Tasks and questions

1 Answers will vary
2

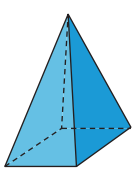
1D – 1 dimension	2D – 2 dimensions:	3D – 3 dimensions:
b	*d,f,g,i,j,k,l*	*a,c,e,h*

3 Answers will vary
4 Answers will vary
5 Answers will vary
6 a 
b 
c 
d 
e 
f 

10D Tasks and questions

1 Answers will vary
2 a 90° b 243°
c 70° d 30°
e 210° f 45°
g 60° h 120°
3 a 
b 
c 
d 
e 
f 
4 In order for Q2: right, reflex, acute, acute, reflex, acute, acute, obtuse
In order for Q3: obtuse, reflex, acute, obtuse, acute, right
5 Answers will vary
6 a 70°
b 35° and 120°
c 130° and 30°
d 35° e 130°
f 130°
7 Answers will vary

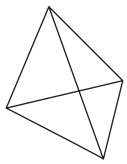
10E Tasks and questions

1 Answers will vary
2 a 3 b 4
c 4 d 5
e 6 f 8
3 Quadrilateral
4 a 

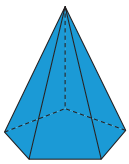
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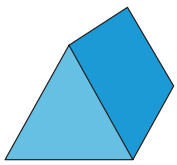
b



c



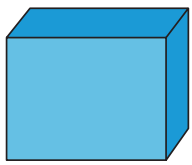
d



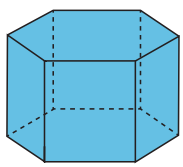
e



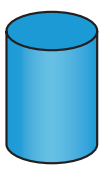
f



g



h



5 Answers will vary

6 Answers will vary

7 **a** regular **b** prism
c edge **d** vertex
e vertical **f** curve
g boundary **h** surface

8 Answers will vary

9 Answers will vary

10F Tasks and questions

1 Answers will vary

2 **a** B, C, E, F, I **b** B, E, G, I
c B **d** A, H
e E, I

3 **a** Rectangular prism
b Parallel lines
c Right-angled triangle
d Parallelogram
e Triangular prism
f Perpendicular lines
g Isosceles triangle
h Ellipse

4 **a** 2 rectangles, 1 circle
b 3 trapeziums and 1 rectangle
c 3 triangles overlapping
d Diamond
e Octagon
f Cone and square
g Rectangles
h 2 semi-circles and 1 rectangle

5 Answers will vary

6 Answers will vary

7 Answers will vary

10G Tasks and questions

1 Answers will vary

2 **a** 53 mm
b 136 mm
c 97 mm

4 Answers will vary

5 Answers will vary

10H Tasks and questions

1 Answers will vary

2 **a** 100 **b** 20
c 4000 **d** 2
e 25 **f** $\frac{2}{3}$

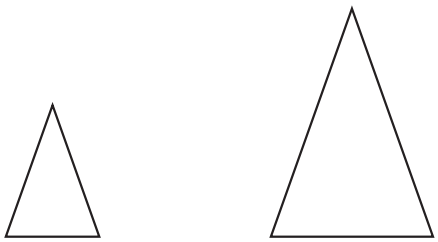
3 **a** $\frac{1}{2}$ **b** $\frac{1}{3}$

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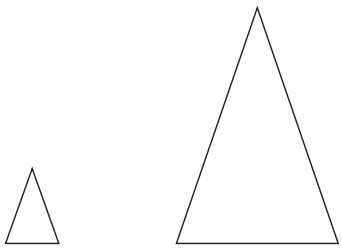
c $\frac{1}{25}$ **d** $\frac{1}{20}$

e $\frac{1}{400}$ **f** $\frac{1}{63}$

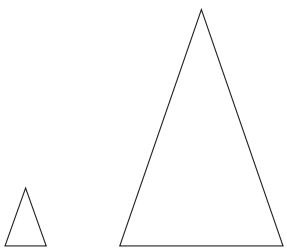
4 a



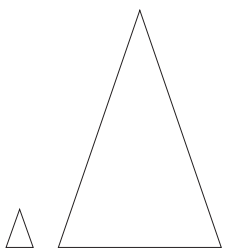
b



c



d



5 Model: A visual depiction/replica used for scientific purpose
Scale: The ratio a size has been changed/altered

6 a $\frac{1}{10}$ th **b** $\frac{1}{50}$ th

c 250 times

7 a 11.25 m **b** 75 mm

c 9.555 mm **d** 1.275 m

8 a C **b** B

c D **d** A

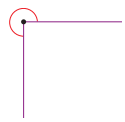
e A

10I Tasks and questions

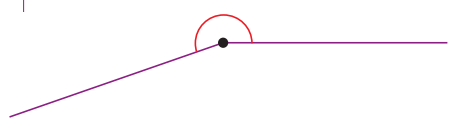
1 Answers will vary
2 Answers will vary
3 Answers will vary
4 Answers will vary
5 Answers will vary
6 Answers will vary

Chapter review questions

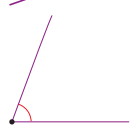
1 Answers will vary
2 Answers will vary
3 Answers will vary
4 a



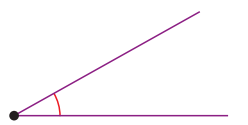
b



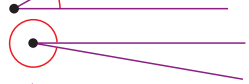
c



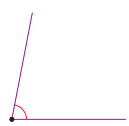
d



e



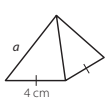
f



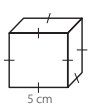
5 a 85° **b** 25°

c 80°

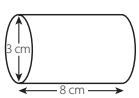
6 a



b



c



7 Answers will vary
8 Answers will vary

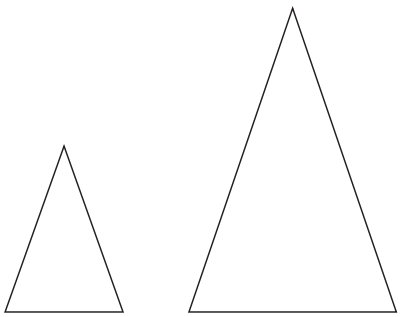
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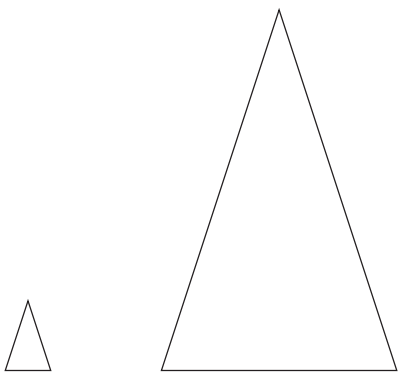
9 **a** 10 **b** 5
c 12.5 **d** 6
e 10 000

10 **a** $\frac{1}{3}$ **b** $\frac{2}{7}$
c $\frac{1}{50}$ **d** $\frac{1}{20}$
e $\frac{1}{1200}$

11 **a**



b



12 Answers will vary

Chapter 11

11B Practice questions

1 **a** The size and shape of the cookies, the number of cookies
b Answers will vary
c Answers will vary
d Answers will vary

2 Answers will vary

3

Device	Used to measure	Units of measurement
Tape measure	lengths	mm, cm, m
Measuring cup	quantity of water, flour, sugar	mL
Syringe	medicine for injections	mL
Bucket	quantity of water, paint	L
Bathroom scales	body weight	kg
Checkout scales	weight of groceries	g
Oven thermometer	temperature	°C
Answers will vary	areas	mm^2 , m^2, km^2
Answers will vary	volumes	mm^3 , m^3, km^3

11C Tasks and questions

1 **a** m^2, answers will vary
b m/s, answers will vary
c km/h, answers will vary
d m^3, answers will vary
e g/cm^3, answers will vary
f min/km, answers will vary

2 **a** 5 cm **b** 10 cm
c 8 cm

3 **a** 40 mm **b** 180 mm
c 1200 mm **d** 6000 mm
e 9000 mm **f** 25000 mm

4 **a** 4 m **b** 3.2 m
c 2.79 m **d** 5 m
e 8.9 m **f** 4.68 m

5 **a** 3.5 km **b** 4 km
c 2.5 km

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6 **a** 5000 mL
b 7500 mL
c 1250 mL
d 250 mL
e 2100 mL
f 125 mL

7 **a** 0.5 L
b 0.0175 L
c 2.5 L
d 1.25 L
e 0.05 L
f 12.25 L

8 **a** 5 kL
b 17.5 kL
c 2.5 kL
d 0.125 kL
e 0.05 kL
f 1.2 kL

9 **a** 2500 mg
b 75 000 mg
c 125 000 mg
d 250 mg
e 2 000 000 mg
f 125 000 mg

10 **a** 2.5 kg
b 32.75 kg
c 0.65 kg
d 0.0255 kg
e 2750 kg
f 0.2 kg

11 **a** 12.754 tonne
b 0.75 tonne
c 0.00275 tonne
d 0.0001275 tonne
e 0.055755 tonne
f 0.00525 tonne

12 **a** 37.5 cm
b 2500 kg
c 2500 mL
d 3755 m
e 0.085 L
f 0.2565 km
g 1.125 tonne
h 7.25 km
i 333 L
j 200 g
k 0.05 g
l 200 000 mg

13 Answers will vary

14 **a** 100 mm **b** 350 mm
c 2000 mm **d** 2550 mm
e 100 mm **f** 350 mm
g 2000 mm **h** 2550 mm
i 460 mm **j** 210 mm

15 **a** 470 mm **b** 0.5 L
c 1000 mL **d** 0.4 kg
e 5000 g
f 1.167 hours

11D Tasks and questions

1 Answers will vary

2 **a** 4 cm **b** 6 cm
c 13 cm **d** 8 cm
e 3 cm **f** 2.5 cm
g 5.7 cm **h** 6.4 cm
i 4.3 cm

3 Answers will vary

4 **a** 22 or 53 **b** 20 or 44
c Answers will vary

5 **a** $\frac{1}{2}$ **b** 62.5 g
c 125 mL **d** 375 mL
e 250 g butter
1 cup sugar
4 eggs
3 cups self-raising flour
2 tsp cinnamon
2 tsp mixed spice
2 tsp bicarbonate of soda
4 tbsp milk
6 ripe bananas, mashed
2 pinches salt

6 Answers will vary

7 **a** 60% **b** 35%
c 75% **d** 90%
e 30 L, 17.5 L, 37.5 L, 45 L

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8 **a** 45 L **b** 700 km
c 1.4 tanks
d Answers will vary
e Answers will vary
f Answers will vary

9 Yes, it will take him 10 minutes to return his car

11E Tasks and questions

1 Answers will vary

2 **a** 8 h **b** 9 h 45 min
c 5 h 15 min **d** 7 h 45 min

3 **a** 1.3 min **b** 5 min
c 0.5 min **d** 1.5 min

4 **a** 1 h **b** 2 h
c 6.7 h **d** 1.5 h
e 5.5 h

5 **a** 300 min **b** 600 s
c 2.5 h **d** 3600 s

6 **a** 30 min **b** 1.5 h
c 2 h 28 min **d** 15 min
e 1.27 min **f** 45 min
g 108.3 h **h** 15 min
i 4 h 18 min **j** 30 min

7 Answers will vary

8

	Start	Finish	Time worked (h:min)
Mon	-	-	
Tues	6 pm	9:15 pm	3:15
Wed	8 am	4 pm	8:00
Thurs	8 am	12 pm	4:00
Fri	4:30 pm	9:15 pm	4:45
Sat	8 am	1:30 pm	5:30
Sun	-	-	

9 One year, from July first through till June 30 the next year.

10 Answers will vary
11 Answers will vary
12 20.88 min
13 15.5 min
14 23 April
15 **a** 255 days
b June 27 the next year
c December 27 the next year
16 For 2022 9:30 am-12:30 am. Melbourne partakes in daylight savings whilst WA does not. However, daylight savings typically ends before April 9. So there is no need to take it into account.

11F Tasks and questions

1 Answers will vary
2 Answers will vary for part **i**
a 31.4 cm
b 37.7 m
c 15707.96 mm
d 109.96 cm
e 18.8 cm
f 40.8 cm
3 Archimedes
4 Answers will vary
5 It doubles
6 You must half it

11G Tasks and questions

1 Answers will vary
2 Answers will vary
3 The United States and Liberia use the imperial system
4 Answers will vary
5 **a** Single = 21 m^2, double = 33 m^2
b 12 m^2
c 1.57 times larger

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11H Tasks and questions

1 Answers will vary

2 **a** 384 cm^2 **b** 9600 cm^2
c 5400 cm^2 **d** 24 cm^2
e 2400 mm^2
f 118 680 m^2 or 91 997.3m^2
g 62 cm^2 **h** 242 m^2
i 9750 m^2

3 **a** 314.2 mm^2 **b** 113.1 m^2
c 28.3 m^2 **d** 78.5 m^2

4 **a** 32 cm **b** 22.5 m^2
c 150.8 cm^2 **d** 384 cm^2
e 2.16 m^2

5 1. perimeter
2. length
3. radius
4. prism
5. volume
6. circumference
6. capacity
7. breadth
8. pyramid
9. total surface area
10. cylinder
11. diameter
12. height
13. polygon
14. base

6 **a** 4 m^2, 5 m^2, 4 m^2, 3.4 m^2
b 5 m^2 **c** 21.4 m^2

7 **a** 22 boxes **b** $1650

11I Tasks and questions

1 **a** Typically no
b Answers will vary

2 **a** 30 m^3 **b** 50.3 mm^3
c 12 m^3 **d** 720 m^3
e 4096 cm^3 **f** 523.6 m^3

3 **a** 180 cm **b** 204.8 m^2
c 763.4 cm^3 **d** 2500 m
e 696.9 cm^3

4 Answers will vary

5 Answers will vary

6 **a** 30 mL, 3 caps, 18 L
b 1 bucket

7 **a** 17.5 L
b Answers will vary

8 Answers will vary

9 180 mL water to 18 mL cleaner

10 Answers will vary for parts iii and iv
a **i** 24 000 L **ii** 24 m^3
b **i** 48600 L **ii** 48.6 m^3
c **i** 80 424.77 L **ii** 80.4 m^3
d **i** 9450 L **ii** 9.45 m^3

Chapter review questions

1 **a** 0.005 m **b** 1.6 hours
c 2.75 km **d** 7500 kg
e 27 500 mg **f** 563 L
g 1530 mL **h** 6.754 tonne
i 0.015 L **j** 12.5 g

2 **a** 1 335 510 m^2 **b** 133.551 ha

3 Answers will vary

4 Answers will vary

5 Answers will vary

6 **a** 100 mL cordial, 900 mL water
b 200 mL cordial, 1800 mL water
c 25 mL cordial, 225 mL water

7 **a** The train which arrives at 4:04 pm
b 2:36 pm

8 1 hr 7 mins or 1 hr 32 mins

9 **a** 2020 mm
b 4400 mm

10 **a** 8244 cm^2
b 3442.8 cm^2
c 12 105 cm^2

11 **a** 3 487 400 mm^2 **b** 4 043 900 mm^2
c 4 600 400 mm^2

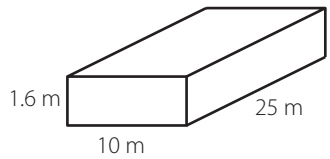
12 **a** 21 501.06 cm^2 **b** 5026.55 cm^2
c 432 928.17 cm^2

13 **a** 60 m^3 **b** 76.97 m^3
c 108.84 m^3 **d** 210 m^3

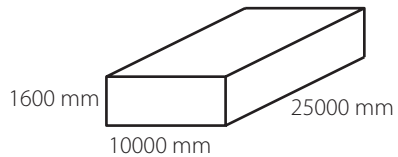
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14 a



b



c 250 m^2 **d** 362 m^2

e Volume = 375 m^3, capacity = 375 kL

Chapter 12

12B Practice questions

1 Answers will vary
2 Answers will vary
3 Answers will vary

12C Tasks and questions

1 Answers will vary
2 Answers will vary
3 a North **b** North
c West **d** SE
e SW
4 a i Next to
ii South of
iii East of
iv North of
v Opposite to
vi West of
b i False
ii True
iii False
iv True
v False
5 West
6 West
7 North
8 a West **b** East
c North-East **d** South-East
e South **f** South-East
g South-West **h** North-East
9 a West **b** South-East
c East **d** North-East
e South-West **f** North-West
g South **h** South-West
10 a Compass **b** location,
c direction **d** adjacent
e anticlockwise
11 Answers will vary

12D Tasks and questions

1 Answers will vary
2 a 2 **b** The Post Office
c West-East **d** North
3 a 3 **b** No
c North
4 a North **b** West
c Anticlockwise
5 i a G6, H6 **b** J6
c J5, J6
ii a Bunnings
b Strandbags, Specsaver, Hoskings, Muffin Break, Jay Jays
c Millers
6 Answers will vary
7 a Caravan park **b** Oval
c Hospital
8 a B4 **b** E3 and B4
9 North to South
10 NE
11 a Dunkeld Racecourse
b Railway Station Church and Recreation Reserve Church
12 a B5 **b** C4
c C4 and D4
13 West

12E Tasks and questions

1 Answers will vary
2 Answers will vary

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3 **a** 34.3 km/h **b** 7.6 km/h
c 58.7 km/h **d** 32.4 km/h
4 **a** 16.8 m/s **b** 16.8 m/s
c 7.2 m/s **d** 13.7 m/s
e 1.7 m/s
5 **a** 3 h and 8 min **b** 2 h and 51 min
c 4 h and 16 min
6 **a** 233.8 km **b** 79.2 km
c 12.8 km
7 Answers will vary
8 Answers will vary
9 **a** 6 km **b** 45 min
c 2 h 8 min
10 **a** 7.2 m/s **b** 49.4 km/h
c 3 h 7 min 30 s **d** 2 h 50 min 40 s
e 233.8 km **f** 79.2 km

12F Tasks and questions

1 Answers will vary
2 m or km
3 km
4 **a** 150 m **b** 1050 m
c 975 m
5 **a** 10 km **b** 120 km
c 175 m
6 1:250 000
7 1:20 000
8 **a** 530 m **b** 807.7 m
c Answers will vary
10 **a** 7.5 km
b Approximately 10 km
c 10.6 km
d 1 h 45 min

12G Tasks and questions

1 Answers will vary
2 **a** 30 **b** 10
c 48 **d** 23
e 37
3 4:45 pm
4 4:10 pm
5 **a** 5:41 am
b 5:46 am
c 10 min
d The trams that arrive at Stop 57 at either 5:20 am or 5:32 am
6 **a** 11:07 taking 3 h 28 min
b 16:59 taking 3 h 53 min
c Either of the trains that depart southern cross at 07:39 am and 10:06 am
7 1 hour and 6 minutes
8 32 minutes
9 11 minutes
10 **a** 10:40 am
b The train that departs at 11:06 am
c 49 minutes
11 **a** 10:13 am **b** 10:28 am
c 29 min
12 Answers will vary
13 **a** 6 **b** 9
c 27 min
14 **a** 9:12 am **b** 4:12 pm
c 2 hours and 26 min
15 **a** On Saturday he catches the train from 9:40–14:14, and Sunday 18:51–23:19
b 9:20 am
c 9 hours and 2 minutes
16 **a** The drive takes 1 hour and 20 mins, the walk takes 3 hours and 42 minutes
b Start drive at 8:20 am, arrive at 9:00 am. Walk till 12:42 pm. Have lunch till 1:12 pm
Drive back at 1:12 pm. Return to Yulara at 1:52 pm

12H Tasks and questions

1 Answers will vary
2 **a** via Baker St
b No. Traffic lights however could cause one route to be slower
c Answers will vary
d Answers will vary
3 Answers will vary

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4 Answers will vary
5 Note that these are not the only solutions to this problem
   a 2 (565 km,621 km)
   b 4 (8 h 18 min, 8 h 20 min, 115 min, 8 h 19 min)
   c 8 h 18 min by 2 mins
6 Note that these are not the only solutions to this problem
   a 2 (65 km, 55 km)
   b 4 (1 hr, 59 min, 57 min, 1 hr)
   c 57 min by 2 mins
7 Note that these are not the only solutions to this problem
   a 2(10.2 km for 37 min or 10 km for 36 min)
   b 2(8 km and 8.1 km, both for 1 hr 42 min)
   c The 36 minute, 10 km bike ride by 1 minute
8 Answers will vary
9 Answers will vary
10 Answers will vary
11 Note that these are not the only solutions to this problem
   a 10:42 am b 11:24 am
   c 1:31 pm d 2:11 pm
   e 1 hour 22 mins f No
12 Note that these are not the only solutions to this problem
   Leave Maryborough at 8:56 am, arrive in Ballarat at 10:05 am, 1 hour 9 min.
   Depart Ballarat at 2:51 pm, arrive in Maryborough at 3:58 pm, 1 hour 7 min
13 a Wednesday depart Port Fairy at 5:24 am and arrive in Geelong at 8:32 am
   Thursday depart Geelong at 8:27 pm and arrive in Port Fairy at 11:24 pm
   b Wednesday depart Port Fairy at 5:24 am and arrive in Geelong at 8:32 am
   Thursday depart Geelong at 8:17 pm and arrive in Port Fairy at 11:24 pm
   c 6 hours and 5 minutes
14 a 4
   b Car is 40+ minutes less
   c Answers will vary
15 a 9
   b Answers will vary
   c They range from 2 hours 40 mins to 4 hours 27 minutes. Averaging 3 hours 20 mins
   d Answers will vary
   e Answers will vary
16 Answers will vary

Chapter review questions

1 Answers will vary
2 Answers will vary
3 a 100 km b 250 km
   c 70 km d 70 km
   e 90 km f 160 km
   g 60 km
4 Answers will vary
5 a 14 mins b 17 mins
   c 1 h 30 mins
6 a 160 km b 8.3 km
   c 183.3 km
7 a 26.4 m/s b 15 m/s
   c 18.8 m/s
8 a 1 h 50 mins b 12:56 pm
   c 11:31 am d 3 hours 16 mins
   e The bus departing Southern Cross at 6:16
   f The 10:50 bus from Southern Cross
   g From a birds path, 75 km

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