NELSON SENIOR MATHS

MATHEMATICS ESSENTIAL
UNITS 1 AND 2

Revised for WA and Australian Curriculum

YEAR 11

Sue Thomson
Judy Binns
2ND EDITION

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PREFACE

Nelson Senior Maths 11: Mathematics Essential Units 1 and 2 has been revised and updated for the WA syllabus and Australian curriculum. In this book, students and teachers will find familiar features such as clear worked examples, graded exercises, strong syllabus coverage, Investigations, Technology and a glossary/index. You will also notice new features including *Test yourself* chapter reviews and *Practice set* mixed reviews. We have also introduced a NelsonNet student website containing worksheets, video tutorials and *ExamView quizzes*, while the *NelsonNet* teacher website contains the entire *ExamView* questionbank and software.

The Mathematics Essential course is designed for students heading towards the workforce or further training after school. The course demonstrates interesting and relevant applications of mathematics.

The Years 11 and 12 books cover the syllabus with 16 short chapters written in plain English, with an emphasis on numeracy, literacy and real-life applications. Themes include sport, health, travelling, personal finance, art, building and measurement. We wish all teachers and students using this book every success in embracing the Mathematics Essential courses.

ABOUT THE AUTHORS

Sue Thomson is an experienced teacher and educational leader. She was an examination writer, assessor, marker and curriculum writer. Sue is a prolific and successful author with an interest in language development, financial literacy and making mathematics accessible to all. With her husband, Ian Forster, she wrote the successful *Workable Maths* and *Hands-on Maths in Practice* series for WA.

Judy Binns is a mathematics coordinator and experienced author who has taught in urban and rural schools. She has an interest in motivating students with learning difficulties, and wide experience in teaching senior practical mathematics courses. Judy co-wrote a successful mathematics series for Years 7–8 and often presents at local and state conferences.

CONTRIBUTING AUTHORS

Deborah Van Hoek wrote many of the *NelsonNet* worksheets.

John Drake, Katie Jackson and **Joanne Magner** created the video tutorials.

Roger Walter wrote the *ExamView* questions.

SYLLABUS REFERENCE GRID

Topics and subtopics	Nelson Senior Maths 11 Mathematics Essential chapter
UNIT 1	
Basic calculations, percentages and rates	
Checking and making sense of all calculations	1 What's the score?
Basic calculations	1 What's the score?
	8 Earning money
Percentages	2 Giving 110%
Rates	6 Healthy figures
Using formulas for practical purposes	
	4 Using formulas
Measurement	
Linear measure	3 Measuring length and area
Area measure	3 Measuring length and area
Mass	7 Turn up the volume
Volume and capacity	7 Turn up the volume
Units of energy	6 Healthy figures
Graphs	
Reading and interpreting graphs	5 Show me the graph
Drawing graphs	5 Show me the graph
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Representing and comparing data	
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Data presentation and interpretation	9 Show me the data
Summarising and interpreting data	14 It's better than average
Comparing data sets	16 Comparing data
Percentages	
Percentage calculations	11 Applying percentages
Applications of percentages	11 Applying percentages
Rates and ratios	
Ratios	14 Colourful ratios
Rates	13 Applying rates
Time and motion	
Time	10 It's about time
Distance and length	15 Going places
Speed	15 Going places

ABOUT THIS B◯◯K

AT THE BEGINNING OF EACH CHAPTER

- Each chapter begins on a double-page spread showing a **Chapter Problem** to be solved, a chapter table of contents, a **What we will do in this chapter?** list of outcomes, and a **How are we ever going to use this?** list of applications.

BASIC CALCULATIONS, PERCENTAGES AND RATES

1.

WHAT'S THE SCORE?

Chapter problem
Ben bought fish and chips for $11.25 and paid with a $50 note.
The cashier gave him a $20 and a $5 note and a few coins for his change.
Could the change be wrong?

1.01 Target practice
1.02 Playing darts
1.03 Percentages, fractions and decimals
1.04 Order of operations
1.05 How much do I pay?
1.06 Estimating costs
1.07 Rounding numbers
1.08 Practical multiples
1.09 After the point
1.10 How much do I get?
Keyword activity
Solution to the chapter problem
Test yourself

WHAT WILL WE DO IN THIS CHAPTER?

- Calculate with numbers
- Convert between percentages and fractions/decimals
- Find a fraction or decimal of a quantity
- Add, subtract, multiply and divide using order of operations, with and without a calculator
- Estimate and check the reasonableness of answers
- Understand place value after the decimal point in decimals
- Round numbers, including to decimal places
- Solve practical problems involving numbers

HOW ARE WE EVER GOING TO USE THIS?

- Keeping score in sporting events
- Shopping
- At work
- Budgeting: for yourself or for a party
- Home renovations

NELSON SENIOR MATHS 11. Essential Mathematics

IN EACH CHAPTER

- Worked examples are explained clearly step-by-step, with the mathematical working shown on the right-hand-side.

- Important facts and formulas are highlighted in a shaded box.

- Important words and phrases are printed in **red** and listed in the glossary at the back of the book.

- Graded exercises are linked to the worked examples and include exam-style problems and realistic applications.

- **Investigations** and **practical activities** explore the syllabus in more detail, through group work, discovery and modelling activities.

- **Technology** promotes ICT in the classroom, using spreadsheets and the Internet.

Sample page showing worked examples:

i		0.73	
j	$\frac{1}{3}$		
k			$66\frac{1}{3}\%$

Example 5

7 Find:

a $\frac{3}{5} \times 40$ b $\frac{1}{4} \times 28$ c $\frac{1}{6} \times 24$

d $\frac{2}{3} \times 15$ e $\frac{7}{10} \times 60$ f $\frac{5}{8} \times 16$

g $\frac{3}{4}$ of 1 km (in metres)   h $\frac{1}{3}$ of 1 day (in hours)

i $\frac{2}{5}$ of 1 L (in mL)   j $\frac{1}{8}$ of 1 t (in kg)

k $\frac{5}{6}$ of 1 year (in months)   l $\frac{7}{12}$ of 1 hour (in min)

1.04 Order of operations

What is the answer to $200 \div 20 \times 2$? Is it 20 or 50?

BIDMAS is an easy way to remember the **order of operations** in a **mixed calculation**.

B   I   D   M   A   S

Brackets Indices ÷ × + −

To solve this problem, we have special rules for the order in which we do calculations.

- **B**rackets ( ) first
- **I**ndices (powers) next
- Then any **D**ividing ÷ or **M**ultiplying ×, working from left to right
- Finally, any **A**dding + or **S**ubtracting −, working from left to right

So $200 \div 20 \times 2 = 20$, because we do × and ÷ at the same time and we work from left to right.

---

10 The Boomers and the Snakes are two opposing teams in an AFL match. In AFL, teams score 6 points for a goal and 1 point for a behind. At three-quarter time the Boomers had scored 18 goals and 2 behinds while the Snakes had scored 17 goals and 8 behinds. Who is winning?

11 The BBQ Specialists are catering for Mala's garden party. They are supplying catering and bar service for 42 people. How much will Mala have to pay?

The BBQ specialists
Catering
Steak and salad with bread rolls: $18.75 per person
Bar service
Fruit juices and soft drink: $6.50 per person

PRACTICAL ACTIVITY

THE YEAR 11 PARTY

Budget catering

Price per person

Finger food:	$5.60
BBQ steak:	$3.20
BBQ sausages:	$2.10
BBQ seafood:	$8.25
Salad:	$4.50
Bread rolls:	90c
Desserts:	$5.95
Coffee/tea:	$1.10
Cheese platters and biscuits:	$2.60
Fruit platters:	$2.40
Non-alcoholic drinks:	$7.40

Toby is responsible for organising the catering for the Year 11 end-of-year party. The organising committee has allocated $4000 to spend on the food and non-alcoholic drinks for the 180 people expected to attend.

Your group's task is to help Toby decide on an interesting menu for food and drink. Remember to stay within your budget.

1.06 Estimating costs

It's difficult to mentally calculate the total cost of the items in your supermarket trolley, but careful shoppers can **estimate** using approximation techniques.

EXAMPLE 9

Patrick is purchasing the supermarket items shown below: 5 cans of dog food, Caesar salad, blueberries, teabags, strawberries and macadamia nuts. The price of each item is shown.

Patrick has $54 in his wallet. Estimate whether he has enough to pay for his shopping.

Solution

Mentally round each price *up* to the nearest dollar.

Dog food: $5 \times \$3 = \$15$
Caesar salad: $6
Blueberries: $5
Teabags: $7
Strawberries: $5
Macadamia nuts: $14

Estimated price = 15 + 6 + 5 + 7 + 5 + 14 = 52

When we estimated the costs, each estimate was more than the true cost.

The items cost approximately $52.

The true cost of the items is less than $52.

Write the answer to the question.

Patrick has enough money to pay for his shopping.

AT THE END OF EACH CHAPTER

- **Keyword activity** focuses on the mathematical language and terminology learned in the chapter.

- **Solution to the chapter problem** revisits the problem introduced at the start of the chapter and presents a solution to the problem.

- **Test yourself** contains revision linked to the relevant exercise set.

- **Practice sets** revise the skills and knowledge of previous chapters.

AT THE END OF THE BOOK

- **Glossary/Index** is a comprehensive dictionary of course terminology.

- **Answers**.

NELSONNET STUDENT WEBSITE

Margin icons link to print (PDF) and multimedia resources found on the NelsonNet student website, **www.nelsonnet.com.au**. These include:
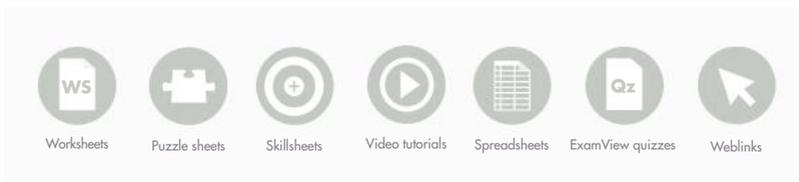
- **Worksheets** and **puzzle sheets** that are write-in enabled PDFs
- **Skillsheets** of examples and exercises of prerequisite skills and knowledge
- **Video tutorials**: worked examples explained by 'flipped classroom' teachers explained online
- **Spreadsheets**: *Excel* files
- **ExamView quizzes**: interactive and self-marking

NELSONNET TEACHER WEBSITE

- **ExamView**: exam-writing software and questionbanks
- **A teaching plan**, in Microsoft Word and PDF formats
- **Chapter PDFs** of the textbook
- **Resource Finder**: search engine for *NelsonNet* resources

Note: Complimentary access to *NelsonNet* is only available to teachers who use this book as a core educational resource in their classroom. Contact your sales representative for information about access codes and conditions.

NELSONNETBOOK

NelsonNetBook is the web-based interactive version of this book found on *NelsonNet*.

- To each page you can add notes, voice and sound bites, highlighting, weblinks and bookmarks
- **Zoom** and **Search** functions
- Chapters can be customised for different groups of students

1.

WHAT'S THE SCORE?

Chapter problem

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The cashier gave him a $20 and a $5 note and a few coins for his change.
Could the change be wrong?

WHAT WILL WE DO IN THIS CHAPTER?

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1.01 Target practice

Alan coaches a junior football team. He designed a ball-throwing competition to help his players improve the accuracy of their passes. Each player throws a football at the target two times each turn. The first player to reach 100 points is the winner.

The 2 red crosses on the diagram show where Marc's throws landed. One throw landed in **double 6** and the other in **8**.

Marc's score = $2 \times 6 + 8$

$\qquad = 12 + 8$

$\qquad = 20$

Exercise 1.01 Target practice

1 Without using a calculator, work out the scores for each turn.

a

b

c

d
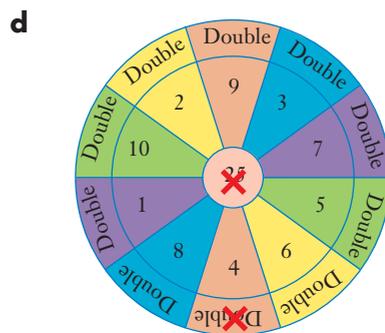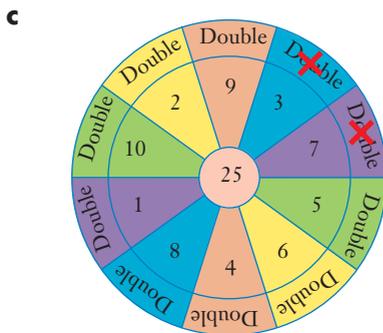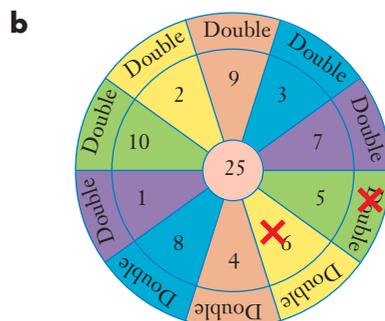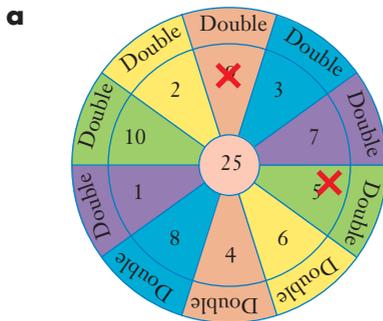
2 Add each set of scores as quickly as you can.

    a A 7 and a 9   **b** Double 5 and 8   **c** Double 6 and double 4

    d Double 9 and double 5   **e** Bullseye and double 10   **f** A 3 and double 7

3 Jason's score from 2 throws was 13. Suggest 5 different combinations of points that can make a score of 13.

4 How many different ways can you get a score of 7 from 2 throws? List the ways.

5 To win the game, a player's score must add to exactly 100. David's score is 77.

    a How many more points does David need to score to win?

    b What strategy can David use to win on his next turn?

6 What is the smallest number of throws required to make a total of exactly 100? How is it achieved?

7 Courtney's score is 81. She decided to aim for a 9 and a 10. With her first throw, Courtney missed the 9 and her ball landed on 3. How can she still make 100 on her second throw?

8 When Alan designed the positions of the numbers on the target, he didn't put any big numbers next to each other. He put small numbers on each side of the big numbers. Why do you think Alan arranged the numbers in this way?

PRACTICAL ACTIVITY

DESIGN A PRACTICE COMPETITION

What you have to do

1 Design a practice competition to develop the skills of children learning to play a sporting game that you enjoy.

2 Determine the rules and how you will score the game.

3 Use the practice competition with some younger children in your area.

4 How successful was the competition in developing the children's skills?

5 Did the scoring help to improve the children's number skills?

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1.02 Playing darts

Double points
Triple points
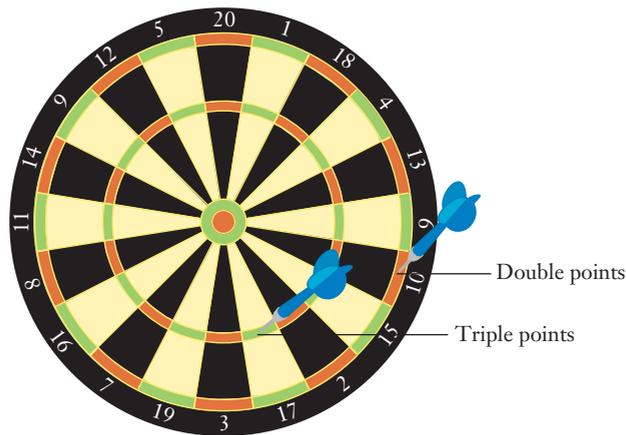
There are 20 numbers on a dartboard and each player throws 3 darts on their turn.
If a dart lands in the **outside ring** of a number, the dart scores **double points**. It scores
triple points if it lands in the **inside ring**. The **bullseye** is worth 50 points. The green ring
around the bullseye is worth 25 points.

Exercise 1.02 Playing darts

1 Calculate the score for each player.

a
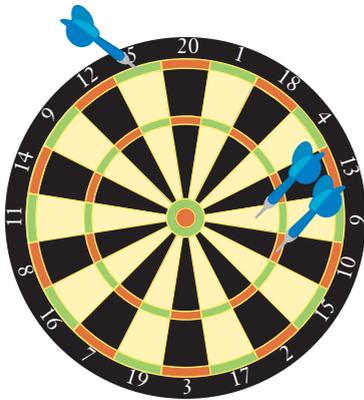
b
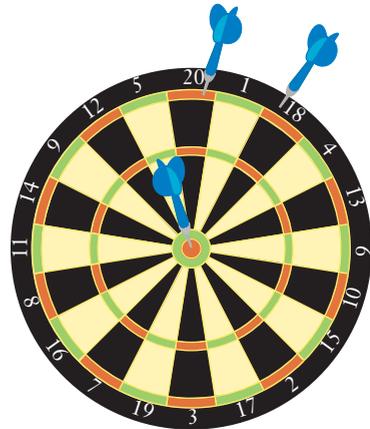
2 What is the highest score possible with 3 darts?

3 How can you score a total of 37 using 3 darts? Suggest 2 possible ways.

4 In the dart game '201', players start with 201 points and they keep subtracting the points they score with 3 darts. The winner is the first to reach 0, but they must finish with a double. If a player's score on one turn is more than their remaining points, *no* points are subtracted for that turn. Use the rules of the game to answer the rest of the questions in this exercise.

With her first set of 3 darts, Madeleine scored a 7, a double 5 and a triple 11.

How many points did Madeleine have left after this?

5 After the second round, Tim had 152 points left and Rebecca had 147. Who is winning the game: Tim or Rebecca?

6 Fiona had 126 points remaining before her turn. After her turn, she had 103 points. One of her darts landed on double 1 and another on 5. Where could her third dart have landed?

7 Divya's score was 86. She threw 2 double 20s and a triple 19. What was Divya's score after her turn?

8 Before he had his turn Santo had 136 points remaining. His first dart landed on 20, his second landed on triple 4 and his third missed the board. How many points did Santo have left after his turn?

9 Andre needs to score 34 points, finishing with a double, to win a game of 201.

How could he win using:

a one dart? **b** 2 darts? **c** 3 darts?

10 What is the largest number of points a player can have and still win on their next turn? Explain your answer.

11 Renata and Samantha are playing 201, writing their progress scores on a board.

Turn	Renata	Samantha
	201	201
1	162	175
2	102	143
3	63	85
4	39	55
5	24	29
6	0	

a In what number turn did Samantha score a total of 30 points?

b Who threw 20 three times in the same turn? In which turn did she do it?

c What was Samantha's biggest score in one turn?

d In which turn did Samantha throw a double 3, triple 2 and single 20?

e Renata finished when she threw a double 7. Explain how it was possible for her to finish with a double 7.

f Samantha can tie the game if she can score a total of 29, finishing with a double. Explain why Samantha will need more than one throw to score 29.

g What strategy do you suggest Samantha should adopt to try to tie the game?

1. What's the score?

1.03 Percentages, fractions and decimals

A percentage is a fraction whose denominator is 100.

> **Converting a fraction or decimal to a percentage**
> - To **convert a percentage to a fraction**, write the percentage with a denominator of 100 and simplify if needed
> - To **convert a percentage into a decimal**, divide it by 100

EXAMPLE 1

Convert each percentage to a simplified fraction.

a 55%   **b** 130%   **c** $37\frac{1}{2}$ %

Solution

a Write the percentage as a fraction over 100 and simplify. Alternatively, enter 55 $a^{b}/_{c}$ 100 on the calculator and press $=$.

$$55\% = \frac{55}{100}$$
$$= \frac{11}{20}$$

b Write 130 as a fraction over 100 and simplify.

$$130\% = \frac{130}{100}$$
$$= \frac{13}{10}$$
$$= 1\frac{3}{10}$$

c Write $37\frac{1}{2}$ as a fraction over 100 and simplify.

> Or enter $37\frac{1}{2} \div 100$ to get 0.375, then use the calculator key that converts a decimal into a fraction.

$$37\frac{1}{2}\% = \frac{37\frac{1}{2}}{100}$$
$$= \frac{37\frac{1}{2} \times 2}{100 \times 2}$$
$$= \frac{75}{200}$$
$$= \frac{3}{8}$$

EXAMPLE 2

Convert each percentage to a decimal.

a   8%   **b**   43.6%   **c** $18\frac{1}{2}\%$

Solution

a   Write the percentage as a division by 100 and simplify. Alternatively, enter 8 [÷] 100 on the calculator and press [=].

$$8\% = \frac{8}{100}$$
$$= 8 \div 100$$
$$= 0.08$$

> To mentally divide a number by 100, move the decimal point 2 places to the left.

b   Divide 43.6 by 100.

$$43.6\% = \frac{43.6}{100}$$
$$= 43.6 \div 100$$
$$= 0.436$$

c   Divide $18\frac{1}{2}$ by 100.

$$18\frac{1}{2}\% = \frac{18\frac{1}{2}}{100}$$
$$= 18.5 \div 100$$
$$= 0.185$$

Converting a fraction or decimal to a percentage

To **convert a fraction or a decimal to a percentage**, multiply it by 100

- $\frac{1}{4} = 25\%$ because $\frac{1}{4} \times 100\% = 25\%$
- $0.2 = 20\%$ because $0.2 \times 100\% = 20\%$

EXAMPLE 3

Convert each fraction to a percentage.

a $\frac{11}{20}$ **b** $\frac{7}{8}$

Solution

a   Multiply the fraction by 100.

$$\frac{11}{20} = \frac{11}{20} \times 100\%$$
$$= 55\%$$

b   Multiply the fraction by 100.

$$\frac{7}{8} = \frac{7}{8} \times 100\%$$
$$= 87\frac{1}{2}\%$$

EXAMPLE 4

Convert each decimal to a percentage.

a   0.65   **b**   0.267

Solution

a   Multiply the decimal by 100.

$$0.65 = 0.65 \times 100\%$$
$$= 65\%$$

> To mentally multiply a number by 100, move the decimal point 2 places to the right.

b   Multiply the decimal by 100.

$$0.267 = 0.267 \times 100\%$$
$$= 26.7\%$$

EXAMPLE 5

Find:

a $\dfrac{1}{5}$ of 45   **b** $\dfrac{7}{8}$ of \$32   **c** $\dfrac{1}{3}$ of 1 year   **d** $\dfrac{4}{5}$ of 2 kg (in grams)

Solution

a   To find a fraction of an amount, we multiply. Check that the answer is reasonable.

$\dfrac{1}{5}$ is a small fraction, so 9 sounds like a reasonable answer for $\dfrac{1}{5}$ of 45.

$$\dfrac{1}{5} \times 45 = 9$$

b $\dfrac{7}{8}$ is a big fraction so \$28 sounds like a reasonable answer for $\dfrac{7}{8}$ of \$32.

$$\dfrac{7}{8} \times \$32 = \$28$$

c   Convert 1 year to months first. $\dfrac{1}{3}$ is less than $\dfrac{1}{2}$, so the answer should be under 6 months, which it is.

1 year = 12 months

$$\dfrac{1}{3} \text{ of 1 year} = \dfrac{1}{3} \times 12 \text{ months}$$
$$= 4 \text{ months}$$

d   Convert 2 kg to grams first. $\dfrac{4}{5}$ is more than $\dfrac{1}{2}$ so the answer should be between 1000 and 2000 g, which it is.

$$2 \text{ kg} = 2 \times 1000 \text{ g} = 2000 \text{ g}$$

$$\dfrac{4}{5} \text{ of } 2\,\text{kg} = \dfrac{4}{5} \times 2000\,\text{g}$$
$$= 1600 \text{ g}$$

Exercise 1.03 Percentages, fractions and decimals

1 Convert each percentage to a simplified fraction.

a	60%	**b**	75%	**c**	31%	**d**	8%
e	30%	**f**	85%	**g**	99%	**h**	3%
i	160%	**j**	135%	**k**	25%	**l**	250%

2 Which decimal is equal to $62\frac{1}{2}\%$? Select the correct answer **A**, **B**, **C** or **D**.

A	62.12	**B**	62.5	**C**	0.625	**D**	0.0625

3 Convert each percentage to a decimal.

a	18%	**b**	82%	**c**	2%	**d**	50%
e	120%	**f**	51.1%	**g**	79%	**h**	$12\frac{1}{2}\%$
i	16.3%	**j**	4%	**k**	18.7%	**l**	$5\frac{1}{4}\%$

4 Convert each fraction to a percentage.

a	$\frac{17}{100}$	**b**	$\frac{7}{10}$	**c**	$\frac{13}{50}$	**d**	$\frac{11}{20}$	**e**	$\frac{5}{8}$	**f**	$\frac{24}{25}$
g	$\frac{8}{5}$	**h**	$\frac{2}{3}$	**i**	$\frac{5}{4}$	**j**	$1\frac{2}{5}$	**k**	$\frac{27}{40}$	**l**	$\frac{1}{16}$
m	$\frac{590}{200}$	**n**	$\frac{4}{9}$	**o**	$\frac{40}{12}$	**p**	$\frac{12}{15}$	**q**	$1\frac{1}{6}$	**r**	$\frac{7}{11}$

5 Convert each decimal to a percentage.

a	0.38	**b**	0.55	**c**	0.96	**d**	0.625
e	0.08	**f**	0.054	**g**	0.6	**h**	0.003
i	1.9	**j**	0.405	**k**	1.26	**l**	0.114

6 Copy and complete this table.

	Fraction	**Decimal**	**Percentage**
a		0.65	
b		0.6	
c			20%
d			84%
e	$\frac{1}{2}$		
f	$\frac{1}{8}$		
g			36%
h	$\frac{5}{8}$		

This table continues next page.

i		0.73	
j	$\dfrac{1}{3}$		
k		$66\frac{2}{3}\%$

Example 5

7 Find:

a $\dfrac{3}{5} \times 40$ **b** $\dfrac{1}{4} \times 28$ **c** $\dfrac{1}{6} \times 24$

d $\dfrac{2}{3} \times 15$ **e** $\dfrac{7}{10} \times 60$ **f** $\dfrac{5}{8} \times 16$

g $\dfrac{3}{4}$ of 1 km (in metres)   **h** $\dfrac{1}{3}$ of 1 day (in hours)

i $\dfrac{2}{5}$ of 1 L (in mL)   **j** $\dfrac{1}{8}$ of 1 t (in kg)

k $\dfrac{5}{6}$ of 1 year (in months)   **l** $\dfrac{7}{12}$ of 1 hour (in min)

1.04 Order of operations

Order of operations

What is the answer to $200 \div 20 \times 2$? Is it 20 or 50?

BIDMAS is an easy way to remember the **order of operations** in a **mixed calculation**.

$$\textbf{B} \quad \textbf{I} \quad \textbf{D} \quad \textbf{M} \quad \textbf{A} \quad \textbf{S}$$

Brackets **Indices**   ÷   ×   +   –

To solve this problem, we have special rules for the order in which we do calculations.

- **B**rackets ( ) first
- **I**ndices (powers) next
- Then any **D**ividing ÷ or **M**ultiplying ×, working from left to right
- Finally, any **A**dding + or **S**ubtracting –, working from left to right

So $200 \div 20 \times 2 = 20$, because we do × and ÷ at the same time and we work from left to right.

EXAMPLE 6

Evaluate each mixed expression.

a $60 - 2 \times 5^2$

b $(12 + 5 \times 3) \div 9 + 4$

c $11 + (5 + 11) \div (12 \div 3)$

> Most calculators 'know' the order of operations. If you press the = key only at the end of the calculation, your calculator's answer will be correct. Check the answers in this example using a calculator.

Solution

a The 5 is squared, so do indices first. $60 - 2 \times 5^2 = 60 - 2 \times 25$

Next comes multiply. $= 60 - 50$

Subtraction comes last. $= 10$

b Do $\times$ before the $+$ inside the brackets first. $(12 + 5 \times 3) \div 9 + 4 = (12 + 15) \div 9 + 4$

Then do the $\div$. $= 27 \div 9 + 4$

The $+ 4$ comes last. $= 3 + 4$

                                                  $= 7$

c Do both sets of brackets first. $11 + (5 + 11) \div (12 \div 3) = 11 + 16 \div 4$

Then do the $\div$. $= 11 + 4$

The $+$ outside the brackets comes last. $= 15$

Exercise 1.04 Order of operations

1 Is each statement true or false? Write the correct value for any false statements.

Example 6

a $4 + 2 \times 3 = 18$
b $12 - 3 \times 4 = 0$
c $20 \div 2 + 2 = 12$
d $6 + 18 \div 3 = 12$
e $2 \times 4^2 = 64$
f $48 \div 4 \times 3 = 4$
g $20 - 5 + 8 = 7$
h $5 \times (20 - 3 \times 4) = 40$
i $2 \times 5^3 = 250$

2 Find the value of each expression. Check your answers using a calculator.

a $18 - 3 \times 5$
b $24 \div (5 + 3)$
c $8 \times 3 - 10 \div 5$
d $(2 + 10) \times (12 - 9)$
e $3 \times (1 + 4)^2$
f $36 \div 12 \div 3$
g $30 \div 5 \times 2$
h $40 \times 2 \div 8$
i $4 \times (7 - 2) \div (3^2 + 1)$
j $4^2 + 5^2 - 3 \times 9$
k $10 + 5 \times 6$
l $300 - 20 \times 8$
m $120 \div 4 \times 5$
n $10 + 4^2$
o $5 \times (12 - 3 \times 2)$

3 Copy each statement and insert brackets to make the statement true.

a $4 + 7 \times 5 = 55$
b $60 \div 5 + 7 = 5$
c $3 \times 2^2 = 36$
d $6 + 8 \times 9 - 5 = 56$
e $3 \times 4 + 5 \times 2 = 34$
f $28 - 4 \times 5 \times 2 = 16$

4 When Siobhan used her calculator to evaluate $3 + 6 \times 5$, she got the wrong answer. She pressed the following calculator keys:

3 **+** 6 **=** **×** 5 **=**

Explain why Siobhan's answer was wrong.

5 In the game of **snooker** the points scored are determined by the colours of the balls sunk in the correct order. This table shows the value of each colour.

Colour	Red	Yellow	Green	Brown	Blue	Pink	Black
Points	1	2	3	4	5	6	7

In snooker, Brad sank 4 red balls, 2 brown balls, one pink and 2 blacks.
In the same game, he lost 15 points for foul shots.

a What does the expression $4 \times 1 + 2 \times 4 + 6 + 2 \times 7$ represent?

b Determine Brad's score for the game.

6 Mr Healy, the school principal, has a parent complaining about the marking of his daughter's maths exam. He claims his daughter's correct answer was marked wrong.

This is the question: $48 - 8 \times 3$

The daughter's answer was 120.

a Why was the daughter's answer wrong?

b How could Mr Healy explain why the daughter's answer is wrong?

c Put brackets in $48 - 8 \times 3$ to make the daughter's answer correct.

1.05 How much do I pay?

We use numbers in every aspect of our lives: from earning and spending money, through to organising schedules, preparing food, assisting with leisure activities and scoring sporting events.

EXAMPLE 7

Muspha's rent is $42 768 annually. How much is his rent per month?

Solution

⟵ Annually means 'per year'.

There are 12 months in a year. Divide the **annual** amount by 12 to calculate the monthly amount.

Monthly rent $= 42\,768 \div 12$
$= 3564$

Write your answer.

Each month Muspha pays $3564.

Gillian bought 3 books online and paid with her debit card. She paid $6.40 for postage and $7.95 for each book. Before Gillian bought the book the balance of her debit card was $160. Calculate the balance after her online purchase.

Solution

Calculate the cost of the postage and the books. Remember to do × before +.	Cost = $6.40 + 3 × $7.95 $$= \$30.25$$ The books and postage cost $30.25.
Subtract the amount that Gillian spent from the balance of her debit card.	$160 − $30.25 = $129.75
Write your answer.	The balance of Gillian's debit card was $129.75.

Exercise 1.05 How much do I pay?

1 Finn's annual business expenses total $82 440. Calculate his average monthly expenses.

2 Gazi pays $3250 per month for rent. Calculate the annual rent that Gazi pays.

3 Li pays $12 per hour for parking. How much does he pay when he parks for 7 hours?

4 Aisling's business spends $1840 per fortnight on electricity.
  a How much does it spend per week on electricity?
  b Calculate the amount the business spends annually on electricity.

> Remember! A fortnight is 2 weeks long and there are 26 fortnights in a year.

5 Rob ordered 2 burgers and some fries for his lunch. The burgers cost $4.80 each and the fries cost $3.20. Rob paid with a $20 note. How much change should he get?

6 Voula spends 45 minutes at the gym 6 days per week. How many hours does she spend at the gym each week?

7 Joel plays golf 3 times per week. On average his golf games take 3 hours and 15 minutes.
  a How many hours does Joel play golf per week?
  b During holidays Joel plays golf every day. Calculate the number of hours he played golf on his 5-week holiday.

8 Reah hates TV ads. During a one-hour period she counted there were twelve 30-second ads and twenty-four 15-second ads. How many minutes of ads were included in the one-hour period?

9 The Rockets and the Rascals are opposing teams in a rugby league match. Tries are worth 4 points and goals 2 points. The Rockets scored 5 tries and 3 goals and the Rascals scored 6 tries and no goals. Which team won and by how many points?

10 The Boomers and the Snakes are two opposing teams in an AFL match. In AFL, teams score 6 points for a goal and 1 point for a behind. At three-quarter time the Boomers had scored 18 goals and 2 behinds while the Snakes had scored 17 goals and 8 behinds. Who is winning?

11 The BBQ Specialists are catering for Mala's garden party. They are supplying catering and bar service for 42 people. How much will Mala have to pay?

The BBQ specialists

Catering
Steak and salad with
bread rolls: $18.75 per person

Bar service
Fruit juices and
soft drink: $6.50 per person

PRACTICAL ACTIVITY

THE YEAR 11 PARTY

Budget catering

Price per person

Finger food:	$5.60
BBQ steak:	$9.20
BBQ sausages:	$2.10
BBQ seafood:	$8.20
Salad:	$4.35
Bread rolls:	90c
Desserts:	$3.95
Coffee/tea:	$1.10
Cheese platters and biscuits:	$2.60
Fruit platters:	$2.40
Non-alcoholic drinks:	$7.40

Toby is responsible for organising the catering for the Year 11 end-of-year party. The organising committee has allocated $4000 to spend on the food and non-alcoholic drinks for the 180 people expected to attend.

Your group's task is to help Toby decide on an interesting menu for food and drink. Remember to stay within your budget.

1.06 Estimating costs

It's difficult to mentally calculate the total cost of the items in your supermarket trolley, but careful shoppers can **estimate** using approximation techniques.

EXAMPLE 9

Patrick is purchasing the supermarket items shown below: 5 cans of dog food, Caesar salad, blueberries, teabags, strawberries and macadamia nuts. The price of each item is shown.

$2.98
$5.50
$4.59
$6.99
$13.98
$4.98

Scout Kozakiewicz

Patrick has $54 in his wallet. Estimate whether he has enough to pay for his shopping.

Solution

Mentally round each price *up* to the nearest dollar.

Dog food:	$5 \times \$3 = \$15$
Caesar salad:	$6
Blueberries:	$5
Teabags:	$7
Strawberries:	$5
Macadamia nuts:	$14

Estimated price $= 15 + 6 + 5 + 7 + 5 + 14$
$= 52$
The items cost approximately $52.

When we estimated the costs, each estimate was more than the true cost.

The true cost of the items is less than $52.

Write the answer to the question.

Patrick has enough money to pay for his shopping.

Exercise 1.06 Estimating costs

Answer all questions *without* using a calculator.

For Questions **1** to **5**, select the correct answer **A**, **B**, **C** or **D**.

1 Which is the best estimate of the value of $9.99 × 8?

    A $72   **B** $80   **C** $90   **D** $100

2 What is the best approximate value of $25.99 + $4.10 + $15.05 + $3.90?

    A $45   **B** $49   **C** $55   **D** $60

3 Gavin ordered 19.5 m of materials at a cost of $29.90 per metre. Estimate the cost of the materials.

    A $60   **B** $90   **C** $600   **D** $900

4 Seth is buying small chocolates that cost 49c each. Approximately how much will 50 cost?

    A $9   **B** $25   **C** $99   **D** $2500

5 Davinia buys bags of nuts and bolts to use in her furniture business. The bags contain between 48 and 51 nuts and bolts. She has 11 bags in her supply cupboard. Approximately how many nuts and bolts does she have?

    A   50   **B**   550   **C**   1100   **D**   2500

6 Christina cuts 18.9 m long lengths of wool for the warp in her loom. She requires 82 lengths.

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    a   Approximately how many metres of wool will she need for the 82 warp threads?

    b   The wool Christina uses comes in 400-metre long balls. How many balls of wool will Christina need?

    c   Use a calculator to check your answer to part **b**.

7 When Bryce bought 2 pizzas at $8.95 each and a salad for $5.80, he paid with a $50 note. Approximately how much change should he get?

8 Sebastian has only $60 remaining on his debit card until payday. He has these items in his supermarket basket:

- 2 packets of sausages @ $5.99 per packet
- 1 packet of potatoes $4.99
- 1 carton of milk $3.95
- 1 carton of yoghurt $6.95
- 1 packet of breakfast cereal $5.95

a Estimate the cost of the items in Sebastian's supermarket basket.

b Will he have sufficient funds in his account to pay for his shopping?

c Does he have enough money to add a $9.80 carton of soft drink to his shopping?

9 Paige is knitting a scarf. It takes her 29 seconds to complete 1 row.

a Explain why we can use the calculation $80 ÷ 2 = 40$ to calculate the number of minutes Paige takes to complete 80 rows of knitting.

b Paige needs to knit 50 more rows to finish the scarf. Approximately how long will it take her?

INVESTIGATION

MY SHOPPING DOCKET

To complete this investigation you will need samples of supermarket shopping dockets.

What you have to do

- Estimate the total cost of the items on a docket.
- Compare your estimate to the total on the docket. Was it more or less than the actual total?
- What is the difference between your estimate and the true cost?
- Use this formula to calculate how much your estimate is different from the true cost as a percentage.

$$\text{Percentage error} = \frac{\text{difference}}{\text{true value}} \times 100\%$$

- Repeat the process for a different shopping docket. Does your percentage error become smaller with practice?

Chapter problem

You've covered the skills required to solve the chapter problem. Can you solve it now?

1.07 Rounding numbers

Rounding decimals

Calculators often show a lot of **decimal places**. When Imran used his calculator to divide 5.7 by 1.3, it showed the answer as 4.384 615 385. Imran wants the answer with only 1 decimal place, so he has to **round** his answer.

Imran has to decide whether 4.384 615 385 is closer to 4.3 or 4.4. He will check using just the first 2 decimal places: 4.38. On the number line, he can see that 4.38 is closer to 4.4.
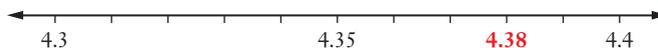
| Remember that 4.30 is the same as 4.3 and 4.40 is the same as 4.4. |

This is because the 8 in 4.38 is more than 5, which is the halfway mark. Imran will round to 4.4.

Rounding numbers

When the digit following the decimal place you want to round to is:

- **4 or smaller** – just **round down** and leave all the extra digits off.

- **5 or bigger** – **round up** and add 1 to the digit in the decimal place you want to round to, and leave all the extra digits off.

This table shows the results when some decimals are correctly rounded to 1 decimal place.

Original decimal	Rounded to one decimal place
6.802 956	6.8
6.830 5	6.8
6.849 99	6.8
6.853	6.9
6.893	6.9

EXAMPLE 10

Round 18.3721 to one decimal place.

Solution

Decide whether 18.3721 is closer to 18.3 or 18.4.
The figure following the 1st decimal place is 7.

Round the 3 up to 4. $18.3721 \approx 18.4$

Rounding up or down

When we have to round an answer to the nearest whole number, to one decimal place or to the nearest 5 cents, we have to decide whether to round up or round down. Imagine you've calculated that you need 2.1 cans of paint to cover the walls in your living room. You'll have to buy 3 cans, even though 2.1 is closer to 2. Two cans won't be enough and the shop wouldn't sell you 0.1 of a can! In this case, we must round UP.

In Australia, supermarket bills are rounded to the nearest 5 cents because that is the smallest unit of cash.

EXAMPLE 11

Jad bought several items in a supermarket and the bill came to $23.58.
How much will he pay?

Solution

Bills are rounded to the nearest 5c. We have to decide whether $23.58 is closer to $23.55 or $23.60. It is 2c from $23.60 and 3c from $23.55.

Jad will pay $23.60 for the items.

Exercise 1.07 Rounding numbers

1 Round each number correct to 1 decimal place.

a	16.1256	**b**	29.7681	**c**	14.6472
d	13.2836	**e**	104.554	**f**	195.219

Example 10

2 Write 124.727 56 correct to 2 decimal places.

3 Darryn correctly rounded a number to 16.3. Suggest 2 possible values the original number could have been.

4 In surfboard-riding competitions, scores are rounded to 1 decimal place. This is how scores are calculated.

Step 1: Each of 5 judges awards a result from 0.0 to 10.0 for the wave.

Step 2: The lowest and highest scores are removed.

Step 3: The **average** of the 3 remaining scores is determined by adding them together, then dividing by 3. The average is rounded to 1 decimal place.

Step 4: Each competitor's best 2 scores are added to obtain their final competition score.

Here are the scores that the judges gave Sally for her first wave. Use calculations to show that Sally's score for her first wave is 7.7.

7.5	7.3	8.1	7.9	7.6

5 Mia and Elissa are competing against each other in a surfboard-riding competition. This table shows the points judges awarded them on 4 waves.

Mia's scores					Elissa's scores			
Wave 1	**Wave 2**	**Wave 3**	**Wave 4**		**Wave 1**	**Wave 2**	**Wave 3**	**Wave 4**
4.7	7.2	8.5	7.4		6.9	7.8	5.2	8.2
5.1	7.1	8.5	7.8		7.0	7.9	5.1	8.1
4.9	7.5	8.4	7.6		7.2	7.8	5.3	8.4
5.0	7.3	8.2	7.9		6.9	8.0	5.2	8.0
4.9	7.5	8.6	7.5		7.1	7.8	5.0	8.9

a Calculate the score awarded to each surfer for each wave.

b Calculate each surfer's final score for the competition.

c Who won the event?

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6 Express the total of 2 m, 148 cm and 384 mm in metres, correct to 1 decimal place.

7 Ben's car travels 8.9 km on 1 L of petrol. The car's fuel tank holds 60.5 L of petrol. How far can the car travel on one full tank of petrol? Express your answer in kilometres, correct to 1 decimal place.

8 Pauline buys knitting wool in **hanks** from a wool mill. Two of the hanks contained 1560 m each, and the other 3 hanks contained 1875 m each.

a Calculate the total length of wool in Pauline's 5 hanks.

b How many kilometres of wool are in the 5 hanks? Express your answer correct to 1 decimal place.

9 Thanh bought 79.3 L of petrol at 155.8c/L

a Explain why the value of 80×1.5 will give the approximate cost of the petrol in dollars.

b Approximately how much will the petrol cost?

c Use a calculator to determine the cost of the petrol, correct to the nearest 5 cents.

d How different is your approximation to the actual cost?

10 The gas company replaces the LPG (liquid petroleum gas) in the bottles at Jaye's house each month. Today's delivery docket showed a delivery of 151.65 L of LPG priced at $1.35 per litre.

Alamy Stock Photo/redsnapper

a Jaye wanted to estimate the total cost. She calculated that the cost will be between $150 \times \$1$ and $150 \times \$2$. Will the cost be closer to $150 or $300? Give reasons for your answer.

b Calculate the value of $151.65 \times \$1.35$ and express the answer correct to 2 decimal places.

c Jaye allows $2200 in her annual budget for gas. Is this too much or not enough? Justify your answer.

11 Simone paid $48.62 for 3 metres of fabric. Calculate the amount she paid per metre, correct to the nearest cent.

12 Round each item's price to the nearest 5 cents.

Example **11**

a

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$2.87

b

Shutterstock.com/Melinda Fawver

$3.54

c

Shutterstock.com/Kotema

$2.93

13 Tri bought a bag of fruit priced at $5.78 and he paid with a $10 note. How much change should he receive?

14 At lunchtime, Roberto bought a can of drink marked at \$1.38 and a bread roll priced at \$1.18 from the local shop. He was charged \$2.60 for his purchases: \$1.40 for the drink and \$1.20 for the roll. Was Roberto charged the correct amount? Give a reason for your answer.

15 Dallas calculated that she requires 18.2 bags of mulch for her garden. How many bags should she buy?

16 Zoe paid \$4.25 cash for a bottle of milk. What are the smallest and largest prices that could have been marked on the bottle?

17 Daniel is a landscape gardener. He calculated that he needs 4.5 bags of concrete to complete laying some paving bricks. How many bags will he have to buy?

18 Jess sells boxes of eggs from her hens. Each box contains 12 eggs. How many boxes can she fill with 80 eggs?

19 Calculate each amount, correct to the nearest whole number.

a $\dfrac{2}{3}$ of 700 mL   **b** $\dfrac{3}{4}$ of 85 m   **c** $\dfrac{5}{8}$ of 775 g

d 0.3 of 165 cm   **e** 0.7 of 25 min   **f** 0.9 of 365 days

20 Calculate each amount, correct to one decimal place.

a $\dfrac{2}{3}$ of 500 mL   **b** $\dfrac{3}{4}$ of 825 g   **c** $\dfrac{5}{8}$ of 710 kg

d 0.8 of 28 minutes   **e** 0.9 of 19.5 km   **f** 0.75 of 51 seconds

PRACTICAL ACTIVITY

ACCURACY IN MEASURING LENGTHS

In this activity you are going to investigate how accurately each member of your group can measure lengths. Each group will need a tape measure that measures in metres, centimetres and millimetres.

What you have to do

1 Choose 3 suitable distances in your school environment; for example, the length of the school verandah, or the distance from your classroom doorway to the nearest tree.

2 Each member of the group measures the lengths as accurately as possible.

3 Compare your group's measurements. At what level of accuracy (for example, answers in metres correct to 1 decimal place) are the measurements the same?

1.08 Practical multiples

Nuts and bolts can be sold in packets of 20 or 100, fertiliser in 40 kg bags and copy paper in lots of 500. Many manufacturers package items in multiple quantities for use by tradespeople, and in most cases it's not possible to buy part of a packet.

EXAMPLE 12

Anna starts a dog-walking service and wants to have some advertising pamphlets printed. The printer handles advertising pamphlets only in multiples of 250. Anna wants 600 pamphlets. How many will she have to order?

Solution

The multiples of 250 mean 'lots of 250', that is 1×250, 2×250, 3×250, 4×250, 5×250, etc. The first 5 multiples are 250, 500, 750, 1000, 1250. Anna can't order 600 pamphlets so she must choose the next multiple of 250 that is higher.

Anna will have to order 750 pamphlets if she requires 600 pamphlets.

EXAMPLE 13

Timber is available only in lengths that are multiples of 300 mm.

a Is it possible to buy a 1 m length of timber? Why, or why not?

b Peter needs 2 lengths of timber each 1300 mm long. What is the best way for him to buy the timber?

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Solution

a Determine whether 1 m is a multiple of 300 mm by dividing it by 300 mm. If the answer is a whole number, then it is a multiple of 300 mm. First convert 1 m to mm.

1 m = 1000 mm

1 m ÷ 300 mm = 1000 mm ÷ 300 mm

= 3.333...

The answer is not a whole number, so 1 m is not a multiple of 300 mm.

It is not possible to buy a 1 m length of timber.

b Find the total length.

Total length = 2 × 1300 mm

= 2600 mm

Divide by 300 mm to check if it is a multiple of 300.

It isn't so round up to 9 and buy 9 × 300 mm.

2600 ÷ 300 = 8.666... (not a multiple of 300).

Length required = 9 × 300 mm

= 2700 mm

Cut 2 × 1300 mm from 2700 mm length (100 mm left over).

Exercise 1.08 Practical multiples

1 Business envelopes are sold in boxes of 200.

> Example **12**

   a At the end of each month, Xanthe posts accounts to all the company's customers. She ordered 8 boxes of envelopes for the letters. How many envelopes are contained in the boxes Jane ordered?

   b Mike requires 600 envelopes to post statements to customers. How many boxes of envelopes will he need?

   c What are the first four multiples of 200?

   d Tash needs 840 envelopes. How many boxes does she need to order?

2 Timber is available only in multiples of 300 mm.

> Example **13**

   a Explain why you can't buy a piece of timber 1400 mm long.

   b If you need a piece of timber 1400 mm long, what length do you need to buy?

   c Oliver needs 2 pieces of timber, each 1150 mm long. What length of timber should he buy?

   d A building plan requires a piece of timber 1.04 m long. What length of timber should be bought?

3 At the wholesaler, electrical wire is available only in multiples of 100 m. Kelly calculated that for her next job she will need 3 × 74 m lengths of wire and 2 × 180 m lengths. How much wire does she need to buy for the job?

4 Rose likes to make patchwork quilts. At the shop, fabric is available only in lengths that are multiples of 20 cm. Rose requires 15 cm of a pink fabric and 22 cm of a white fabric. Both fabrics cost $22 per metre.

    a What length of each fabric does Rose need to buy?

    b How much will the fabric that she needs cost?

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5 Ashok is making a fence from treated pine. The wood is available in lengths that are multiples of 0.3 m from 2.1 m to 3 m. He needs 17 posts each 1.35 m long, and 8 top rails each 2.3 m long. What lengths of timber should he order from the timber yard?

1.09 After the point

While 1.5 metres means 1 metre and 50 centimetres, 1.5 hours doesn't mean 1 hour and 5 minutes, and 1.5 years doesn't mean 1 year and 5 months. Fortunately, scientific calculators have a 'degrees, minutes, seconds' key (○'" or DMS) that converts 1.5 hours into 1 h 30 min, but in other situations we have to think for ourselves!

EXAMPLE 14

What does the .45 represent in the following 2 situations?

a $16.45   **b** 16.45 metres

Solution

a For money, the 2 digits after the decimal point represent cents.   In $16.45, the .45 represents 45 cents.

b For metres, the 2 digits after the decimal point represent centimetres.   In 16.45 m, the .45 represents 45 cm.

EXAMPLE 15

Write 2.7 hours in hours and minutes.

Solution

Change 2.7 hours to hours and minutes using your calculator by pressing 2.7 [o'"] [=] or 2.7 [2ndF] [DMS].	2.7 hours = 2 h 42 min
OR first change the decimal part, 0.7 hours, into minutes by multiplying it by 60 minutes (1 hour).	0.7 hours = 0.7×60 $= 42$ minutes
Write the answer.	2.7 hours = 2 h 42 min

EXAMPLE 16

Express 1.6 months in months and days, assuming that an 'average month' is 30 days.

Solution

Change 0.6 months into days. Multiply 0.6 by 30.	0.6 month = 0.6×30 $= 18$ days
Write the answer.	1.6 months $\approx$ 1 month and 18 days.

Exercise 1.09 After the point

Example **14**

1 What does the .24 represent in each amount?
    a $7.24   **b**   7.24 m

2 What does the .9 represent in each measurement?
    a $18.9   **b**   18.9 m

Example **15**

3 Use the [o'"] or [DMS] key on your calculator to express the following times in hours and minutes.
    a   2.5 h   **b**   3.8 h   **c**   1.4 h   **d**   2.9 h

4 Follow these steps to convert 4.5 years into years and months.
    a   How many months are there in 1 year?
    b   Multiply the number of months in a year by 0.5.
    c   4.5 years is 4 years and the number of months you calculated in part **b**.

5 Convert 2.25 years into years and months.

6 a How many months are equivalent to 0.75 years?

  b Write 5.75 years in years and months.

7 Express each time in months and days. Assume that there are 30 days in a month and write your answers correct to the nearest day.

  a 6.5 months **b** 8.9 months **c** 3.24 months **d** 5.3 months

8 A cricket match is measured in 'overs'. An over consists of 6 balls.

  a Express 18 balls in 'overs'.

  b During a test match the commentator said 'There are 18.5 overs remaining until the end of play'. If the commentator was using mathematics correctly, how many overs and balls should be remaining?

  c The commentator meant that there were 18 overs and 5 balls remaining. Why do you think cricket commentators use decimal points in this non-standard way?

1.10 How much do I get?

Everyday life is full of occasions when we use calculations. We earn, spend and invest money, pay tax, cook food, buy and sell property. On every occasion, there are calculations involved.

EXAMPLE 17

Tom's taxable income last year was $42 500. This table shows the Australian income tax rates. Use the table to calculate Tom's income tax for $42 500.

Taxable income	Tax on this income
0 – $18 200	Nil
$18 201 – $37 000	19c for each $1 over $18 200
$37 001 – $90 000	$3572 plus 32.5c for each $1 over $37 000
$90 001 – $180 000	$20 797 plus 37c for each $1 over $90 000
$180 001 and over	$54 097 plus 45c for each $1 over $180 000

© Australian Taxation Office for the Commonwealth of Australia

Solution

$42 500 belongs to the $37 001 – $90 000 row. Use the rule for this row. Write '32.5c in the dollar' as 32.5% = 0.325.

$$\text{Tax} = \$3572 + 0.325 \times (\$42\,500 - \$37\,000)$$
$$= \$5359.50$$

Write the answer.

Tom will pay $5359.50 in income tax.

Exercise 1.10 How much do I get?

1 Karen earns $726 per week, but her employer is changing her payroll system to pay wages fortnightly. Calculate Karen's fortnightly pay.

> Remember there are 2 weeks in 1 **fortnight**.

2 After tax and other deductions, Damian's fortnightly pay is $1425. Damian works 9 days per fortnight. Calculate his net pay per day.

3 Jemma is making mascarpone cheese. Combining 700 ml of milk, 300 ml cream and 1 pinch of starter culture will produce 500 g of the cheese. Jemma needs to make 750 g of mascarpone for dessert. How much milk, cream and starter culture will she need?

4 Tyson has a 4-year apprenticeship and is employed for 5 days per week. During his first year he earns $347.80 per week. If he completes all his trade educational requirements, his wage in the second year will increase by $108 per week.

   a What will Tyson's weekly wage be in his second year if he completes all his trade educational requirements?

   b How much will he earn per year as a second-year apprentice?

> Remember there are 52 weeks in a year.

5 Alyssa earns $20.21/hour as a receptionist. The timesheet shows the hours she worked last week.

	Normal hours	Overtime
Monday	7	
Tuesday	8	
Wednesday	7	
Thursday	8	3
Saturday		4

   a How many hours did Allysa work at normal time?

   b Calculate her pay for the normal hours she worked.

   c When Allysa works overtime, she is paid 1.5 times as much per hour. Calculate her pay per hour when she works overtime.

   d Calculate Allysa's pay for the overtime hours.

   e Calculate her total pay for the hours she worked last week.

6 Anand is a 4th year apprentice in a mining company. He is paid $728.70 per week. Before he receives his pay, Anand's employer deducts $73.43 for income tax and $14.57 for Medicare.

   a Calculate Anand's annual (yearly) pay without deductions.

   b How much should Anand receive per week for his take-home pay?

   c Anand receives cheap accommodation and food from the mining company. It costs only $\frac{1}{4}$ of his take-home pay. How much does Anand pay per week for his accommodation and food?

   d How much of his weekly pay is left after he pays for tax, Medicare, accommodation and food?

   e Anand saves 0.7 of the money he has left into a regular savings account. How much does he have left to spend?

Shutterstock.com/SeventyFour

7 The ingredient list for making a Polish vegetable salad to serve 8 people includes:

300 g carrots	200 g parsnip
120 g celeriac	440 g potatoes
4 eggs	200 g apples
260 g pickled cucumbers	

Aleksandra wants to make salad for 2 people. How much of each ingredient does she require?

8 Use the tax table on page 29 to calculate the income tax payable on each taxable income.

   a $55 600   **b** $99 850   **c** $200 000

Example **17**

9 The taxable income of the CEO of NelsonNetBank was $2.5 million. Use the tax table on page 29 to calculate her income tax.

10 Gareth operates a mobile coffee van. The table shows the sales he made yesterday.

	Price	Number sold
Flat white	$4.50	20
Cappuccino	$5	63
Mocha	$5.50	12
Long black	$4	28
Late	$4.75	14

   a Calculate the total number of coffees Gareth sold yesterday.

   b What was the total sales figure for these coffees?

   c This total sales figure includes the goods and services tax (GST). Gareth is required to send the GST to the government. Calculate the GST by dividing the value of Gareth's total sales by 11. Express the answer correct to the nearest dollar.

INVESTIGATION

GST AT THE SCHOOL CANTEEN

GST is a 10% tax on goods and services. It is not charged on essential foods, but it is included in a lot of the foods typically served in a canteen. Fruit and bread don't have a GST, but cakes, pies, packets of chips and ice cream are subject to GST.

- Visit the school canteen and obtain a list of 5 items the canteen sells that include GST.

- Record the selling price of each item.

- In a typical week, how many of each of the items are sold?

- Calculate the total amount the canteen receives from selling these items in a typical week.

- Determine the amount of GST included in the week's sales of these items by dividing the total value of the sales by 11. (110% ÷ 11% = 10% GST)

- Concentrate on one of the items. How much GST is included in the price of the item? What is the GST-free price? How would the price of the item change if the rate of GST was increased by half?

CALCULATIONS FIND-A-WORD

Use each clue to find 11 keywords. Then copy the puzzle grid below (or print a copy from NelsonNet) and find the same 11 keywords in the grid.

1 Multiply by 2.

2 Multiply by 3.

3 The centre of a dartboard.

4 Number of months in a year.

5 The initials we use to remember the 'order of operations' rules.

6 Shopping bills are rounded to the nearest _____ cents.

7 Another word for powers, beginning with I.

8 For order of operations, we calculate what's inside these first.

9 A percentage is a fraction with this number as denominator.

10 A game played on a circular board numbered with points values.

11 To convert a percentage to a decimal, you _____ by 100.

X	P	O	D	I	V	I	D	E	Y	T
D	M	I	C	T	N	P	D	L	S	G
T	R	A	U	B	I	D	M	A	S	W
W	B	N	E	G	A	F	I	V	E	J
E	U	R	W	Z	C	F	R	C	J	A
L	L	O	A	K	T	H	X	N	E	I
V	L	D	M	C	U	R	H	C	Q	S
E	S	H	Y	N	K	G	I	V	O	B
R	E	S	D	J	R	E	F	P	O	Y
B	Y	R	H	D	A	R	T	S	L	R
K	E	L	P	O	X	F	N	S	R	E
D	O	U	B	L	E	M	F	O	Z	U

SOLUTION TO THE CHAPTER PROBLEM

Problem

Ben bought fish and chips for $11.25 and paid with a $50 note. The cashier gave him a $20 and a $5 note and a few coins for his change. Could the change be wrong?

Solution

The fish and chips cost approximately $10. Ben's change should have been approximately $50 − $10 = $40. Ben's change included a $20 and a $5 note plus a few coins, so the change was probably between $25 and $30.

Yes, he has probably been short-changed (by about $10).

1. TEST YOURSELF

What's the score?

1 Add each set of target scores without using a calculator.

a A 5 and a 4   **b** Double 5 and a 3

c Double 3 and double 8   **d** A 5 and a triple 6

2 Jasper is playing darts. Calculate his score when his 3 darts landed on:

a 5, 7 and double 11   **b** double 9, 6 and triple 20

3 Convert:

a $\dfrac{13}{40}$ to a percentage   **b** 18.65% to a decimal

c 1.05 to a percentage   **d** 35% to a fraction

4 Find $\dfrac{2}{3}$ of $45.90.

5 Evaluate each expression without using a calculator, then use a calculator to check your answer.

a $8 + 5 \times 2$ **b** $20 \div 10 + 3 \times 4$ **c** $(15 + 9) \div (8 - 2)$

6 Use a calculator to evaluate each expression, correct to 1 decimal place.

a $17.35 + 182.96 - 25.47$ **b** $16.39 + 12.5 \div 3.6$ **c** $(12.3)^2$

7 The balance of Ivan's debit card was $368. He bought a bulk packet of screws and wingnuts for $24.80 plus $9.20 postage from an online hardware store. What was the balance of his debit card after he paid for the purchase and delivery?

8 Isabella ordered the food for her dance group. She ordered 4 chicken wraps and 6 small sushi. The chicken wraps cost $5.50 each and the sushi cost $2.90 each. She paid with a $50 note. How much change should Isabella get?

9 Estimate the value of each purchase.

a 6 items valued at $4.99 each

b 3 metres of fabric at $8.25 per metre

c 95 chocolate frogs at 99c each

10 Jemima bought 8 balls of wool priced at $11.99.

    a   Estimate how much the wool costs.

    b   The shop charged her $71.94. Is the bill right?

11 **a**   Round 15.32 up to the nearest whole number.

    b   Round 16.75 correct to one decimal place.

12 Round each measurement correct to the nearest whole number.

    a   27.9 kg   **b**   135.2 m   **c**   4.5 mm

13 Express $\frac{2}{7}$ as a decimal, correct to 3 decimal places.

14 The buttons that Mai wants to use on a jacket she's designing are sold in multiples of 3. Mai needs 13 buttons for the jacket. How many buttons will she have to buy?

15 Timber is only available in lengths that are multiples of 300 mm. Grigor needs a piece of wood 1930 mm long. What length piece of wood does he need to buy?

16 Convert 3.2 hours into hours and minutes.

17 Write 8.25 years in years and months.

18 Toni earns $1265 per fortnight.

    a   Calculate her weekly pay.

    b   How much does she earn annually?

19 Ella is planning to make boxes of shortbread as Christmas gifts. The ingredients to make 12 biscuits are:

              100 g butter   60 g caster sugar

              170 g flour   1 teaspoon of baking power

Ella wants to make 84 biscuits. How much of each ingredient will she need?

2.

GIVING 110%

Chapter problem

Tanika sells cosmetics. She earns commission at the following rates.

Commission on Tanika's monthly sales	
First $500 of sales	5%
On the next $1000	4%
Remainder of sales	3.5%

Calculate Tanika's commission in a month when her sales were $4200.

WHAT WILL WE DO IN THIS CHAPTER?

- Calculate a percentage of an amount
- Express one amount as a percentage of another
- Increase and decrease an amount by a percentage
- Solve problems involving cost price, selling price, profit, loss, discounts and GST

HOW ARE WE EVER GOING TO USE THIS?

- Calculating discounts on items we want to buy
- Calculating statistics in sport
- Comparing quantities of ingredients in food
- Whenever we come across a percentage – which is often!

2.01 Finding a percentage of a quantity

$$\text{Percentage of a quantity} = \frac{\text{Percentage}}{100} \times \text{quantity} \qquad \text{OR}$$

$$= \text{Percentage} \div 100 \times \text{quantity}$$

EXAMPLE 1

Calculate:

a 23% of $1650 **b** 75% of 620 kg ← 'of' means multiply.

Solution

a Write the percentage as a fraction or decimal and then multiply by the quantity.

$$23\% \text{ of } \$1650 = \frac{23}{100} \times \$1650$$

$$\text{or } 0.23 \times \$1650$$

$$= \$379.50$$

b Write the percentage as a fraction or decimal, then multiply by the quantity.

$$75\% \text{ of } 620 \text{ kg} = \frac{75}{100} \times 620$$

$$= 465 \text{ kg}$$

Some calculators have a percentage key. Check with your teacher whether it is practical to use it.

EXAMPLE 2

Find 32% of 4 m. Give your answer in cm.

Sometimes it is necessary to change the units of the quantity before we calculate the percentage.

Solution

Change 4 metres to centimetres.

$$4 \text{ m} = 4 \times 100 \text{ cm}$$

$$= 400 \text{ cm}$$

Write the percentage as a fraction or decimal and then multiply by the quantity.

$$32\% \text{ of } 400 = 0.32 \times 400$$

$$= 128 \text{ cm}$$

Exercise 2.01 Finding a percentage of a quantity

1 Find:

  a   11% of $300   **b**   60% of 140 kg   **c**   42% of 600 cm

  d   25% of $1230   **e**   90% of 240 marks   **f**   85% of 700 000 people

  g   19.4% of 785 kg   **h**   2.5% of 200 m   **i**   35% of 840 students

  J   5.9% of $5300   **k**   12.5% of 96 L   **l**   17.75% of 640 hectares

2 Calculate each amount.

  a   12% of 8 m, giving your answer in cm

  b   35% of 10 days, giving your answer in hours

  c   60% of 1 year, giving your answer in days

  d   15% of 26 L, giving your answer in mL

  e   10% of $2.30, giving your answer in cents

  f   87.5% of 16 weeks, giving your answer in days

  g   22.5% of 6 km, giving your answer in metres

  h   40% of 1.5 tonnes, giving your answer in kg

3 20% of the students at Nelson State High School study Chinese. There are 1290 students at the school. How many study Chinese?

4 Antony earns 5.5% interest on an investment account. He has $7500 in the account. How much interest will Antony earn in one year?

5 Employees at the GMC Steel Company are given a 2.5% pay increase.

  a   Dinesh is paid $32.40 per hour. How much extra will he be paid per hour after the increase?

  b   Sofija is paid $82 500 per year. How much extra will she be paid per year after the increase?

6 Xi's laptop can be used for 6 hours without recharging. Her laptop shows she has 62% of her time left. How much time does she have left before her laptop needs recharging?

7 Michael planted 850 seedlings in his market garden. 92% of the seedlings survive to full maturity. How many seedlings survive?

8 When Frankie orders stationery for her business, she must pay 10% GST. Calculate the GST payable on stationary purchases of $524.

9 In a poll of 1500 people, 85% of people agreed 'that Mathematics is the most useful subject to study at school'. How many people is this?

10 At the Strolling Bones concert, 65% of seats need to be sold for the promoter to make a profit. The venue seats 18 000 people. How many seats need to be sold to make a profit?

11 Jason decides to go on a weight loss program. His starting weight is 187 kg. In the first six weeks he loses 13% of his body weight. How many kilograms did Jason lose in the first six weeks?

12 Taylor is downloading the latest album of her favourite band. The file is 750 megabytes. So far she has downloaded 45% of the album. How many megabytes has Taylor downloaded so far?

Chapter problem

You've covered the skills required to solve the chapter problem. Can you solve it now?

2.02 What percentage of ...?

We often change amounts into percentages so that we can compare them. For example, we calculate our marks in tests as percentages so we can compare our performance in each subject. To do this, we must first write one amount as a fraction of another, then we change the fraction to a percentage by multiplying it by 100%.

Finding a percentage

$$\text{Percentage} = \frac{\text{amount}}{\text{whole amount}} \times 100\% \qquad \text{OR}$$

$$= \text{amount} \div \text{whole amount} \times 100\%$$

EXAMPLE 3

18 out of the 25 students in the class have part-time jobs. What percentage of the class is this?

Solution

Write as a fraction and multiply by 100%. $\frac{18}{25} \times 100\% = 72\%$

Write your answer.   72% of the class have part-time jobs.

When we compare 2 amounts by writing one as a percentage of the other, we need to make sure that they are in the same units.

EXAMPLE 4

Express 36 minutes as a percentage of 2 hours.

Solution

Both quantities should be in the same units, so change 2 hours to minutes.	2 hours = 2 × 60 minutes
	= 120 minutes
Write as a fraction and multiply by 100%.	$\frac{36}{120} \times 100\% = 30\%$
Write your answer.	36 minutes is 30% of 2 hours.

Exercise 2.02 What percentage of … ?

1 Convert each test mark to a percentage.

   a 32 out of 40   **b** 11 out of 20

   c 60 out of 75   **d** 71 out of 80

2 In a driving test, Melanie answered 21 out of 24 questions correctly.

   a What percentage is this?

   b The pass mark on the driving test is 95%. Did Melanie pass the test?

3 Joe earns $1005 per week and pays $420 in tax. What percentage of his earnings does Joe pay in tax? Answer correct to one decimal place.

4 Express each measurement as a percentage. Remember to have both amounts in the same units! Answer correct to one decimal place.

   a 5 minutes of 1 hour   **b** 18 hours of 4 days   **c** 75c of $6

   d 75 mm of 20 cm   **e** 520 kg of 1 tonne   **f** 400 mL of 3.5 L

   g 3 months of 1 year   **h** 3 days of 1 fortnight   **i** 50 days of 1 year

   j 25 minutes of 3 hours   **k** 36 hours of 1 week   **l** 5 fortnights of 3 years

5 In a survey of 1500 people, 1125 of the respondents agreed that breakfast is the most important meal of the day. What percentage is this?

6 Brianne sells jeans in her boutique for $85. She increases the price by $15. What percentage increase is this? Answer correct to one decimal place.

7 Australia has an area of 7.7 million square kilometres. Of this, desert takes up 3.8 million square kilometres. What percentage of Australia is desert? Answer correct to one decimal place.

8 The cost of Ziad's new glasses is $295. His health fund pays him a benefit of $165. What percentage is Ziad's benefit of the cost of his glasses? Answer correct to one decimal place.

9 Vanessa buys 6 metres of rope to tie up her plants. She uses 315 cm in her backyard. What percentage of the rope has she used?

10 George and Sue are travelling to see their parents. The trip takes 7 hours. They take a break after 2 hours 40 minutes. What percentage of the trip have they completed when they take the break? Answer correct to one decimal place.

11 In a senior class of 23 students, 8 walk to school and 11 travel by bus. Calculate, correct to one decimal place, the percentage of students who:
   a walk to school   **b** travel by bus

12 Kyle had the following results in his half-yearly exams.

English: 45 out of 75

Mathematics: 38 out of 70

Science: 80 out of 125

   a Calculate Kyle's percentage in each subject. Answer correct to one decimal place.
   b In which exam did Kyle achieve the highest result?

HOW MUCH SUGAR IS IN THE FOOD YOU EAT?

Sugar is one of the contributing factors to weight gain. In this investigation you will examine the percentage of sugar in what you eat and drink.

Did you know that sugar has many different names? Some of them include:

- Sucrose – normal table sugar

- Corn sugar – made from cornstarch

- Fructose – sugar in honey, plants and some fruit

- Lactose – found in milk

- Mannitol – a sugar alcohol in many plants

What you need to do

1 Choose 10 items that you regularly eat or drink. You will need to choose items that have product information on the packaging. You should include a soft drink, cereal, pasta or rice, some canned food and a variety of other foods.

2 For each item, find:

    a the serving size

    b the amount of sugar per serving

    c the percentage of sugar in the product

3 Which product had the highest percentage of sugar? Which had the lowest? Write a list of the items from most sugar to least sugar.

4 Compare your findings with other students in your class.

5 Write a report on sugar levels in food. Include recommendations about how a person could reduce the amount of sugar in their diet.

Nutrition Facts

Serving Size 2/3 cup (51g)
Servings Per Container About 9

Amount Per Serving	Cereal	Cereal with 1/2 cup Skim Milk
Calories	240	280
Calories from Fat	70	70
	% Daily Value**	
Total Fat 8g*	**12**%	**12**%
Saturated Fat 2.5g	**13**%	**13**%
Trans Fat 0g		
Cholesterol 0mg	**0**%	**0**%
Sodium 50mg	**2**%	**5**%
Total Carbohydrate 37g	**12**%	**14**%
Dietary Fiber 3g	**12**%	**12**%
Sugars 13g		
Protein 4g	**8**%	**16**%
Vitamin A	0%	4%
Vitamin C	0%	0%
Calcium	2%	15%
Iron	6%	6%

iStock.com/CHRISsadowski

2.03 Percentage increase

Percentage increase means to make a quantity bigger by a given percentage, for example, in pay increases or adding GST to prices.

EXAMPLE 5

Increase $500 by 12%.

> There are two ways to do this. Choose the method you like!

Solution

Find 12% of $500.	$0.12 \times 500 = \$60$
Add this amount to $500.	$\$500 + \$60 = \$560$
OR New amount is 100% plus 12%.	$100\% + 12\% = 112\%$
Find 112% of $500.	$1.12 \times 500 = \$560$

EXAMPLE 6

All Government employees receive a 2.5% pay increase. Georgie is on a salary of $82 000 per year. What is her new salary?

Solution

Find 2.5% of $82 000.	$0.025 \times 82\ 000 = \$2050$
Add this amount to $82 000.	$\$82\ 000 + \$2050 = \$84\ 050$
OR New amount is 100% plus 2.5%.	$100\% + 2.5\% = 102.5\%$
Find 102.5% of $82 000.	$1.025 \times 82\ 000 = \$84\ 050$
Answer the question.	Georgie's new salary is $84 050.

Exercise 2.03 Percentage increase

Example 5

1 a Increase 95 kg by 60%.   **b** Increase $2500 by 6%.
  c Increase 150 m by 5%.   **d** Increase 10 L by 33%.

2 Increase a train fare of $7.50 by 20%.

3 Increase a price of $620 by 10%.

Example 6

4 Nathan earns $32.75 per hour. His boss gives him a pay increase of 8%. What is his new hourly rate?

---

5 Saria runs a fashion business. She determines the selling price of each item of clothing by increasing the cost price by 95%. Find the selling price of a jacket that costs Saria $120.

6 Non-essential items in Australia attract a GST (goods and services tax) of 10%. Find the price of a car costing $18 900 after GST is added.

7 Ken and Amanda buy a house for $64 000 and sell it 10 years later at a profit of 147%.

   a Calculate the profit.

   b What is the selling price of the house?

8 Binnsfield Council plans to increase the amount of parkland in the area by 20%. At present there are 20 hectares of parkland. How much parkland will there be under the new plan?

9 Marcus' weekly pay is $945. He is paid an 8% bonus for 2 weeks. How much will he be paid for these 2 weeks?

10 La Plage restaurant charges a 15% surcharge on public holidays. Find the total charge for a meal costing $160 on Australia Day.

11 The Luxury Hotel charges an additional 1.5% when the customer pays with a credit card. Find the total cost of 3 nights' accommodation at $185 per night if it is charged to a credit card. Round your answer to the nearest cent.

12 Billie practises the trumpet for 4 hours each week. In the weeks before competitions, she increases her practice time by 30%.

   a How long does Billie practise the trumpet per week in the weeks before competition?

   b Calculate the average time Billy practises her trumpet per day in the weeks before competition.

13 Jayden buys TVs at a cost price of $295. He adds 75% of the cost price to get his selling price, then he adds 10% GST to calculate the final selling price.

   a Find the price of the TV after Jayden has added his 75% markup.

   b Find the price of the TV after he adds GST. Round your answer to the nearest cent.

   c Is it likely that Jason will charge his customers exactly that price? Why?

2.04 Percentage decrease

Percentage decrease means to make a quantity smaller by a given percentage, for example, in **discounts** and sale prices.

Discounts
code puzzle

EXAMPLE 7

Decrease $340 by 7%.

Solution

Find 7% of $340.	$0.07 \times 340 = \$23.80$
Subtract this amount from $340.	$\$340 - \$23.80 = \$316.20$
OR New amount is 100% minus 7%.	$100\% - 7\% = 93\%$
Find 93% of $340.	$0.93 \times 340 = \$316.20$

EXAMPLE 8

During an end-of-financial-year sale, computer games are discounted by 25%. Find the cost of a game regularly priced at $115.

Alamy Stock Photo/René van den Berg

Solution

Find 25% of $115.	$0.25 \times 115 = \$28.75$
Subtract this amount from $115.	$\$115 - \$28.75 = \$86.25$
OR New amount is 100% minus 25%.	$100\% - 25\% = 75\%$
Find 75% of $115.	$0.75 \times 115 = \$86.25$
Answer the question.	The computer game will cost $86.25.

NELSON SENIOR MATHS 11. Essential Mathematics

Exercise 2.04 Percentage decrease

1 a Decrease $150 by 57%
  b Decrease 2000 L by 28%
  c Decrease 110 kg by 4.5%
  d Decrease 840 students by 15%
  e Decrease 8 hours by 10%
  f Decrease 4 weeks by 25%

2 Decrease a price of $330 by 25%.

3 Decrease a town's population of 32 780 by 5%.

4 In the January sales all whitegoods are discounted by 15%. Jenna buys a new washing machine usually priced at $799. Calculate the amount Jenna pays for the washing machine during the sale.

iStock.com/billyfoto

5 Last year the Australian road toll was 1603 deaths. This year the road toll decreased by 10.3%. Calculate the road toll for this year. Round to the nearest whole number.

6 Keira and her sister, Amber, have singing lessons. Keira pays full fees of $450 per term, but Amber gets a 5% family discount.

  a Calculate how much Amber is charged for her lessons.
  b Calculate the total amount of fees paid for the 2 sisters.

7 The student population at Binnsfield Christian College last year was 879. This decreased by 7.5% this year. How many students are at Binnsfield Christian College this year? Round to the nearest whole number.

8 An electricity company offers a 2% discount when customers pay the account on time.

    a Calculate the discount if a bill of $1978.70 is paid on time. Round your answer to the nearest cent.

    b How much does the customer pay?

9 Katie works at the local supermarket. She is given a staff discount of 3.5% on all purchases. Find how much she pays for purchases totalling $178.25.

Shutterstock.com/Robert Kneschke

10 At the 'End of model' sale, Honest John's car yard offers a discount of 30% on all cars. Find the cost of a family car originally priced at $39 990.

11 For tax purposes the value of a computer is depreciated at a rate of 20%. Samir buys a computer priced at $1290. What will be its depreciated value in his next tax return?

12 Thomson's Hardware is having a Christmas sale. All items in the store are discounted by 18%.

    a Lauren is a painter. She buys ten 4 L tins of paint regularly priced at $67 per tin.

        i Calculate the cost of the paint at its regular price.

        ii Calculate the cost of the paint after the 18% discount.

    b Because she is a painter, Lauren is also entitled to a trade discount of 10% of the discounted price. Calculate the cost of the paint for Lauren.

2.05 Profit and loss

All successful businesses make a **profit**. Businesses that make a **loss** quickly close down. Most businesses express the profit or loss they make as a percentage of their cost price.

$$\text{Percentage profit} = \frac{\text{profit}}{\text{cost price}} \times 100\%$$

$$\text{Percentage loss} = \frac{\text{loss}}{\text{cost price}} \times 100\%$$

The **cost price** is how much a business buys the item for, from the supplier.

The **selling price** is how much a business sells the item for, to the customer.

EXAMPLE 9

Jacinta buys a necklace for her market stall for $36. She sells it for $47.

a How much profit does Jacinta make when she sells the necklace?

b Calculate the percentage profit. Answer correct to 1 decimal place.

Shutterstock.com/Grisha Bruev

Solution

a Profit = selling price − cost price.

Profit = $47 − $36
= $11

b Write the profit over the cost price and change it to a percentage by multiplying by 100%.

$$\text{Percentage profit} = \frac{11}{36} \times 100\%$$

$$= 30.5555 ....\%$$

$$\approx 30.6\%$$

EXAMPLE 10

During a sale, a bed is sold for $599. The bed cost the store $750.

a Calculate the loss for the store on the bed.

b Calculate the percentage loss, correct to 1 decimal place.

Solution

a Loss = cost price – selling price.

$$\text{Loss} = \$750 - \$599$$
$$= \$151$$

b Write the loss over the cost price and change it to a percentage by multiplying by 100%.

$$\text{Percentage loss} = \frac{151}{750} \times 100 \%$$
$$= 20.13333 \ldots \%$$
$$\approx 20.1\%$$

Exercise 2.05 Profit and loss

Example 9

1 Calculate, correct to one decimal place, the percentage profit for each sale.
  a cost price $35, selling price $45
  b cost price $625, selling price $810
  c cost price $149.75, selling price $274.25
  d cost price $2.60, selling price $4.05

Example 10

2 Calculate, correct to one decimal place, the percentage loss for each sale.
  a cost price $516, selling price $420
  b cost price $2175, selling price $1300
  c cost price $12 500, selling price $11 000
  d cost price $5.20, selling price $4.40

3 Carrie pays $40 for a small cupboard at a garage sale. She later sells it for $75 to a furniture dealer. Calculate her percentage profit.

4 Paolo pays $165 for a ticket to the football grand final. When his team doesn't make the grand final, he sells the ticket for $90. Calculate his percentage loss.

5 Natasha buys an old bicycle for $20. She spends $115 replacing some parts and painting it. She sells it for $150.

    a Has she made a profit or a loss? How much is the profit or loss?

    b Calculate the percentage profit or loss.

6 Keiran buys a used car for $2500 and spends $1750 replacing some parts. At the end of the year he sells it for $3750.

    a Does he make a profit or a loss? How much is the profit or loss?

    b Calculate the percentage profit/loss.

    c Comment on whether you think Keiran would be happy with this outcome.

7 Matt needs to make 65% profit on the items in his camping store to cover costs. What price does he charge for hiking boots that cost him $165?

8 Sophie buys 2000 shares valued at $23 400. She pays a stockbroker's fee of 2.5% on the value of the shares. She later sells all the shares for $10.55 per share.

    a Calculate the stockbroker's fee for Sophie's purchase.

    b Calculate the total amount she paid for the shares.

    c How much money does Sophie receive for her shares when she sells them?

    d Has she made a profit or a loss on the shares?

    e Calculate the percentage profit or loss on the shares. Answer correct to the nearest whole number.

9 Gianni buys 7 boxes of bananas for $45 each. Each box contains 10 kg of bananas. He sells 4 of the boxes at $5.10 per kg. He reduces the price to $4 per kg to clear the remaining boxes before the fruit goes bad.

    a How much do the bananas cost Gianni?

    b How much does he receive from selling the bananas?

    c Does Gianni make a profit or a loss? Calculate the percentage profit or loss, correct to one decimal place.

10 A shoe shop bought pairs of shoes for $48 each and priced them at $90 per pair. During the end-of-season sale, the manager reduced the price by $20. Calculate the percentage profit the shop makes when it sells the shoes during the sale. Answer correct to 1 decimal place.

2.06 Practising percentages

In this exercise you will use all the skills you have learned in this chapter to solve problems involving percentages.

Exercise 2.06 Practising percentages

1 Nelson College's hockey team won 12 games out of 15. What percentage is this?

2 55% of the students at one university are female. The university population is 85 300. How many *males* attend the university?

3 A muesli bar is 35 g.

   a It contains 6.9 g of fat. What percentage is this? Answer to one decimal place.

   b The muesli bar is 64% carbohydrate. How many grams is this?

4 Luka, a real estate agent, earns 2.5% commission on a sale of a house for $345 000. How much was his commission?

5 Zoe buys a used car for $14 000 and sells it at a loss of 20%. Find its selling price.

6 Lachlan's pay rate of $18.45/hour is increased to $19.85/hour. Find the increase as a percentage of the original pay rate. Answer correct to one decimal place.

7 Sarah earns $2346 per fortnight. Her rent is 30% of her income. How much rent does Sarah pay?

8 Alfredo's Spaghetti Sauce contains 11.9% sugar, according to the label. How many grams of sugar are in a 580 g jar?

9 Ashleigh sells kitchenware by visiting homes and is paid a retainer of $320 per week to cover her expenses, plus a commission of 15% on all sales. Ashleigh's sales last week totalled $2896. Calculate her pay for that week.

10 Jacob is buying a house that was priced at $345 000 last year. House prices have risen by 1.5% since then. How much does the house cost now?

11 When a new model is coming, car dealers offer discounts on the current model. Tony is interested in buying a car which has a price of $36 990. The car dealer offers him this car for $31 990. What percentage discount is this?

12 Kaitlyn runs Computer R Us. She purchases a batch of laptop computers that cost her $395 each. She calculates their selling price by adding on 75% of the cost price. What is the selling price of each laptop computer?

13 Daniel's watch loses 3 minutes every 6 hours.
   a What percentage time loss is this?
   b He sets his watch correctly at 8 a.m. in the morning. He finishes work at 5 p.m. in the afternoon. What time will his watch show when he finishes work?

14 So far this season the Cowboys team has scored 584 points and had 355 points scored against them. Calculate their points percentage using the formula below. Answer correct to 1 decimal place.
$$\text{Points percentage} = \frac{\text{points for}}{\text{points against}} \times 100$$

15 The Costello family donates 2% of their annual income to medical research into dementia. Calculate how much they donated in a year when the family income was $225 000.

16 A 500 g can of chicken and corn soup contains 110 g of corn. What percentage of the soup is corn?

17 Shanice buys her wedding dress for $1850. Several months after her wedding, she sells the dress on the Internet for $1280. Calculate her percentage loss on the wedding dress.

18 The book Anthea wrote sells for $54 a copy. She earns a 10% royalty on the first 4000 copies sold and a 12.5% royalty on the remaining sales. Calculate the royalty Anthea receives on the sales of 7000 copies of her book.

USES OF PERCENTAGES

1 Look on the Internet, newspapers, magazines and brochures for examples of different ways we use percentages in real life. Find photographs or draw situations where percentages are used. Present the information you have found as a 1-page display or as a PowerPoint presentation.

2 Select an example from what you have found in part 1. Write a set of 10 questions for the example, using what you have learned about where and how we use percentages in real life. Calculate the answers.

3 Swap the questions you have written with others in the class. Each person should answer at least 3 sets of questions. Ask the student who prepared the questions to mark your answers. If there are any disagreements, check with your teacher.

WS

Percentage passages

KEYWORD ACTIVITY

Here are some keywords used in this chapter.

commission	cost price	decrease	discount
GST	increase	interest	loss
profit	selling price		

1 Some of these words are opposites. Find 2 pairs of words that are opposites. Write a short paragraph that shows the meaning of each word.

2 Which word is a way of earning money? Write a sentence explaining its meaning.

3 Describe the difference between *cost price* and *selling price*.

4 Write a sentence explaining the meaning of discount, GST and interest.

SOLUTION TO THE
CHAPTER PROBLEM

Problem

Tanika sells cosmetics. She earns commission at the following rates.

Commission on Tanika's monthly sales	
First $500 of sales	5%
On the next $1000	4%
Remainder of sales	3.5%

Calculate Tanika's commission in a month when her sales were $4200.

Solution

Commission on first $500 = 5% of $500

$\qquad$ = $25

Commission on next $1000 = 4% of $1000

$\qquad$ = $40

Remainder of sales = $4200 − $500 − $1000

$\qquad$ = $2700

Commission on remainder = 3.5% of $2700

$\qquad$ = $94.50

Total commission = $25 + $40 + $94.50

$\qquad$ = $159.50

Qz

Practice quiz

Giving 110%

Exercise 2.01

1 Find:

    a   8% of $400

    b   75% of 280 mL

    c   12.5% of 90 hectares

    d   20% of 3 m, giving your answer in cm

    e   72% of 5 kg, giving your answer in g

    f $7\frac{1}{2}$% of 18 h, giving your answer in mins

Exercise 2.01

2 In one year, 42% of all road deaths occurred on country roads. If the road toll for that year was 650, how many people died on country roads that year?

Exercise 2.01

3 Maroun earns 3.5% p.a. interest on her investment of $27 000. How much interest does she earn in one year?

Exercise 2.01

4 Ian scores 80% on his driving theory test consisting of 20 questions. How many questions did he get right?

Exercise 2.02

5 Express as a percentage.

    a   Test mark of 34 out of 40

    b   Tax payment of $310 out of $1240

    c   3 students out of 30

    d   750 mL of 1 L

    e $17.50 of $70

    f   1500 m of 10 km

Exercise 2.02

6 Louise sells her home for $825 000. The real estate agent is paid a commission of $28 875. What percentage of the sales price is this?

Exercise 2.02

7 Nelson Stadium holds 40 000 people. Recently, 37 200 people attended a finals game at the stadium. What percentage attendance was this? Give your answer correct to 1 decimal place.

Exercise 2.02

8 Angelo has 3 hours to complete an exam. He checks the time after completing 3 questions and he has used 1 hour and 5 minutes of the exam time. What percentage is this? Give your answer correct to 1 decimal place.

Exercise 2.03

9 Increase:

    a $350 by 5%   **b**   60 kg by 55%   **c**   15 000 people by 20%

10 Michael receives a pay increase of 2.5%. Currently he earns $1442 per week. Calculate his new weekly wage.

11 Goods and services tax in Australia is 10%. Find the GST-inclusive price of a television advertised as '$2100 excluding GST'.

12 Decrease:

   a $90 by 40%   **b**   75 m by 15%   **c**   8 weeks by 25%

13 Max buys a shirt at a '40% off all weekend' sale. If the shirt is marked at $75, how much does Max pay for it?

14 The population of Nelsonville was 74 200 people. It dropped by 7%. Find the current population.

15 Calculate the percentage profit or loss for each situation, correct to 1 decimal place where necessary.

   a   cost price $85   selling price $102

   b   cost price $2500   selling price $3500

   c   cost price $19   selling price $14

   d   cost price $1400   selling price $1267

16 Joanna buys souvenirs for her store at $17 each. She sells them for $29 each. Calculate her percentage profit, giving your answer correct to 1 decimal place.

17 Emad buys shirts for $35 each and sells them for $105 each. In the January sales he reduced the price by $30. Calculate his percentage profit on the sale price.

18 64% of workers at a fast food restaurant are males. How many female workers are there if 325 people work at the restaurant each week?

19 A muesli bar has a serving size of 40 g.

   i   It has 12.2 g of fat. What percentage is this? Answer correct to 1 decimal place.

   ii   It is 5% protein. How many grams of protein are in the muesli bar?

20 Currently, the GST is 10%. Some politicians think it should be raised to 15%. A tradesman charges $320 excluding GST for a morning's work. Calculate how much more you would pay if the GST was raised to 15%.

3.

MEASURING LENGTH AND AREA

Chapter problem

Jake is going to Scotland to 'bag' (climb) as many Munros as he can. Munros are Scottish mountains that are more than 3000 feet high. At 1.34 km above sea level, Ben Nevis is Scotland's highest Munro. How many metres higher than the qualifying height of 3000 feet is Ben Nevis?

WHAT WILL WE DO IN THIS CHAPTER?

- Choose appropriate metric units of length and convert between them
- Estimate and measure lengths
- Calculate perimeters of shapes, including composite shapes
- Choose appropriate metric units of area and convert between them
- Estimate and measure areas
- Calculate areas of triangles, squares, rectangles and composite shapes

HOW ARE WE EVER GOING TO USE THIS?

- Estimating lengths when we don't have measuring equipment
- Calculating the length of fencing we require
- Calculating the quantities of tiles, paint and carpet when building or renovating
- Finding the size of a home or block of land

3.01 Estimating length

Most of us don't walk around with a tape measure or ruler in our pocket, but we often need to know how long an object is. There are a few tricks we can use to closely estimate a length. Our body parts can act as rulers for us; they're convenient and we always have them with us! If you record on your smartphone the length of your little finger, the width of your palm, the length of your shoe and the length of your stride, you can use them to estimate lengths.

And you can use your phone's calculator to help too!

The photos below show some useful lengths. Your own measurements will be slightly different from these.

iStock.com/Hanis

Scout Kozakiewicz

iStock.com/GoodlifeStudio

iStock.com/TayaCho

Reserve Bank of Australia

Reserve Bank of Australia

Shutterstock.com/Happy_studio

Melanie used her shoe to estimate the length of a table. She counted that it was 5 shoes long. Approximately how long is the table?

Solution

According to the photo, a shoe is approximately 30 cm long, so multiply the number of shoes by 30.	$5 \times 30 = 150$ cm
Write your answer.	The table is approximately 150 cm long.

Exercise 3.01 Estimating length

Use the photos on the previous page to help you answer questions 1, 2 and 3.

1 Emma's verandah is 8 shoe lengths wide. Approximately how many centimetres wide is Emma's verandah?

2 Copy and complete this table.

	Item	Length in body parts or other useful measures	Approximate length in cm
a	Children's story book	4 little fingers	
b	Length of a work bench	8 $50 notes	
c	Height of a cake	2 thumbs	
d	Height of a skateboard jump	3 widths of an A4 piece of paper	
e	Child's height	$3\frac{1}{2}$ hand spans	
f	The distance across the room	11 paces	

3 a This horse is 14 hand widths high.
Calculate the height of the horse in cm.

b Why do you think we measure a horse's height as it is shown in the photo and not as the distance of the top of its ears to the ground?

Shutterstock.com/lenkadan

4 A **cubit** is the distance from the tip of our fingers to our elbow. Farrouk measured a piece of rope as 15 cubits long. Calculate the length of the rope in cm.

47 cm

3. Measuring length and area
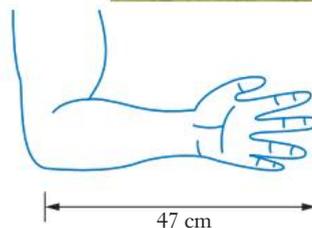
5 The Bible includes the measurements of King Solomon's Temple, which is thought to have been built around 1000 BCE. The temple's length was 60 cubits, its width 20 cubits, and its height 30 cubits.
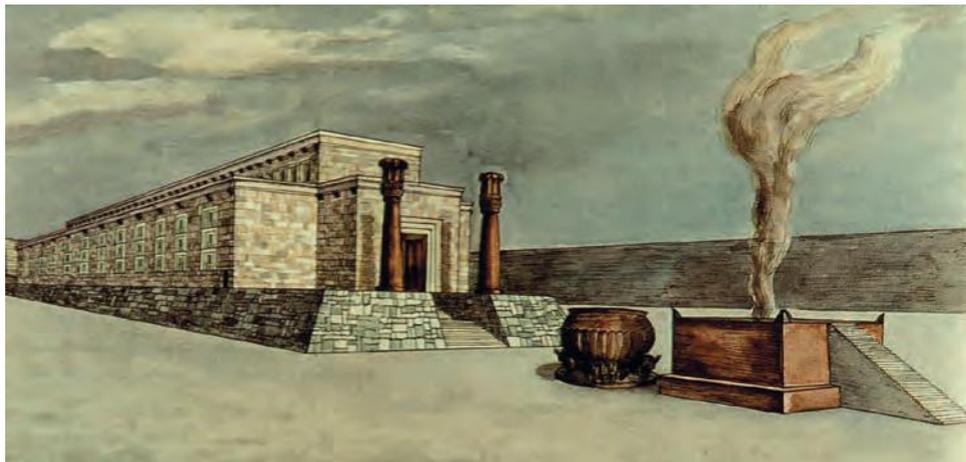
Alamy/www.BiblelandPictures.com

   a Calculate the length, width and height of King Solomon's Temple in centimetres.

   b Divide each measurement by 100 to convert them to metres.

6 A **fathom** is an old English measurement that we can use to help us approximate the length of fabric or fencing wire. It was also used in the imperial system to measure the depth of water (equal to 6 feet). A fathom is the distance from the finger tips on one hand to the finger tips on the other when the arms are stretched wide.

A fathom is 1.8 metres long. Alexis measured that she has 8 fathoms of fabric. How many metres of fabric does she have?

1.8 m

Shutterstock.com/Ampyang

YOUR BODY AS A RULER

To complete this investigation, each member of your group needs a ruler and a copy of the table below, which can be downloaded from the NelsonNet website.

WS

Your body
as a ruler

Part 1

Measure each body part and record the length in the table.

Name:		
Body part	**Approximation use**	**Length**
Top section of thumb	Small lengths	
Little finger	Small lengths	
Hand span	Short lengths	
Foot (shoe)	Short distances on the ground	
Pace	Walking distances	
Fathom	Lengths of fabric or rope	

Part 2

Use your body measurements and a calculation to approximate each length.

1 The length of your classroom

2 The width of a page from this book

3 The length of your calculator

4 The length of a pen

5 The height of your desk above the floor

6 The width of a window in your classroom

7 The distance from your classroom door to the school canteen

8 The height of the classroom door above the floor

Part 3

Use a ruler or tape measure to check the accuracy of your approximations.
How good is your body as a ruler?

3.02 Units of length

Using body parts to estimate lengths is convenient, but it's not very accurate because measurements vary from person to person. In the 1790s, the French Academy of Sciences developed a standardised measurement system called the **metric system**.

In the metric system, the **metre** is the basic unit for measuring length. Originally, one metre was defined to be one ten-millionth of the distance from the Equator to the North Pole at sea level.

Unit	Relationships	How we use it
kilometre (km)	1 km = 1000 m	Used to measure long distances
		For example, the distance between cities or countries
metre (m)	1 m = 100 cm	Used to measure medium lengths
	1 m = 1000 mm	For example, the length of a sporting field or the width of a room
centimetre (cm)	1 cm = 10 mm	Used to measure small lengths
		For example, the dimensions of a brick
millimetre (mm)		Used to measure very small lengths
		For example, the length of an insect or the size of your toenail

Metric units of length

To change from a small unit to a bigger unit, **divide** by the conversion factor.

To change from a big unit to a smaller unit, **multiply** by the conversion factor.
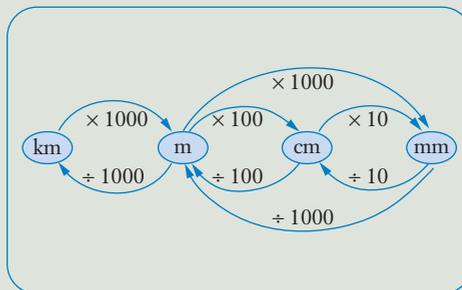
EXAMPLE 2

Convert:

a   30 m to cm   **b**   780 m to km   **c**   65 cm to mm.

Solution

a   There are 100 cm in 1 metre. The conversion factor is 100. Changing from m to cm is changing to a smaller unit. We need to multiply by the conversion factor.

$$30 \text{ m} = 30 \times 100 \text{ cm}$$
$$= 3000 \text{ cm}$$

b	There are 1000 m in one km. Changing from m into km is changing into a bigger unit. We need to divide by the conversion factor.	$780 \text{ m} = 780 \div 1000 \text{ km}$ $= 0.78 \text{ km}$
c	There are 10 mm in one cm. Changing from cm into mm is changing into a smaller unit. We need to multiply by the conversion factor.	$65 \text{ cm} = 65 \times 10 \text{ mm}$ $= 650 \text{ mm}$

Non-metric units

Before Australia adopted the metric system in 1974, we used the Imperial system of measurement based on feet (for length), pounds (for mass) and gallons (for capacity). The Imperial system is still used in the USA today.

Sometimes, we use non-metric lengths. For example, distances at sea and in the air are often given in **nautical miles**. The depth of water can be stated in **fathoms**. Many people still use **miles**, **yards**, **feet** and **inches** to measure distances. The conversion factors are shown in the table below for interest. Note that they are *not* based on powers of 10.
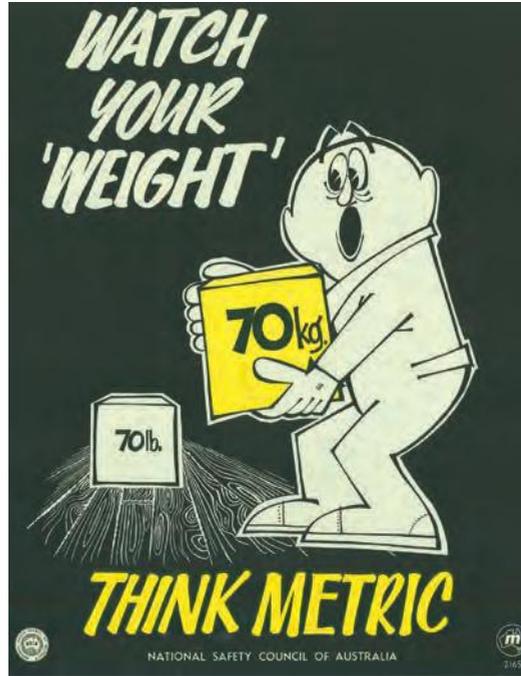
State Library of Victoria © National Safety Council of Australia

Unit	Metric equivalent	How the unit is used
inch	2.54 cm	To measure small lengths.
foot	30.48 cm	To measure small lengths. 1 foot = 12 inches.
yard	0.9144 m	To measure lengths where we would use metres today. 1 yard = 3 feet.
fathom	1.8288 m	To measure the depth of water. 1 fathom = 6 feet.
furlong	201.168 m	A length used in horse racing.
mile	1.609 km	To measure large distances where we would use kilometres today. 1 mile = 1760 yards.
nautical mile	1.852 km	To measure long distances across water or in the air.

EXAMPLE 3

The distance from Perth to Adelaide by air is 1144 nautical miles.
What is this distance in kilometres, correct to the nearest km?

Solution

1 nautical mile = 1.852 km. Changing to km is changing to a smaller unit. Multiply by the conversion factor.

$$1144 \text{ nautical miles} = 1144 \times 1.852$$
$$= 2118.688$$
$$\approx 2119 \text{ km}$$

Write the answer.

The air distance from Perth to Adelaide is 2119 km.

EXAMPLE 4

The pattern for the shawl that Rhea plans to knit requires 856 yards of wool.
She has 820 m of wool. Is this enough?

Solution

1 yard = 0.9144 m. Changing 820 m into yards is changing to the bigger unit. We have to divide the number of metres by 0.9144.

$$820 \text{ m} = 820 \div 0.9144$$
$$= 896.7629 \text{ yards}$$

Rhea has 896 yards of wool for the shawl.

Answer the question.

Rhea needs 856 yards of wool and she has about 896 yards. She has enough wool for the shawl.

Exercise 3.02 Units of length

Example **2**

1 In each part, state the conversion factor and whether you have to multiply or divide.
  a km to m
  b mm to cm
  c cm to m
  d m to km
  e m to cm
  f m to km
  g cm to mm

2 Copy and complete each conversion.

a   3 cm = ___ mm   **b**   5 m = ___ cm   **c**   400 m = ___ km

d   2 km = ___ m   **e**   30 mm = ___ cm   **f**   200 cm = ___ m

g   500 mm = ___ m   **h**   250 m = ___ km   **i**   60 cm = ___ m

j   60 cm = ___ mm   **k**   4500 m = ___ km   **l**   0.8 km = ___ m

m   8 mm = ___ cm   **n**   90 m = ___ cm   **o**   90 m = ___ km

p   6.5 m = ___ mm

3 Follow each step to convert 0.64 km into cm.

a   Change 0.64 km into m.

b   Change your answer to part **a** into cm.

4 Follow each step to convert 85 000 cm into km.

a   Convert 85 000 cm into m.

b   Change your answer to part **a** into km.

5 Copy and complete each conversion.

a   0.45 km = ___ cm   **b**   4 800 000 mm = ___ km

c   1.3 km = ___ mm   **d**   41 750 cm = ___ km

6 Express 5970 m in kilometres, correct to the nearest km.

7 Change 75 640 mm to metres, correct to the nearest m.

8 Every morning, Scott goes to the pool to train. This morning, Scott completed 78 laps at training. Each lap was 50 m long.

a   How many metres did Scott swim this morning?

b   How many kilometres did Scott swim at training this morning?

c   Scott's coach wants him to swim 4.5 km tomorrow. How many laps of the 50 m pool will Scott have to complete to swim 4.5 km?

9 In one layer of a coil there are 165 wire turns. Each wire turn is 12.95 cm long. Calculate the total length of the wire in metres. Express your answer correct to the nearest metre.

10 Melissa is making 75 cm-long elastic bandages from a bulk roll of bandage 120 m long. How many bandages will she be able to make?

11 When Brent went canoeing, he paddled down three 540-metre rapids and two 860-metre rapids.

a   Calculate the total length of the rapids in metres.

b   Express the distance in kilometres.

12 In first-class competitions, cricket pitches are 22.6 m long. During a test match, Grant ran the length of the pitch 137 times.

    a Calculate the length he ran in metres.

    b Calculate the length he ran in kilometres, correct to 2 decimal places.

13 Ian has a lawn and garden maintenance business. He takes all of his green waste to be recycled at the tip. Last week he drove to the tip 6 times and each return trip was 26.8 km. Ian claims 75c for each kilometre he travels as a business expense. Calculate the amount he will claim for last week's trips to the tip.

Photo courtesy of Sue Thomson

14 Copy and complete each conversion, correct to 1 decimal place.

    a 80 nautical miles = ___ km   **b** 15 inches = ___ cm

    c 5 furlongs = ___ m   **d** 2000 feet = ___ m

    e 4 fathoms = ___ m   **f** 7 miles = ___ km

15 Convert 120 yards to metres, correct to 1 decimal place.

16 Which is the longer horse race: 8 furlongs or 1600 m?

17 An old navigation chart shows that the water is 9 fathoms deep. How deep is the water in metres, correct to 1 decimal place?

18 This old flight travel poster is out of date. Design a new poster that shows the distances in kilometres.

19 Rolls of carpet are traditionally 12 feet wide. What is the width of a roll of carpet in metres, correct to 2 decimal places?

20 Olympic swimming pools were once 55 yards long, now they are 50 m long. Are they now longer or shorter than the old pools and by how much?

21 How many furlongs in a mile?

Flying
the new way
to travel

Darwin to Cairns 1040 miles
Darwin - Perth 1650 miles
Adelaide - Melbourne 400 miles
Sydney - Broome 2100 miles
Sydney - Melbourne 545 miles
Alice Springs - Ayers Rock 206 miles
Brisbane - Cairns 865 miles
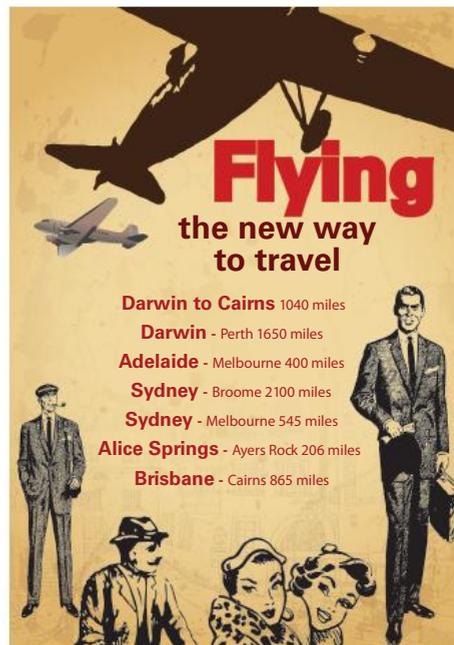
WINNING MARGINS

In horseracing, the winning margin is the distance between the winning horse and the horse that comes second, described using words like 'by a nose' and 'short half-head'. These words are descriptive rather than accurate.

Getty Images/Jamie Squire

Copy the table below or ask your teacher to download it from NelsonNet, then complete the 'Metric equivalent' column to assist people to interpret the language of winning margins in horseracing.

Winning margin	Description	Metric equivalent
Nose	The smallest winning margin, under 3 inches. 1 inch = 2.5 cm	
Head	The length of a horse's head Approximately $\frac{1}{8}$ of a horse's length of 2.4 m	
Neck	The length of a horse's neck Approximately $\frac{1}{4}$ of a horse's length	
$\frac{1}{2}$ length	$\frac{1}{2}$ the length of a horse	
$\frac{3}{4}$ length	$\frac{3}{4}$ the length of a horse	
Length	The length of a horse	
2 lengths	Double the length of a horse	
3 lengths	3 times the length of a horse	
4 lengths	4 times the length of a horse	

Look at the photo of the finish line of a horserace. Describe the winning margin using metric and traditional racing terms.

3. Measuring length and area

ACCURACY IN MEASURING LENGTHS

In this activity you are going to investigate how accurately each member of your group can measure lengths. Each group will need a ruler, tape measure and trundle wheel.

What you have to do

1 Choose three suitable distances in your school environment; for example, the length of the school verandah, or the distance from your classroom doorway to the nearest tree.

2 Each member of the group measures the lengths as accurately as possible.

3 Compare your group's measurements. At what level of accuracy are the measurements the same?

Chapter problem

You've covered the skills required to solve the chapter problem. Can you solve it now?

3.03 Perimeter

When we measure the distance around the outside of a shape, we are measuring its **perimeter**. Home renovators use perimeter calculations to work out the quantity of a variety of materials they need to order.

Shutterstock.com/Phovoir

EXAMPLE 5

To decorate her baby's bedroom, Menhal is applying a wallpaper **frieze** around the top of its walls. The diagram shows the dimensions of the room.

The frieze is available in 5 m and 10 m rolls.

How many rolls of frieze will Menhal need?

4 m
3 m   3 m
4 m
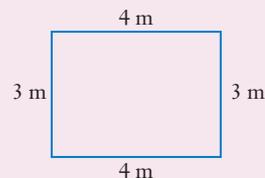
Solution

Calculate the perimeter of the room by adding up the lengths of all sides.

$$\text{Perimeter} = 3 + 4 + 3 + 4$$
$$= 14 \text{ m}$$

Then compare the length that Menhal needs to the lengths of the rolls.

Menhal needs to buy one 10 m roll and one 5 m roll. (She will have 1 m left over.)

Exercise 3.03 Perimeter

1 Calculate the perimeter of each shape.

a

6 m

8 m

10 m

b

5 m

c

10 m

7 m

7 m

10 m
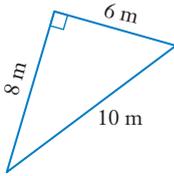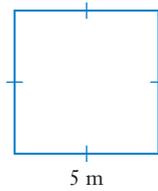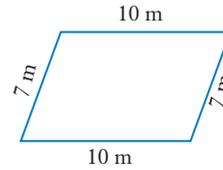
2 The sides of a **rectangle** are 4 m and 11 m long. Calculate the perimeter of the rectangle.

3 Measure the sides of these **polygons** as accurately as you can, then calculate the perimeter of each shape.

a

b
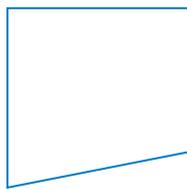
4 The perimeter of a rectangle is 36 m. What could the lengths of its sides be? Suggest 2 possible sets of sides.

5 All the sides in a **regular polygon** are the same size. The diagrams show 3 regular polygons. Write the name of each polygon and its perimeter.

a

5 m

b

4 cm

c

3 cm
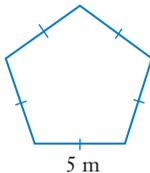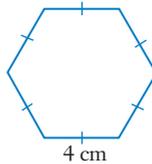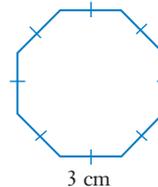
6 The perimeter of a 10-sided regular polygon is 60 m. How long are the sides of the polygon?

7 Kylie needs to replace the fence around her pool and BBQ area. In her **scale drawing**, 1 cm represents 1 m.

a What is the perimeter of Kylie's scale drawing?

b Kylie is going to put a fence around the perimeter with a 90 cm wide gate in it. How long will the fence be?

3. Measuring length and area

8 Alex is replacing the **skirting boards** around the floor in his TV room.

    a Calculate the length of the skirting boards that Alex will need.

    b The skirting boards cost $9 per metre. How much will it cost Alex to buy the skirting boards?

6.5 m

2.5 m

4.5 m

1 m

6.5 m
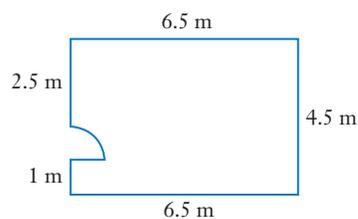
9 The college table tennis tables need some restoration before the competition starts. A special tape is going to be placed on the lines around the outside of the table and down the middle.

274 cm

152.5 cm
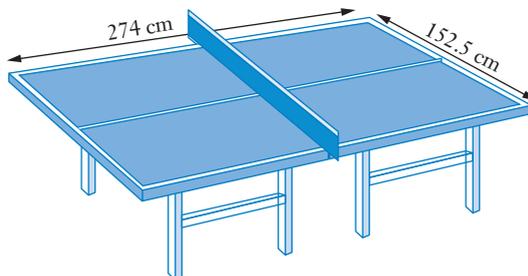
    a Calculate the length of tape required.

    b How many metres of tape will be required for 5 tables?

    c The tape comes in rolls of size 5 m, 10 m and 25 m. Which rolls should the college buy and how many?

3.04 Estimating area

The area of a shape is the amount of surface enclosed by the shape. Area is measured in square units. The number of small squares required to cover the shape is a measure of the shape's **area**.

EXAMPLE 6

Estimate the area of this leaf, which has been drawn on a 1 cm grid.
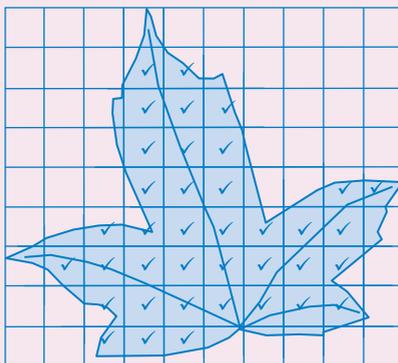
Solution

Count how many squares it takes to cover the leaf. Count a square only if more than half of the square is on the leaf, and put a tick in it. The unit of area will be square cm, or cm^2.

38 squares have ticks in them.

The area of the leaf is about 38 cm^2.

Exercise 3.04 Estimating area

1 Estimate the area of each leaf that has been drawn on a 1 cm grid.

a

b
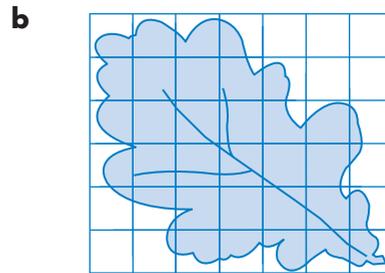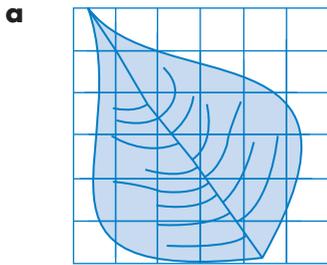
2 Many spiders make a new web every night. Each web takes about an hour to make. Estimate the area covered by the spider's web. Each square has sides of 1 cm.
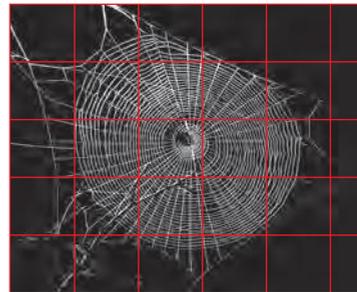
magnetix/Shutterstock.com

3 Jon is having the driveway and path at his new house covered in patterned concrete. The concrete company will charge $65 per square metre. Each square on the plan represents 1 m^2.

a Estimate the area of the driveway and path.

b Approximately how much will the concrete company charge Jon?

3. Measuring length and area
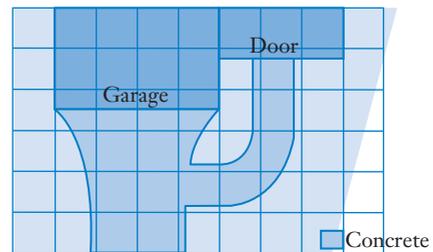
4 Estimate the area of this flower. Each square represents 1 cm^2.
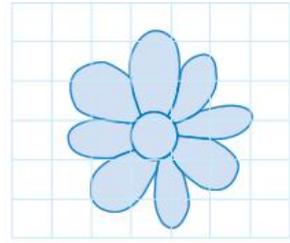
5 Find some leaves in your school grounds and estimate their area. What type of leaf has the largest area?

INVESTIGATION

AREA OF A RECTANGLE

What you have to do

1 Find the area of each rectangle by counting the number of squares. Each square represents 1 square centimetre.

2 Copy and complete the table.

3 Look at the results. Can you see a way of calculating the area of a rectangle without counting squares? Write a sentence to explain how to do it.

Rectangle	Length	Width	Area
	6 cm	4 cm	24 cm^2
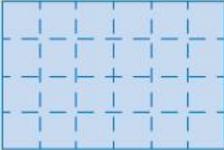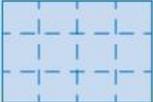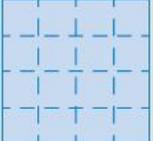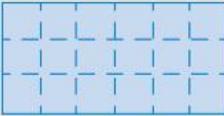
3.05 Areas of rectangles and squares

Area of a rectangle = length × width

$$A = l \times w$$

EXAMPLE 7

a The floor of an Olympic swimming pool is 50 m long and 25 m wide. Calculate the area of the floor.

50 m

25 m
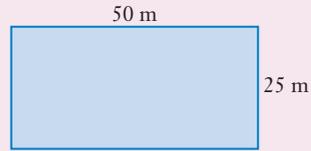
b Gymnastic floor competitions are held in a square with sides 12 m long. What is the area of a square with sides of 12 m?

12 m

12 m
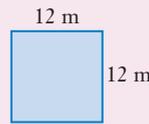
Solution

a Multiply the length by the width.

The units in the question are metres, so the answer for area is in square metres (m^2)

$\text{Area} = l \times w$
$= 50 \times 25$
$= 1250 \text{ m}^2$
The area is 1250 m^2.

b The length and the width are both 12 m.

To calculate the area, multiply 12 by 12.

$\text{Area} = l \times w$
$= 12 \times 12$
$= 144 \text{ m}^2$

Exercise 3.05 Areas of rectangles and squares

1 Carla attends a sports high school. Calculate the area of each of these courts and sporting fields at Carla's school.

Example 7

a Netball

30 m

15 m

b Hockey

91 m

55 m

c Tennis

24 m

11 m

d Basketball

29 m

15 m
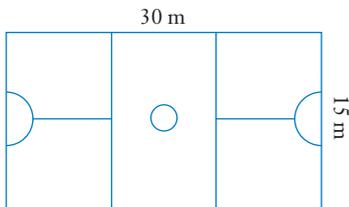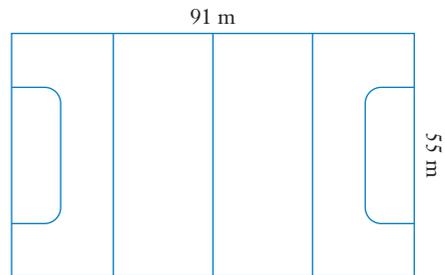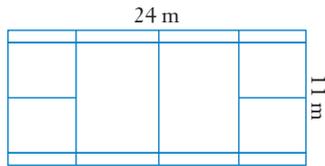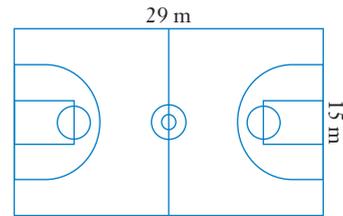
2 The cricket pitch in the school practice nets is 20 m long and 3.4 m wide. Calculate the area of the practice cricket pitch.

3 The infield of a junior softball ground is in the shape of a square with sides 18 m long.

Home plate and batting plate

18 m   18 m

1st base   3rd base

18 m   18 m

2nd base

   a What is the area of the infield?

   b A batter can score a home run if she hits the ball a long way and then runs through all the bases and back to the home plate. Kate hit a home run. How far did she run?
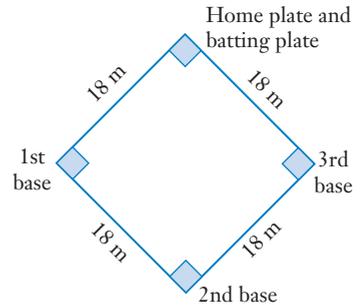
4 Chad plays beach volleyball every Sunday. The court is in the shape of a rectangle, 20 m by 10 m. Calculate the area of the volleyball court.

5 Nabil's driveway is in the shape of a rectangle, 15 m long with area 45 m². How wide is the driveway?

6 The area of a rectangular postage label is 24 cm². What could be the dimensions (length and width) of the label? Suggest 3 different sets of dimensions.

7 The area of a rectangle is 36 cm².

   a What could the dimensions of the rectangle be? Give 2 possible sets of values.

   b Calculate the perimeter of the rectangle for your suggested values in part **a**.

   c What is the smallest the perimeter could be?

8 The roof of Kaitlyn's house is in the shape of a rectangle. She needs to replace the guttering around the outside of the roof.

9 m

12 m

   a Should Kaitlyn calculate the area or perimeter of the roof to work out how much guttering she needs?

   b Calculate the amount of guttering that Kaitlyn needs.

   c The guttering costs $22 per metre. Calculate the total cost of the guttering.
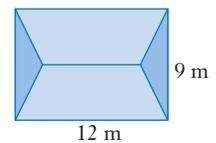
9 The diagram shows the dimensions of a fence that Dean is going to paint. One litre of paint covers 12 m^2.

2 m

35 m
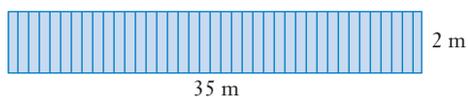
    a Does Dean need to calculate the area or perimeter of the fence to work out how much paint he needs?

    b How many litres of paint will Dean need to paint *both sides* of the fence?

    c How many 4L tins of paint will he need to buy?

10 a Estimate the area of the stamp.

    b Use a ruler to measure the stamp and then calculate the stamp's area. How close was your approximation?

Shutterstock.com/Brendan Howard

11 Roberto has 4 rectangular vegetable beds in his backyard that need refreshing.

N

2.4 m   90 cm   3 m

90 cm

Bed A   Bed B

60 cm

90 cm

Bed C   Bed D
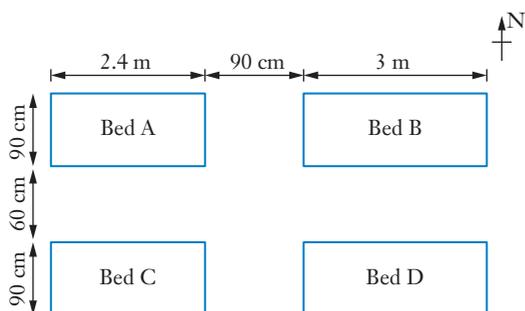
Shutterstock.com/Artazum

Remember to make all the units the same before you start calculations.

    a Calculate the area of each vegetable bed.

    b What is the perimeter of each garden?

    c Roberto's first task is replacing all the wood surrounding each garden. Calculate the total length of wood he will need.

    d The wood is sold in 3 m, 3.3 m and 3.6 m lengths. How many of each length do you recommend he buy to minimise waste and the number of cuts? Discuss your strategy with another student.

e Roberto needs to mix some organic compost into the soil, to condition the soil before he plants anything. His soil requires 4 shovel loads of organic compost per square metre. How many shovel loads of organic compost does he need?

f To stop the sun drying out the soil, good gardeners cover the top of their gardens with mulch. A bale of sugarcane mulch covers 3.6 m² of garden. How many bales of sugarcane mulch will Roberto need to cover his gardens once?

INVESTIGATION

THE LINES ON A SQUASH COURT
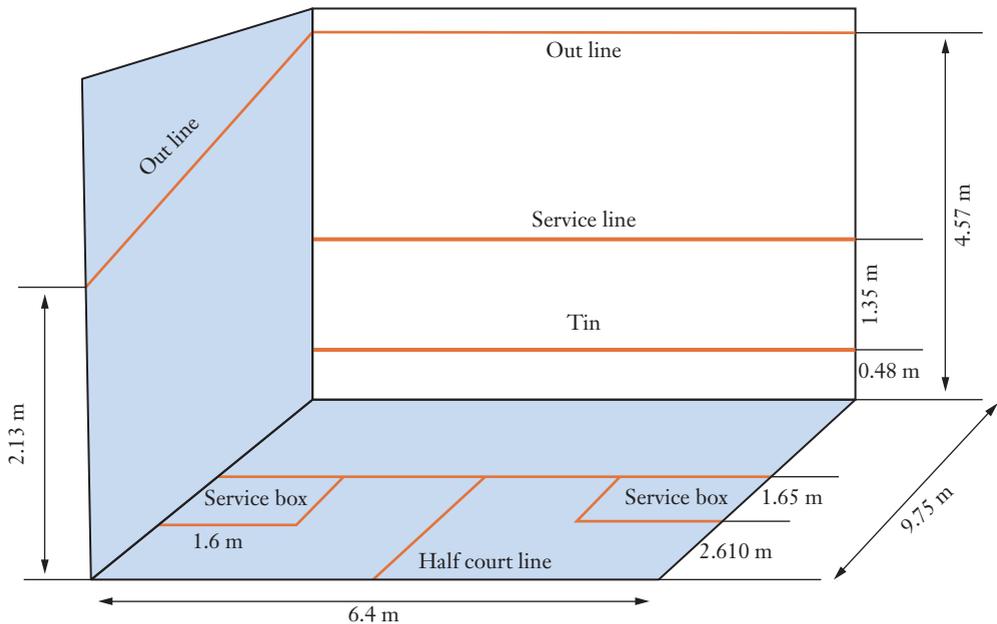
The lines on the two side walls, the floor and the back wall of a squash court need painting. The lines will be 10 cm wide. One litre of line paint covers 11 m² of area.

What you have to do

1 Find the total length of the lines to be painted. The 'out lines' on the side walls are each 10.05 m long.

2 Find the area of the lines that has to be painted.

3 Find the amount of paint required.

3.06 Renovating Grant's house

Grant is very excited. He has just bought his first house but he needs to do some renovations. As you work through the exercise below, you will see how common perimeter and area calculations are in everyday life.

Exercise 3.06 Renovating Grant's house

1 Grant's house is shown on this diagram.
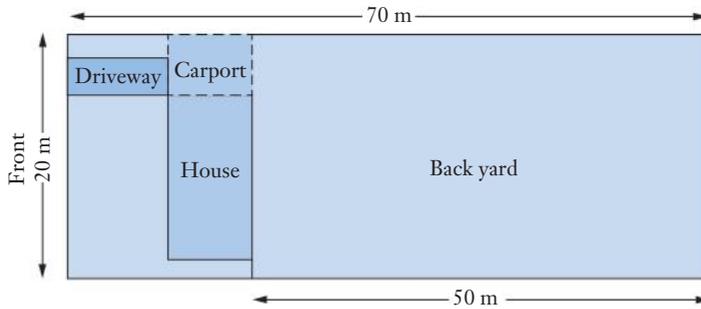
a The block of land is 20 m wide and 70 m long. What is the area of the block of land?

b The land is valued at $95 per square metre. Calculate the value of the block of land.

c The concrete in the driveway needs replacing. It is 3 m wide and 11 m long. Calculate its area.

d Grant would like to replace the concrete with paving tiles. The tiles cost $26 per square metre. How much will the tiles cost?

e The grass in the backyard needs fertilising. One bag of fertiliser covers 150 m^2. Will one bag be enough for the backyard? Give a reason for your answer.

2 The diagram shows the floor plan of Grant's house.
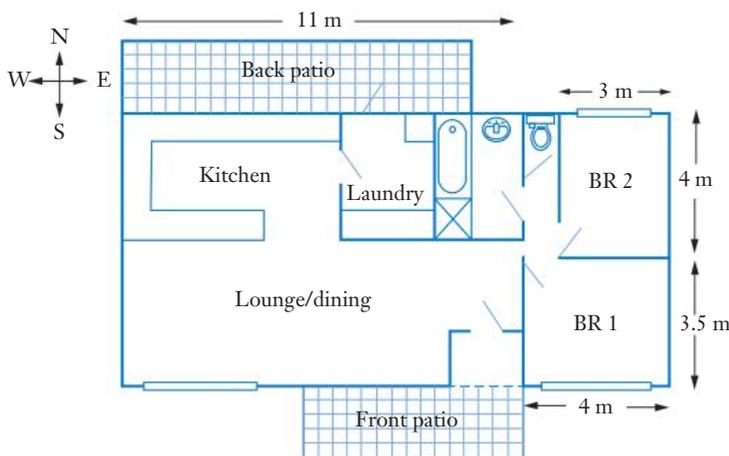
a How many bedrooms are in the house?

b How many doors are in the house?

c What are the dimensions of bedroom 1?

d When you're standing in the lounge room, looking out the window, in what compass direction (north, south, east or west) are you facing?

3 The skirting boards in bedroom 1 need replacing.

a Calculate the perimeter of bedroom 1.

b The door is 1 m wide. How many metres of skirting board will be required?

4 When it rains, the gutter across the front of the house leaks.

a How long is the gutter across the front of the house?

b New guttering comes in 5 m lengths. How many lengths of gutter will Grant need to buy to replace the leaking gutter?

5 Grant is going to paint the walls in the lounge/dining room. He calculated that he needs to paint 84 m² of wall.

a How many square metres will the paint in one 4 L tin cover?

b Grant will need to apply two coats of paint. How many litres of paint will he need?

c If Grant buys the paint in 4 L tins, how many tins of paint will he need?

d The same paint is available in 4 L and 10 L tins. The 4 L tin costs $64 and the 10 L tin costs $110. What is the cheapest way for Grant to buy the paint that he needs?

4 L
Wall paint
1 L covers 12 m²

6 Grant is going to put new carpet on the floors in the bedrooms. Carpet is sold in rolls 3.6 m wide.

a Explain why Grant will need 4 m of carpet for bedroom 1 and another 4 m for bedroom 2, if he lays the carpet without any joins.

b Including underlay and laying costs, the carpet costs $180 per metre. Calculate the cost of the carpet for the bedrooms.

7 The roof tiles need high-pressure steam cleaning. The cleaning company charges $13 per square metre. The diagram shows the dimensions of the roof.

a What shape are the two roof sections?

b What area is covered by the roof tiles?

c How much will the roof cleaning cost?

4.5 m

15 m
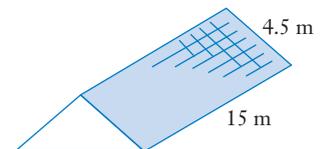
8 The towel rail in the bathroom is broken. The space for the rail is 86 cm long. Grant can buy towel rails that are 1 m long or 75 cm long.

    a How much longer is the 1 m rail than the space in the bathroom?

    b Do you think Grant should cut the longer rail or use the shorter rail? Give a reason for your answer.

9 Grant plans to put mirror tiles on one wall in the lounge/dining room to make the room look bigger. He plans to cover a square with area 3 m by 3 m. The tiles are 30 cm by 30 cm and they cost $5.40 each. Calculate the cost of the tiles.

10 Grant wants to buy a new bed that is 220 cm wide and 180 cm long. Is this size bed suitable for the house? Explain your answer.

11 The tiles on the back patio are old and many are broken. The patio is 9.75 m long by 1.5 m wide.

    a Calculate the patio's area.

    b To allow for cutting and breaking, Grant plans to order enough tiles to cover 10% more than the area of the patio. What area of tiles should Grant order?

    c The tiles are sold in boxes that hold 1.2 m^2 each. How many boxes of tiles should Grant order?

INVESTIGATION

HOUSE PLANS

To complete this activity you will need to obtain a house plan from a home display centre or from a real estate brochure or website.

What you have to do

1 Find a house plan that you would like to build for your home.

2 You will need 10% deposit. Calculate the amount of deposit you will need and the amount of money you will have to borrow.

3 Determine the floor area of the lounge room.

4 Calculate the cost of putting tiles on the floor of the lounge room at $29/m^2 for the tiles and $25/m^2 for laying.

Dreamstime.com/lev Kropotov

AREA OF A TRIANGLE

In this activity you are going to investigate the relationship between the area of a triangle and the area of a rectangle. You will need a pair of scissors and the 'Areas of triangles' worksheet from NelsonNet.

What you have to do

1 Cut out the pair of triangles in Triangle set A.

2 Put the triangles together to make a rectangle.

3 Determine the relationship between the length and height of the rectangle and the triangles.

4 Cut out the pair of triangles in Triangle set B.

5 Keep one triangle whole and cut the other triangle along the height into 2 smaller triangles.

6 Arrange the first triangle and the 2 pieces of the second triangle to make a rectangle.

7 Determine the relationship between the length and height of the rectangle and the triangles.

3.07 Area of a triangle
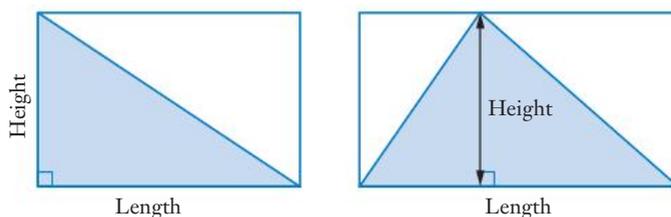
In the practical activity you saw that 2 triangles can be placed together to make a rectangle. This means that the area of the triangle is half the area of the rectangle.

The 2 dimensions of the triangle that are joined by a right angle (90°) become the base and the height of the rectangle.

Area of a triangle

$$\text{Area} = \frac{1}{2} \text{ length of the base} \times \text{height}$$

$$= \frac{1}{2} b \times h$$

where b = the length of the base and h = the **perpendicular height**.

Calculate the area of each triangle.

a

7 cm
24 cm
25 cm

b

5 cm
16 cm
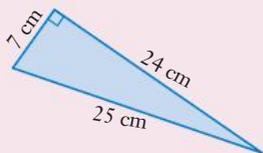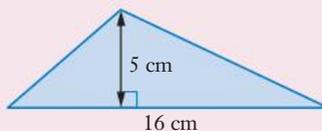
Solution

a The area of a triangle is $A = \dfrac{1}{2}$ base $\times$ height.

$$\text{Area} = \frac{1}{2} b \times h$$

The base and the height must be at 90° to each other. The base = 24 cm and the height = 7 cm.

$$= \frac{1}{2} \times 24 \times 7$$

> The 25 cm length is not used in this calculation. ⟶

$$= 84 \text{ cm}^2$$

b In this triangle, the base is 16 cm and the height is 5 cm.

$$\text{Area} = \frac{1}{2} b \times h$$

$$= \frac{1}{2} \times 16 \times 5$$

$$= 40 \text{ cm}^2$$

Exercise 3.07 Area of a triangle

1 Use the formula $A = \dfrac{1}{2} b \times h$ to calculate the area of each triangle.

Example
8

a

10 cm
7 cm

b

11 cm
10 cm

c

12 cm
10 cm

d

20 cm
8 cm

e

24 mm   16 mm

f

14 m
9 m
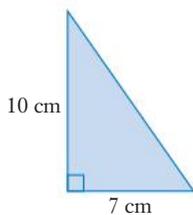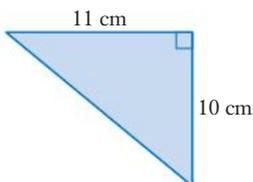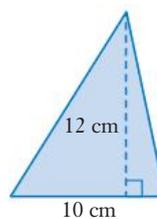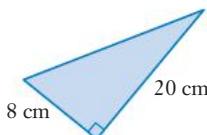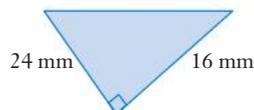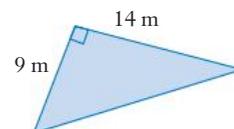
2 a Which two sides of the triangle on the right do you use in the formula $A = \dfrac{1}{2} b \times h$ to calculate the area of the triangle?

b What is the area of the triangle?

21 m
29 m   20 m

3. Measuring length and area
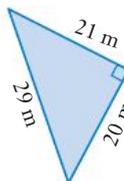
3 Calculate the area of each triangle.

Make sure that you use the two dimensions that are at right angles to each other.

a

17.1 mm
22.1 mm
14.0 mm

b

14 cm
12 cm

c

10 cm
8 cm
11.3 cm
14 cm
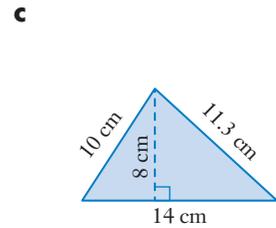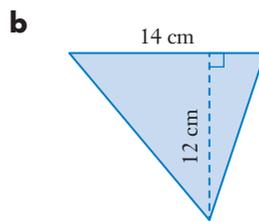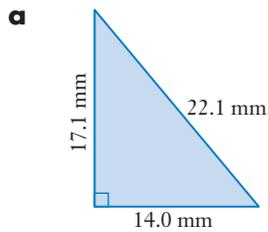
4 Bats are the most common mammal on Earth. The end sections of their wings are triangular. Calculate the area of each triangular section in the bat's wing.

2.8 cm
5.1 cm
2.4 cm
4.5 cm

5 The height of a windsurfer's triangular sail is 3.1 m and its width is 1.9 m. Calculate correct to one decimal place the area of the sail.
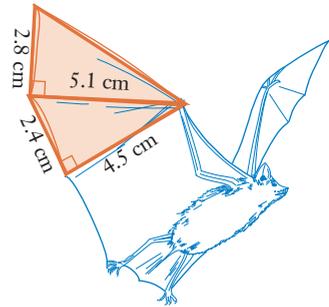
6 The healthy food triangle shows the proportions of different types of foods recommended for a healthy diet. Use a ruler and make any necessary measurements, then determine the area of the healthy food triangle.

Oils, fats, sweets sparingly

Milk, yogurt, cheese
3 servings

Meat, poultry, fish, eggs, nuts, dry beans
2 servings

Vegetables, fruits
5 servings

Bread, cereal, rice, pasta
7 servings
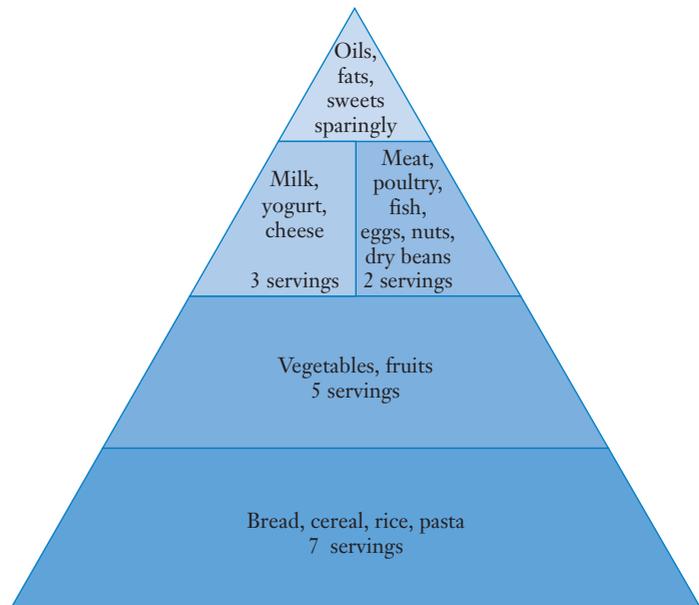
7 Draw 2 possible right-angled triangles that each has an area of 24 cm^2, showing values for the base and height of the triangle.

3.08 Units of area

Area is measured in square units, which are based on the length units.

Area unit	The size of a square of length:	Approximately the size of:
square millimetre (mm^2)	1 mm (Actual size: ▪)	
square centimetre (cm^2)	1 cm (Actual size: ⬛)	a fingernail
square metre (m^2)	1 m	the floor of a large shower recess
hectare (ha)	100 m	The area bounded by an athletics track, or an international rugby pitch
square kilometre (km^2)	1 km	a theme park

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Shutterstock.com/Foamfoto

Alamy/Archideaphoto

1 cm = 10 mm
1 cm^2 = 10 × 10 mm^2
    = 100 mm^2
	10 mm
	1 cm^2 10 mm
		1 m = 1000 mm
		1 m^2 = 1000 × 1000 mm
		    = 1 000 000 mm^2
			1000 mm
			1 m^2 1000 mm
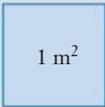
1 m = 100 cm
1 m^2 = 100 × 100 cm^2
    = 10 000 cm^2
	100 cm
	1 m^2 100 cm
		1 ha = 100 × 100 m
		    = 10 000 m^2
			1 ha 100 m
			100 m
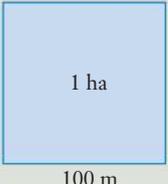
Similarly, 1 km^2 = 1 km × 1 km = 1000 m × 1000 m = 1000 000 m^2

When converting area units, we have to convert the length unit twice. One conversion is for the length and the other for the width. We *square* the simple linear conversion factor to get the area conversion factor.

For example,   to change from m to cm,   multiply by 100,

                but to change from m^2 to cm^2,   multiply by 100^2 = 10 000.

Metric units of area

$1 \text{ cm}^2 = 100 \text{ mm}^2$

$1 \text{ m}^2 = 10\ 000 \text{ cm}^2 = 1\ 000\ 000 \text{ mm}^2$

$1 \text{ ha} = 10\ 000 \text{ m}^2$

$1 \text{ km}^2 = 1\ 000\ 000 \text{ m}^2$

To change from a small unit to a bigger unit, **divide** by the conversion factor.

To change from a big unit to a smaller unit, **multiply** by the conversion factor.

EXAMPLE 9

Convert:

a 3 cm^2 to mm^2 **b** 4000 mm^2 to m^2 **c** $81\ 000 \text{ m}^2$ to ha

Solution

a cm^2 to mm^2, large to small unit: $\times 100$.

$$3 \text{ cm}^2 = 3 \times 100 \text{ mm}^2$$
$$= 300 \text{ mm}^2$$

b mm^2 to m^2, small to large unit: $\div 1\ 000\ 000$.

$$4000 \text{ mm}^2 = 4000 \div 1\ 000\ 000 \text{ m}^2$$
$$= 0.004 \text{ m}^2$$

c m^2 to ha, small to large unit: $\div 10\ 000$.

$$81\ 000 \text{ m}^2 = 81\ 000 \div 10\ 000 \text{ ha}$$
$$= 8.1 \text{ ha}$$

Exercise 3.08 Units of area

1 Select the best unit (km^2, ha, m^2, cm^2 or mm^2) for measuring each area.

  a a farm   **b** the floor of a classroom   **c** a shirt

  d the school oval   **e** a sheet of paper   **f** your eardrum

  g Australia   **h** a flattened insect   **i** Rottnest Island

Example 9

2 Copy and complete each conversion.

  a $7.9 \text{ cm}^2 = \underline{\hspace{1cm}} \text{ mm}^2$ **b** $1\ 500\ 000 \text{ mm}^2 = \underline{\hspace{1cm}} \text{ m}^2$

  c $690 \text{ mm}^2 = \underline{\hspace{1cm}} \text{ cm}^2$ **d** $76\ 000\ 000 \text{ m}^2 = \underline{\hspace{1cm}} \text{ km}^2$

  e $865\ 000 \text{ cm}^2 = \underline{\hspace{1cm}} \text{ m}^2$ **f** $12 \text{ ha} = \underline{\hspace{1cm}} \text{ m}^2$

  g $0.32 \text{ km}^2 = \underline{\hspace{1cm}} \text{ m}^2$ **h** $4.5 \text{ m}^2 = \underline{\hspace{1cm}} \text{ cm}^2$

  i $0.75 \text{ m}^2 = \underline{\hspace{1cm}} \text{ mm}^2$ **j** $19\ 000 \text{ m}^2 = \underline{\hspace{1cm}} \text{ ha}$

3 Arrange the measurements in ascending order: 6.5 m^2, $25\,050\,000 \text{ mm}^2$ and $114\,000 \text{ cm}^2$.

> To compare sizes, the measurements need to be in the *same units*.

4 Arrange these amounts in descending order: 990 mm^2, 54 cm^2 and $0.000\,032 \text{ m}^2$.

5 The centre of Adelaide is approximately a square bounded by North, South, East and West Terraces. Its area is about $3\,521\,000 \text{ m}^2$. Express the area of this square in:

  a hectares   **b** square kilometres

6 a Calculate the area of this rugby league field in square metres.

68 m   100 m

Alamy Stock Photo/Stadium Bank

  b How much smaller than 1 ha is the area of this field?

7 Which field below has an area closer to 1 ha? Justify your answer.

75 m, 110 m, Soccer field

Alamy Stock Photo/imageBROKER

Rugby union field, 100 m, 70 m

Alamy Stock Photo/A.P.S. (UK)

8 A large bushfire is burning out of control. Overnight it destroyed 24 000 ha of bush.

   a Convert 24 000 ha to m^2.

   b Convert your answer from part **a** to km^2.

   c The burnt bush is in the shape of a rectangle. What could the dimensions of the burnt area be?

9 Ross is going to tile his verandah. The square tiles are 30 cm long.

   a Calculate the area of one tile in cm^2.

   b How many tiles cover 1 m^2?

   c Ross' verandah is a rectangle 3 m wide by 8.4 m long. How many tiles will he need to cover the verandah?

   d To allow for cutting and breakage, Ross is going to order 5% more than the minimum number of tiles he requires. How many tiles should he order?

10 The area of the United Kingdom is 241 540 km^2 and the area of Western Australia is 2 646 000 km^2. How many times bigger is Western Australia than the United Kingdom? Express your answer correct to 2 decimal places.

11 We use nautical miles to measure distances and area on the surface of the Earth. 1 square nautical mile is equivalent to 3.43 km^2. The area of the surface of the Earth is 510 million km^2 and 71% of the Earth's surface is covered by water. Calculate the area of the Earth's surface that is covered by water. Express your answer in square nautical miles, correct to the nearest million.

KEYWORD ACTIVITY

CHAPTER SUMMARY

Copy and complete this summary of the chapter.

Throughout history, people used different ways to measure items and it was quite confusing. In the 18th century, the French developed a measuring system called the [1]_____ system. In this system, the metre is the basic unit for measuring [2]_____. For larger distances, we use [3]_____, which equals 1000 m. We can use millimetres, which are one-[4]_____ of a metre to measure small lengths.

We use length units when we measure [5]_____, the distance around the outside of a shape. We use units like m^2, km^2 and hectares when we measure [6]_____.

SOLUTION ^{TO}_{THE} CHAPTER PROBLEM

Problem

Jake is going to Scotland to 'bag' (climb) as many Munros as he can. Munros are Scottish mountains that are more than 3000 feet high. At 1.34 km above sea level, Ben Nevis is Scotland's highest Munro. How many metres higher than the qualifying height of 3000 feet is Ben Nevis?

Solution

Convert 3000 feet to metres.

$$3000 \text{ feet} = 3000 \times 30.48 \text{ cm}$$
$$= 91\ 440 \text{ cm}$$
$$= (91\ 440 \div 100) \text{ m}$$
$$= 914.4 \text{ m}$$

1.34 km Ben Nevis

914 m Munro qualifying height

Sea level
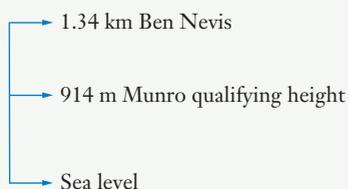
Convert 1.34 km to metres to compare with 914 m.

$$1.34 \text{ km} = 1.34 \times 1000 \text{ m}$$
$$= 1340 \text{ m}$$

Height difference $= 1340 - 914$
$$= 426 \text{ m}$$

Ben Nevis is 426 m higher than the qualifying height for a Munro.

Measuring length and area

1 A cubit is the distance from our fingertips to our elbow, approximately 47 cm. Approximately how many cubits long is the width of a car?

2 Copy and complete each conversion.

    a   5 cm = _____ mm   **b**   3 m = _____ cm

    c   3600 m = _____ km   **d**   4.2 m = _____ mm

    e   80 m = _____ km

3 Rugby league players aged 6 – 8 years play on a field that is 68 m long by 30 m wide. During training, each player ran 7 laps around the outside of the field.

    a   Calculate the distance the players ran in metres.

    b   Convert your answer from part **a** to kilometres.

    c   Calculate the area of the field.

4 The diagram shows the dimensions of a badminton court.
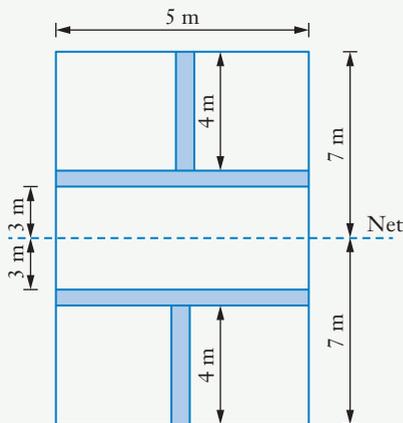
Billie is going to repaint the white lines on the court. In preparation for painting, she is going to put white tape along *both* sides of all the white lines. How many metres of tape will she need?

5 Estimate the area of Isabella's hand. Each square represents 1 cm^2.
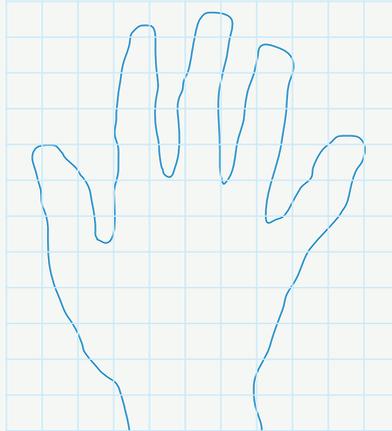
6 Calculate the area of each shape.

a

11 m

Rectangle

3 m

b

Square

6 m
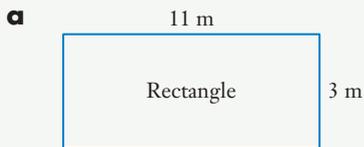
7 Marguerita's rectangular vegetable garden is 3.6 m long and 90 cm wide. She is going to cover the surface with bark mulch. Each bag covers 1.7 m^2. How many bags will she need?

8 Grant is going to buy tiles to cover his rectangular verandah, which is 11 m long by 2.5 m wide. How many square metres of tiles should he order, allowing an additional 10% for cutting and breakages?

9 How many litres of paint are required to paint a wall 12 m long by 2.8 m high if 1 litre covers 14 m^2?

10 Calculate the area of each triangle.

a

5 cm

13 cm

12 cm

b

6 m

8 m

10 m

c

4 m

12 m

11 Copy and complete each conversion.

    a $6 \text{ m}^2 = \underline{\qquad} \text{ cm}^2$

    b $76\,000 \text{ m}^2 = \underline{\qquad} \text{ ha}$

    c $5.8 \text{ cm}^2 = \underline{\qquad} \text{ mm}^2$

    d $0.5 \text{ ha} = \underline{\qquad} \text{ m}^2$
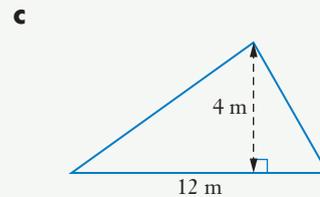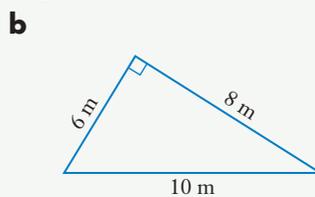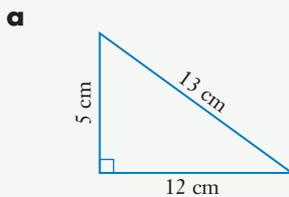
Practice set 1

⬤◯◯◯

Section A   Multiple-choice questions

For each question select the correct answer **A**, **B**, **C** or **D**.

1 Which decimal can be rounded to 6.74?

    A 6.7349   **B** 6.732   **C** 6.7452   **D** 6.744

2 How many square centimetres are in 3.57 m^2?

    A 35 700   **B** 357   **C** 0.357   **D** 0.0357

3 In one season, a soccer team scored 20 goals. Quan scored 4 of them. What is this as a percentage of the team score?

    A 4%   **B** 5%   **C** 20%   **D** 40%

4 Jan wants to knit a child's jumper. The wool she wants to use is only available in 135 m long balls. Jan needs 695 m of wool. How many balls does she need to buy?

    A 5   **B** 5.14   **C** 5.15   **D** 6

5 What is the area of this triangle?
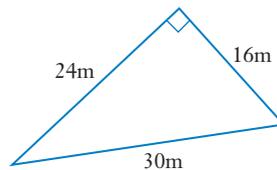
    A 192 m^2 **B** 240 m^2 **C** 360 m^2 **D** 5760 m^2

6 What is 7.2 hours in hours and minutes?

    A 7 h 2 mins   **B** 7 h 12 mins   **C** 7 h 20 mins   **D** 7 h 52 mins

7 A department store has a mark-up of 200% on clothing. The store buys a vest for $12. What will be its selling price after the mark-up?

    A $24   **B** $36   **C** $212   **D** $224

8 This figure is made up of a rectangle and an equilateral triangle. Find its perimeter.

12 cm

10 cm
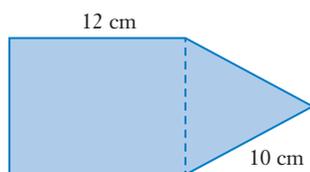
    A   22 cm   **B**   44 cm   **C**   54 cm   **D**   64 cm

9 A window is 2 metres long and 90 cm wide. Find its area.

    A 0.18 m^2 **B** 1.8 m^2 **C** 18 m^2 **D** 180 m^2

10 Calculate $12\frac{1}{2}\%$ of 6 m in millimetres.

    A   0.75 mm   **B**   7.5 mm   **C**   75 mm   **D**   750 mm

Section B   Short-answer questions

1 Do not use a calculator for this question.

Dog food costs $2.98 a can, teabags $6.99 a packet, strawberries $4.59 a punnet, blueberries $4.98 a punnet, macadamia nuts $13.98 a bag. Estimate the value of each purchase.

    a   3 cans of dog food and 1 packet of teabags

    b   1 punnet of strawberries, 1 punnet of blueberries and 1 bag of macadamia nuts

    c   10 cans of dog food

2 Copy and complete each conversion.

    a   6.4 m = _____ cm   **b**   240 mm = _____ cm

    c   15.8 km = _____ m   **d**   9800 mm = _____ m

3 Find:

    a   2% of 250 kg   **b**   75% of $150 000

    c   80% of 4 hours (in minutes)   **d**   18% of 36 L (in mL)

4 Calculate:

    a $2 + (13 - 6) \times 11$ **b** $\dfrac{8 - 3}{100 \div 4}$

    c $14 - 5 \times -3$ **d** $\dfrac{42}{16 \div (-2)}$

5 What percentage is

    a   69 out of 75?   **b**   9 mm out of 300 mm?

    c   300 g of 2 kg?   **d**   6 h of 1 day?

Exercise
1.07

Exercise
3.05-3.07

Exercise
2.05

Exercise
3.06

Exercise
1.08

Exercise
3.06

6 Round to the nearest whole number:

  a   85.4 m   **b**   16.9 kg   **c** $9.80

7 Find the area of each shape.

  a

16 cm

35 cm

  b

80 mm

  c

9 cm

11 cm
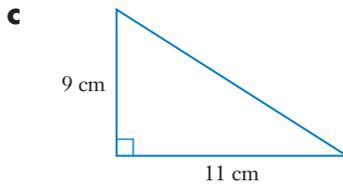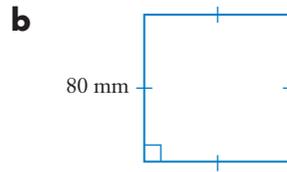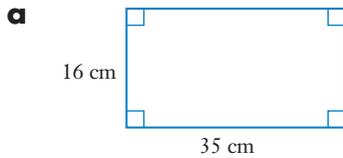
8 Terry and Andrea purchased a block of land for $133 000. Six years later they sell it for $164 000. Calculate their percentage profit, correct to 2 decimal places.

9 Geoffrey and Melissa are renovating their bathroom. They are going to put a frieze of decorative tiles around the walls. The diagram shows the dimensions of the room.

2.65 m

2.1 m

2.1 m

1.75 m
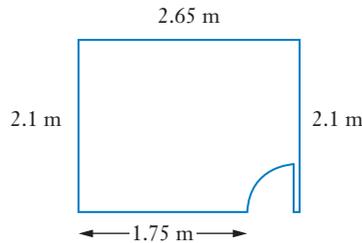
  a   What length of tile is required?

  b   Each decorative tile is 15 cm square. How many tiles will Geoffrey and Melissa need?

  c   Tiles come in boxes of 15. How many boxes will Geoffrey and Melissa need to buy?

10 Timber is only available in lengths that are multiples of 300 mm. What length of timber does Amber need to buy if she needs a piece that is:

  a   775 mm long?   **b**   2345 mm long?

11 The front yard of a house is rectangular and measures 20 m by 8 m. The backyard is also rectangular and measures 35 m by 7.5 m. Calculate the cost of covering both yards with turf that costs $18.60/m^2.

12 At a end of financial year sale, a dealer offers an 18% discount on all cars currently in the car yard. Calculate the price of a car marked at $29 990, correct to the nearest dollar.

13 Sue is planning to make apple pudding as the dessert for her dinner party.
The ingredients to make the pudding for 2 people are:

    30 g butter

    1 tablespoon sugar

    1 egg

    1 tablespoon self-raising flour

    411 g can of sweetened pie apple

    $\frac{1}{4}$ cup coconut

Sue will have 12 people at her dinner party. How much of each of the ingredients will she need?

14 Andre grows vegetables in a raised rectangular garden bed measuring 3.2 m by 1.3 m.

a What is the perimeter of her garden bed?

b Andre is replacing the wood around the garden bed. Wood comes in 3 m, 3.3 m and 3.6 m lengths. How many of each length do you recommend she buy to minimise waste and the number of cuts?

c Andre needs to mix some organic compost into the soil. The soil requires 4 shovel loads of organic compost per square metre. How much organic compost does he need?

15 Tiana is paid 7.5% royalties of the selling price of her book. Calculate the royalties she will receive on the sale of 2400 books at $49.95 each.

4.

USING FORMULAS

Chapter problem

Children learn words at an amazing rate. When a child is aged between 1 and 5 years, we can predict the typical number of words they will understand using the formula $N = 60m + 100$, where m represents the age of the child in months and N is the number of words.

Abigail, a childcare worker, is worried about Liam, a 20-month-old boy at her daycare centre who doesn't appear to understand many words. He has been tested and understands about 900 words.

Should Abigail be concerned? Use calculations to support your answer.

WHAT WILL WE DO IN THIS CHAPTER?

- substitute values to evaluate algebraic expressions
- apply formulas to practical situations
- complete tables of values using formulas

HOW ARE WE EVER GOING TO USE THIS?

- Algebra and formulas are used in many trades and workplaces
- Formulas are used in health and fitness, for example, to calculate BMI (body mass index)

4.01 Substitution

Substitution is the mathematical term for replacing a **variable** (or pronumeral) with a number, and **evaluate** is the term for finding the value of an algebraic expression.

EXAMPLE 1

Evaluate each expression when $x = 7$.

a $8x + 2$ **b** $5(2x - 4)$ **c** $\dfrac{3x - 1}{4}$ **d** $3x^2$

Solution

a   Replace x with 7 and simplify. $8 \times 7 + 2 = 58$

b   Replace x with 7 and simplify. $5 \times (2 \times 7 - 4) = 5 \times 10$
Do the brackets first. $= 50$

c   Replace x with 7 and simplify. $\dfrac{3 \times 7 - 1}{4} = \dfrac{20}{4}$

> Remember to calculate the value of the **numerator** first, then divide by the **denominator**. $= 5$

d   Replace x with 7 and simplify. $3 \times 7^2 = 3 \times 49$

       Calculate the square first. $= 147$

Exercise 4.01 Substitution

Example 1

1   Calculate the value of $\dfrac{3x}{5}$ when:

     a $x = 10$ **b** $x = 30$ **c** $x = 6$
     d $x = 0.4$ **e** $x = 0.65$ **f** $x = 12.6$

2   Evaluate $5(2x - 4)$ when:

     a $x = 7$ **b** $x = 16$ **c** $x = 3.5$
     d $x = 12.75$ **e** $x = 25.5$ **f** $x = 3\frac{1}{2}$

3   Calculate the value of $\dfrac{4a}{3}$ when $a = 12$.

4   Determine the value of $6(2p + 3)$ when $p = 3$.

5   Evaluate $\dfrac{3x - 1}{4}$ when:

     a $x = 2$ **b** $x = 8$ **c** $x = 1.5$ **d** $x = 2\frac{1}{3}$

6   Calculate the value of $3x^2$ when:

     a $x = 5$ **b** $x = 10$ **c** $x = 1.5$ **d** $x = 3\frac{1}{2}$

7 For each value of n, evaluate $\dfrac{2(3+n)}{5}$.

    a $n = 12$ **b** $n = 17$ **c** $n = 1.8$ **d** $n = 2\frac{1}{2}$

8 Copy and complete this table.

a	8	6	14	4.5	9	6.25	$3\frac{1}{2}$
b	3	5	12	3	7.5	0	2
$a + b$							
$a - b$							
$2a + 3b$							
$5(a + 4b)$							
$\dfrac{2(3a - b)}{5}$							
$a^2 + b$							

9 Use the values in the table to evaluate each expression.

Variable	t	y	k	p	z	w
Value	4	0	3.5	16	$1\frac{1}{2}$	10

    a $k + w$ **b** $p - t$ **c** $3y + p$

    d $\dfrac{wp}{t}$ **e** $\sqrt{p}$ **f** $\dfrac{2k + 3z}{w}$

10 In your group, write a list of 5 different algebraic expressions that have a value of 12 when $p = 6$ and $q = 3$.

4.02 Formulas

Many people use **formulas** in the workplace. Concrete contractors use formulas to determine the amount of concrete required for paths. Electricians use formulas to calculate voltage changes. Nurses use formulas to calculate solution quantities for injections and medications.

EXAMPLE 2

Fried's formula can be used to calculate the infant dose of an adult's medicine.

$D = \dfrac{MA}{150}$, where:

D = the infant dose in mL

A = the adult dose in mL

M = the child's age in months.

The adult dose of a cough medicine is 30 mL.
What dose of cough medicine can be given to a 12-month-old child?

Formulas

Solution

We need to calculate the size of the child's dose, which is D.

$D = ?$

The adult dose is 30 mL.

$A = 30$

M is the child's age in months.

$M = 12$

Substitute the values into the formula.

$$D = \frac{MA}{150}$$
$$= \frac{12 \times 30}{150}$$
$$= 2.4$$

Write the answer.

The child's dose is 2.4 mL.

EXAMPLE 3

A civil engineer uses the formula $V = 0.25A(d_1 + d_2 + d_3 + d_4)$ to estimate the amount of cut and fill required to excavate a rectangular area. V is the volume of dirt and rock, A is the area of the site and d_1, d_2, d_3 and d_4 represent the depth of the excavation at the 4 corners.

Shutterstock.com/Doug Mclean

A rectangular excavation site is 55 m long by 130 m wide and the depth of the excavation at each corner is 1.4 m, 0.7 m, 1.5 m and 2.8 m. Use the formula to estimate the amount of cut and fill required for the excavation.

Solution

Calculate A, the area of the rectangular site.

$A = 55 \times 130$
$= 7150 \text{ m}^2$

Substitute the values of d_1, d_2, d_3 and d_4 into the formula, then calculate the answer.

$d_1 = 1.4$, $d_2 = 0.7$, $d_3 = 1.5$, $d_4 = 2.8$

$V = 0.25A(d_1 + d_2 + d_3 + d_4)$
$= 0.25 \times 7150 \times (1.4 + 0.7 + 1.5 + 2.8)$
$= 11\ 440$

Write the answer.

$11\ 440 \text{ m}^3$ is the cut and fill required.

Exercise 4.02 Using formulas

1 The adult dose of a pain relief drug is 24 mL. Use Fried's formula $D = \dfrac{MA}{150}$ from Example **8** to calculate the dose of the drug that can be given to an 18-month old child. Answer correct to the nearest mL.

2 The formula $V = \dfrac{4}{3}\pi r^3$ gives the volume, V, of a sphere with radius r. Calculate the volume of a sphere with a radius of 6 cm, correct to 1 decimal place.

3 The formula $C = \dfrac{5}{9}(F - 32)$ is used to convert temperatures in degrees Fahrenheit (°F) to temperatures in degrees Celsius (°C). A cake recipe requires an oven set at 350°F. At what temperature in °C should Maria set her oven to cook the cake? Answer correct to the nearest whole degree.

4 The formula $D = S \times T$ relates distance, speed and time. $D =$ the distance travelled, $S =$ the speed and $T =$ the time. A truck is travelling at an average speed of 95 km/h on the motorway.

  a Calculate the distance the truck will travel in 3 hours.

  b Express 45 minutes as a fraction of an hour, then calculate how far will the truck travel in 45 minutes.

5 Cockroaches can run at a speed of 80 cm/s. Sarah saw a cockroach run for 3.5 seconds. Use the formula $D = S \times T$ to calculate the distance the cockroach ran while Sarah was watching it.

6 Young and Clark have different rules for approximating the children's dose of adult's medicine.

Young's rule: $\text{Dosage} = \dfrac{\text{age of the child in years} \times \text{adult dose}}{\text{age of the child in years} + 12}$

Clark's rule: $\text{Dosage} = \dfrac{\text{weight of the child in kilogram} \times \text{adult dose}}{70}$

Isabella is 5 years old and weighs 15 kg. The adult dose of the cough medicine that Isabella's mother wants to give her is 35 mL.

  a Calculate the amount of the medicine Isabella should have, based on each of Young and Clark's rules.

  b Most 5-year-old girls weigh approximately 18 kg. Should Isabella's mother use Young's or Clark's formula to calculate the dose to give her? Justify your answer.

7 The compound interest formula $FV = PV(1 + r)^n$ shows the relationship between the future value FV of an investment, the present value PV of an investment, the annual rate of interest r as a decimal and the length of the investment n in years. This morning, Charles invested \$5400 at 6% p.a. for 7 years.

  a Express 6% p.a. as a decimal.

  b Calculate the future value of Charles' investment.

8 The efficiency of a pumping station is given by the formula $E = PM$, where P is the efficiency of the pump, M is the percentage efficiency of the motor and E, P and M are expressed as decimals. Determine the percentage efficiency of the pumping station when the pump is at 85% efficiency and the motor is at 60% efficiency.

> Make sure you express the percentages as decimals. Remember: 85% = 0.85.

Example 3

9 Use the excavation formula $V = 0.25A(d_1 + d_2 + d_3 + d_4)$ from Example **3** to determine the volume of soil and rock that must be removed from a square of land 60 m by 60 m. The depth of soil at the corners of the land is 0.3 m, 1.1 m, 1.4m and 1.8 m.

10 When a car's skid marks are in a straight line, the formula $V = 16\sqrt{FS}$ can be used to estimate the car's speed before the brakes were applied. V is the speed of the car in km/h, F is the road surface coefficient of friction and S is the length of the skid marks in metres.

Accident investigators measured the length of a skid mark to be 31 metres. The road's coefficient of friction is 0.85. Calculate the speed of the car that left the skid marks. Answer correct to the nearest km/h.

iStockphoto/brazzo

11 One formula for estimating blood alcohol content (BAC) in females is

$$BAC = \frac{10N - 7.5H}{5.5M}$$

where N = the number of standard drinks

H = the number of hours drinking and

M = the person's mass.

Olivia's mass is 65 kg and she had 5 standard drinks in 2 hours. Calculate her blood alcohol content, correct to 4 decimal places.

12 One formula for estimating blood alcohol content (BAC) in males is $BAC = \frac{10N - 7.5H}{6.8M}$, where N, H and M are as defined in question **11**. Will and Kate both have a mass of 70 kg and they each consumed 4 standard drinks in 90 minutes.

a Express 90 minutes in hours.
b Who had the greater BAC and by how much?
c Why do Will and Kate have different BACs? Refer to the formulas in your explanation.

Chapter problem

You've covered the skills required to solve the chapter problem. Can you solve it now?
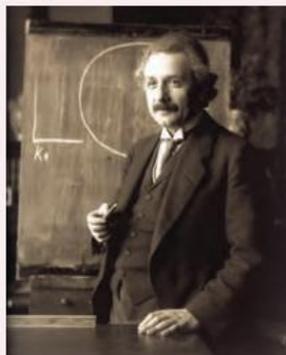
INVESTIGATION

YOUR HEIGHT CAN BE FOUND IN YOUR BONES!

Forensic scientists use science and mathematics help them determine all kinds of information. For example, the length of one of the 4 human 'long bones' and the sex of the person is all they require to be able to calculate the height of the person. They use formulas that allow them to determine height from the length of a skeleton's femur, tibia, humerus and radial bones.

Femur

Tibia
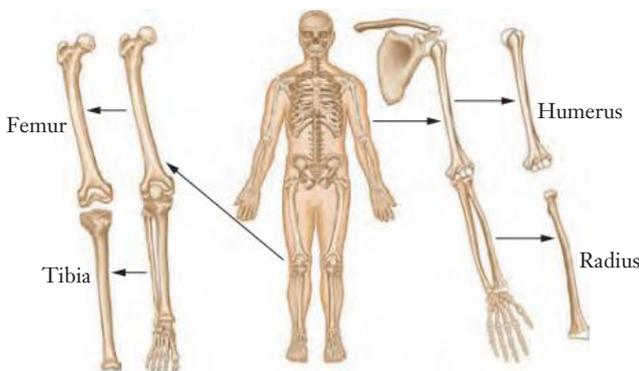
Humerus

Radius

	Females	Males
Humerus	$h = \dfrac{3144H + 64\ 977}{1000}$	$h = \dfrac{2970H + 73\ 570}{1000}$
Radius	$h = \dfrac{3876R + 73\ 502}{1000}$	$h = \dfrac{3650R + 80\ 405}{1000}$
Tibia	$h = \dfrac{2533T + 72\ 572}{1000}$	$h = \dfrac{2392T + 81\ 688}{1000}$
Femur	$h = \dfrac{2317F + 61\ 412}{1000}$	$h = \dfrac{2238F + 69\ 089}{1000}$

h = the person's height

H = the length of the humerus (upper arm bone)

R = the length of the radius (lower arm bone)

T = the length of the tibia (lower leg bone)

F = the length of the femur (upper leg bone)

All measurements are in centimetres.

1 The bones of a man and a woman were found in a shallow grave. The woman's humerus was 33.5 cm long and the man's tibia was 41 cm. What was the height of each person?

2 Several bones of a male skeleton were found in a forest. The humerus was 40 cm, the radius was 31 cm and the tibia was 47.5 cm.

a Calculate the height of the skeleton, based on each bone.

b What height do you think should be recorded?

c Can you suggest a reason why the bones don't give exactly the same height?

3 Measure your height and use the appropriate formula below to calculate the length of your tibia bone.

Female: $T = \dfrac{1000h - 72572}{2533}$ Male: $T = \dfrac{1000h - 81688}{2392}$

4.03 Tables of values

Completing tables of values can help us when we want to construct a graph.

EXAMPLE 4

Complete this table of values for the formula $y = 10 - 2x$.

x	0	1	2	3	4	5
y						

Solution

Substitute $x = 0$ into $y = 10 - 2x$, work out the value and write it in the table under $x = 0$.

$y = 10 - 2 \times 0$

$= 10 - 0$

$= 10$

x	0	1	2	3	4	5
y	10					

Do the same for each value of x in the table.

When $x = 1$ $y = 10 - 2 \times 1 = 8$

When $x = 2$, $y = 10 - 2 \times 2 = 6$

When $x = 3$, $y = 10 - 2 \times 3 = 4$

When $x = 4$, $y = 10 - 2 \times 4 = 2$

When $x = 5$, $y = 10 - 2 \times 5 = 0$

Complete the table.

x	0	1	2	3	4	5
y	10	8	6	4	2	0

Exercise 4.03 Tables of values

1 Copy and complete each table of values.

Example **4**

a $y = 20 - 2x$

x	1	2	4	7	10
y					

b $y = 2x + 3$

x	1	2	3	5	11
y					

c $y = 3x - 5$

x	4	2	5	7	3
y					

d $y = \dfrac{1}{2}x$

x	1	2	3	6	9
y					

2 Copy and complete this table for the relationship $x + y = 12$.

x	1	2	5	9	10
y					

3 Match each formula in parts **a** to **f** with a table of values in **A** to **F**.

a $y = 3x$

b $y = 3 + x$

c $y = x^2$

d $xy = 12$

e $y = 6 - x$

f $y = \dfrac{1}{2}x + 1$

A

x	1	2	3	4	6
y	1	4	9	16	36

B

x	1	2	3	4	6
y	4	5	6	7	9

C

x	1	2	3	4	6
y	12	6	4	3	2

D

x	0	2	8	4	6
y	1	2	5	3	4

E

x	1	2	3	4	6
y	5	4	3	2	0

F

x	1	2	3	4	6
y	3	6	9	12	18

4 Find the formula for each table of values.

a

x	1	2	3	4	5
y	2	3	4	5	6

b

x	1	2	3	4	5
y	0.1	0.2	0.3	0.4	0.5

c

x	1	2	3	4	5
y	4	8	12	16	20

d

x	1	2	3	4	5
y	1	4	9	16	25

e

x	1	2	3	4	5
y	9	8	7	6	5

f

x	1	2	3	4	6
y	24	12	8	6	4

g

x	1	2	3	4	5
y	6	5	4	3	2

h

x	1	2	3	4	5
y	2	4	6	8	10

5 Construct your own table of values to illustrate the relationship $x - y = 1$.

INVESTIGATION

BODY MASS INDEX (BMI)

Health professionals use the body mass index formula $\text{BMI} = \dfrac{m}{h^2}$ to assess a person's future health risk. In the formula, m is the person's mass in kg and h is their height in metres. In adults, a person's BMI relates to their chance of developing several weight-related medical conditions.

Health ratings and BMI at different ages

Weight category	15 to 17 years old	18 to 65 years old	Over 65 years old
Anorexia	na	Less than 17.5	
Possibly malnourished	na	17.5 to 18.4	Less than 24
Healthy	18 to 24	18.5 to 24.9	24.0 to 30.0
Overweight	24.1 to 29.2	25.0 to 29.9	30.1 or more
Obese	29.3 or more	30 or more	

1 Tom is 85 years old. He is 1.7 m tall and weighs 58 kg.

   a Calculate Tom's BMI.

   b Should Tom be worried about his weight?

2 Lyn is 1.69 m tall and has a constant mass of 63 kg. How did her health rating change after her 65th birthday?

3 Measure your height and mass, then use the formula to calculate your BMI. Use the table to identify your weight category.

4 Calculate your BMI if you were 5 kg lighter and 5 kg heavier. Is your BMI very different? Did your weight category change?

5 Now imagine you are 5 cm taller and 5 cm shorter. Calculate your BMI using your true mass. A change in which measure has the greater effect on BMI: height or mass?

NELSON SENIOR MATHS 11. Essential Mathematics

CROSSWORD

Copy this crossword and use the clues to complete the missing words.

				S					
1				U					

Down: **S U B S T I T U T I O N**
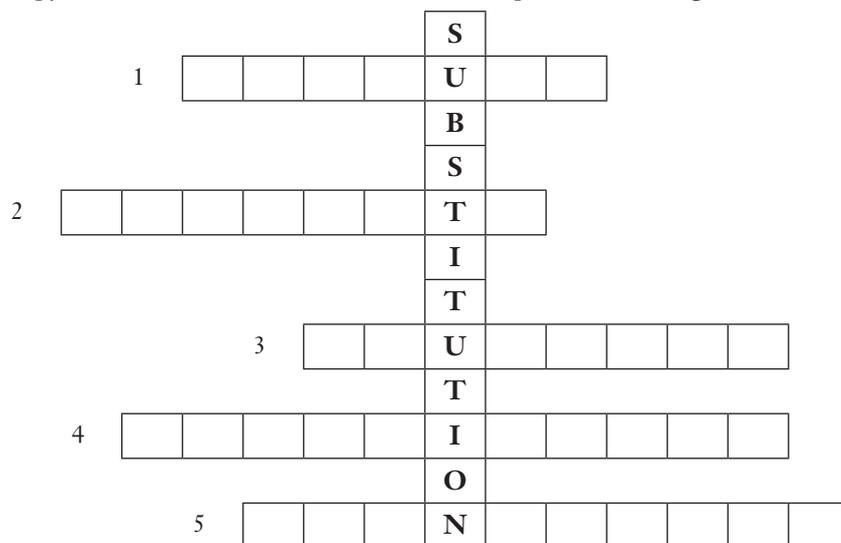
Clues

1 A mathematical rule written using pronumerals.

2 To find the value of an algebraic expression.

3 You need this to complete a table of values, another name for formula.

4 The bottom of a fraction.

5 A letter of the alphabet such as *x* that represents a number, another word for variable.

SOLUTION ^{TO THE} CHAPTER PROBLEM

Problem

When a child is aged between 1 and 5 years, we can predict the typical number of words they will understand using the formula $N = 60m + 100$, where m represents the age of the child in months and N is the number of words.

Abigail, a childcare worker, is worried about Liam, a 20-month-old boy at her daycare centre that doesn't appear to understand many words. He has been tested and understands about 900 words.

Should Abigail be concerned? Use calculations to support your answer.

Solution

The child is 20 months old. Substituting $m = 20$ into the formula $N = 60m + 100$:

$N = 60 \times 20 + 100$

$\quad = 1300$

A typical 20-month old child understands 1300 words.

Liam understands about 900 words, which is well below 1300, so Abigail should be concerned.

Using formulas

1 Evaluate each expression if $k = 15$.

   a $2k$ **b** $3(k + 7)$ **c** $\dfrac{2k}{5}$ **d** $\sqrt{k+1}$

2 Calculate the value of the expression $2y + x$ when $x = 10.2$ and $y = 5.8$.

3 The formula $D = S \times T$ relates distance, speed and time. D = the distance travelled, S = the speed and T = the time. A motorcycle is travelling at an average speed of 115 km/h on the motorway.

   a   Calculate the distance the motorcycle will travel in 4 hours.

   b   Express 15 minutes as a fraction of an hour, then calculate how far will the bike travel in 15 minutes.

4 The formula for calculating a person's weekly wage is $W = b + 1.5hr$, where b = base wage, h = the number of overtime hours worked and r = the hourly wage rate. Benji has a base wage of $784 and he usually earns $22.40 per hour. Use the formula to calculate Benji's weekly wage when he worked 6 hours overtime.

5 Tanya is 1.73 m tall and she weighs 65 kg. Use the body mass index formula $\text{BMI} = \dfrac{m}{h^2}$ to calculate Tanya's BMI, correct to 1 decimal place.

6 Copy and complete each table of values.

   a $y = 3x + 4$

x	0	2	4	7	12
y					

   b $y = 12 - x$

x	1	3	4	6	12
y					

   c $y = \dfrac{1}{3}x$

x	0	3	9	15	12
y					

   d $x + y = 16$

x	2	5	9	11	13
y					

5.

SHOW ME THE GRAPH

Chapter problem

During a drought, the water authority produced a graph to show the decreasing supply of water in a dam due to the water usage of local residents. Is the decrease in water supply as bad as the graph shows? If the graph gives a false impression, identify what has been done to create this impression.

Water in the dam
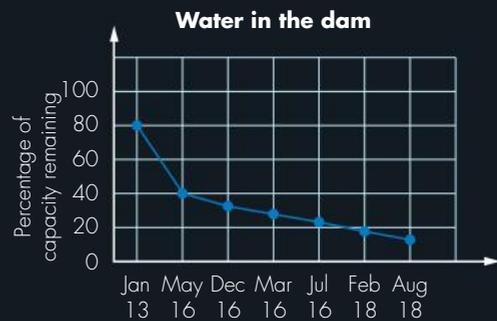
WHAT WILL WE DO IN THIS CHAPTER?

- Interpret information presented in a variety of graphs and two-way tables: picture graphs, column graphs, line graphs, conversion graphs, step graphs and pie graphs
- Determine which type of graph is best suited to display a particular set of data
- Use spreadsheets to graph data
- Identify misleading graphs appearing in the media and in advertising

HOW ARE WE EVER GOING TO USE THIS?

- When reading a graph that is presented in a newspaper, magazine or website
- When drawing a graph to illustrate data to others
- When noticing a graph is being misleading in a report or advertisement

5.01 Interpreting graphs

Statistical data can be represented in a variety of ways. The exercise below revises and extends your knowledge of different graphs.

Exercise 5.01 Interpreting graphs

1 **Picture graphs** use symbols to represent quantities. This picture graph shows the number of cars passing a local high school at different times of day.

Key: Each represents 10 cars.

Number of cars passing the school gate

6:00 a.m. – 8:00 a.m.

8:00 a.m. – 10:00 a.m.

10:00 a.m. – 12:00 noon

12:00 noon – 2:00 p.m.

2:00 p.m. – 4:00 p.m.

4:00 p.m. – 6:00 p.m.
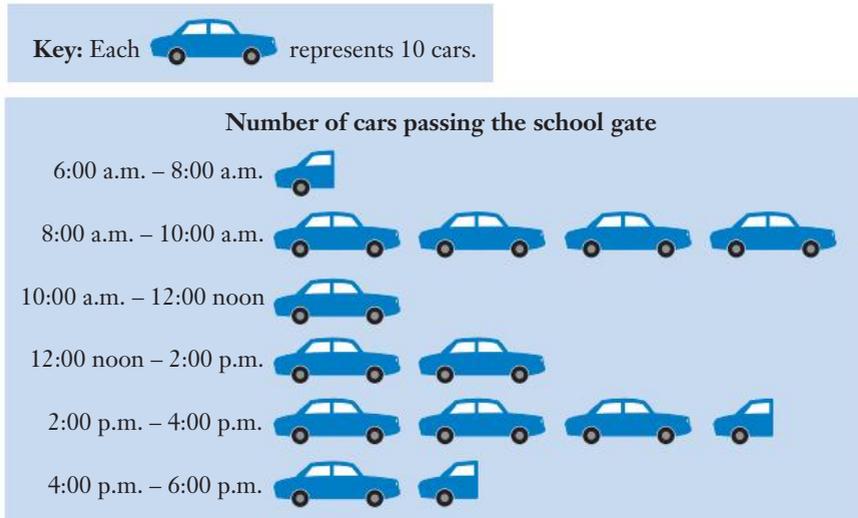
a What does represent?

b How many cars passed the school between 2 p.m. and 4 p.m.?

c What time of day had the least traffic?

d Write a paragraph describing the traffic flow and suggesting reasons for the differences.

2 This picture graph shows the number of letters delivered to an office each day last week.

a How many letters were delivered on Thursday?

b On which day were 11 letters delivered?

c How many letters were delivered to the office last week?

d What is one disadvantage of this type of graph?

Letter deliveries

Monday

Tuesday

Wednesday

Thursday

Friday

 = 4 letters

3 **Column graphs** are mostly used for data that is in categories. This column graph shows the populations of the 8 Australian state capitals.
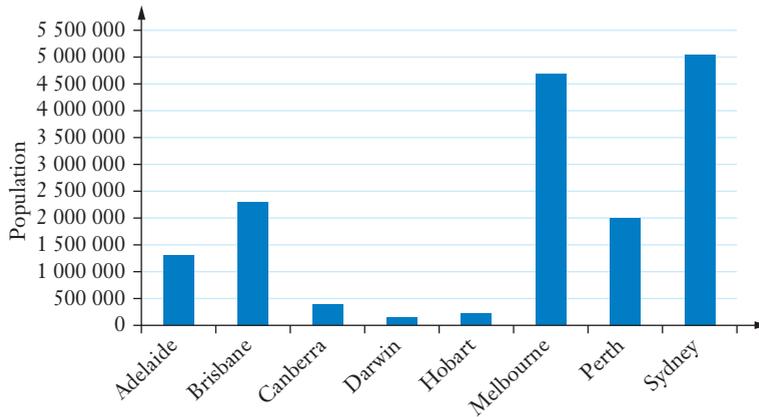
a What does one interval on the vertical axis represent?

b Which city has the largest population? Estimate its population from the graph.

c Which city has the smallest population? Estimate its population from the graph.

d Explain why we can only *estimate* the population from the graph.

e Which city has an approximate population of 1.3 million?

f Use the Internet to find the current populations of each city.

4
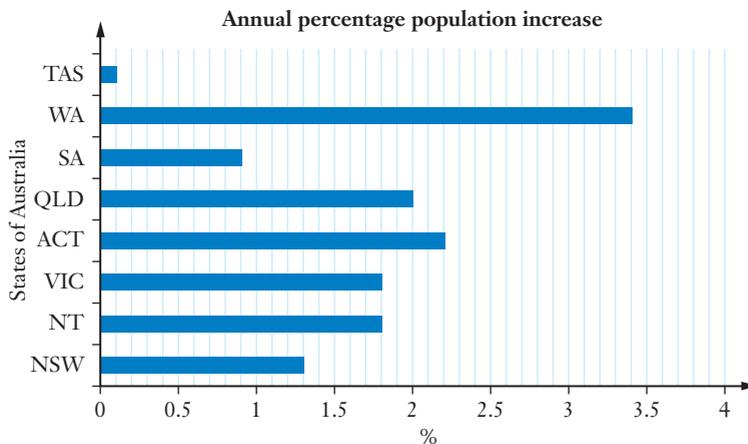
A column graph on its side is sometimes called a **horizontal bar graph**.

a By what percentage did Queensland's population increase?

b In which state was the percentage population increase 1.3%?

c Which 2 states had the same percentage increase?

d Does this graph tell you anything about the actual population of each of the states? Explain your answer.

e The population of Tasmania last year was approximately 512 400. Calculate the actual increase in Tasmania's population.

5 We use a **clustered column graph** for categories we want to compare. This graph shows the nutritional information for different foods.

Percentage of protein, fat and carbohydrates
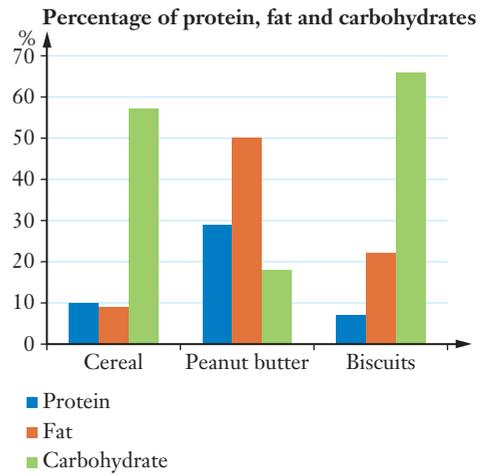
a Which food has the highest percentage of protein?

b Which food has the highest percentage of carbohydrate?

c Which food has the lowest percentage of fat?

d What is the difference in the percentage of fat in peanut butter and biscuits?

e If you were on a low carbohydrate diet, which food could you include in your diet?

f If you were on a low protein diet, which foods could be included in your diet?

g Jack had a 140g serving of cereal for his breakfast. Approximately how many grams of protein did the serving of cereal contain?

h Lizzie has to limit her carbohydrate intake. What foods should she avoid?

6 This clustered column graph shows the number of motor vehicle thefts per year for 3 different areas.
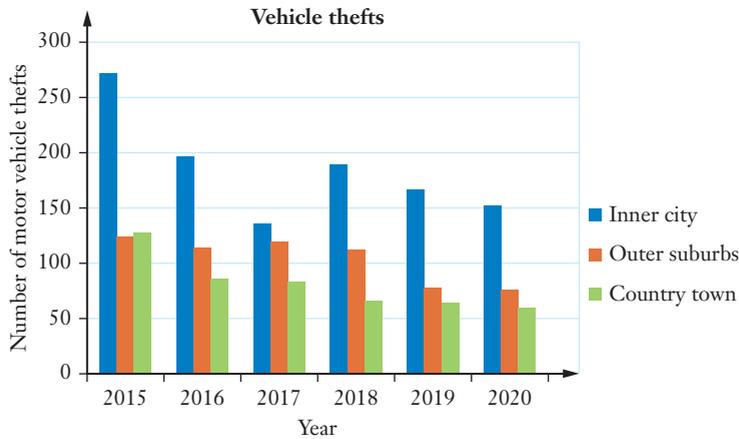
a Describe the trend in motor vehicle thefts in the country town.

b In which year do the outer suburbs have the lowest number of thefts?

c In which year is the difference between the number of thefts in the inner city and the country town smallest? Estimate this difference.

d Write a brief paragraph describing the differences and similarities in the number of motor vehicle thefts in these 3 areas.

7 A **line graph** shows data that changes over time. The graph below shows the dramatic changes in home loan interest rates during the 1990s.

Home loan interest rates
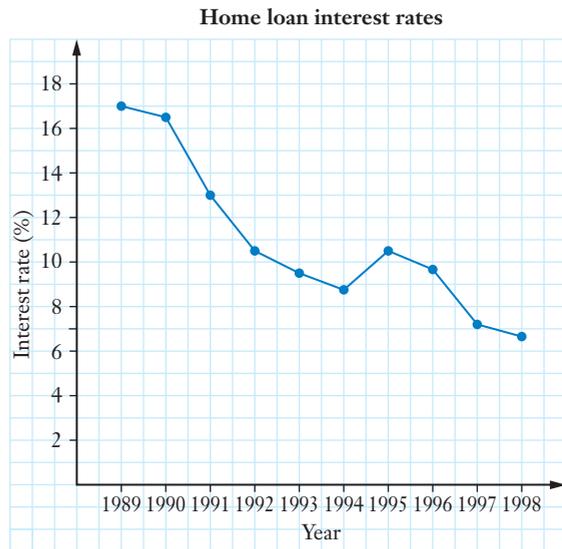
a By how much did the interest rates drop between 1989 and 1998?

b Between which 2 years was the drop the greatest?

c Between which 2 years did interest rates increase?

d Anand borrowed $120 000 in 1989 to buy a house. If a flat rate of interest was used, how much interest did he pay in one year?

e Catriona borrowed the same amount in 1997.

    i Approximately how much interest did she pay in one year?

    ii How much more did Anand pay in one year?

8 This graph shows the electricity consumption for a household over a fortnight.

One household's electricity consumption
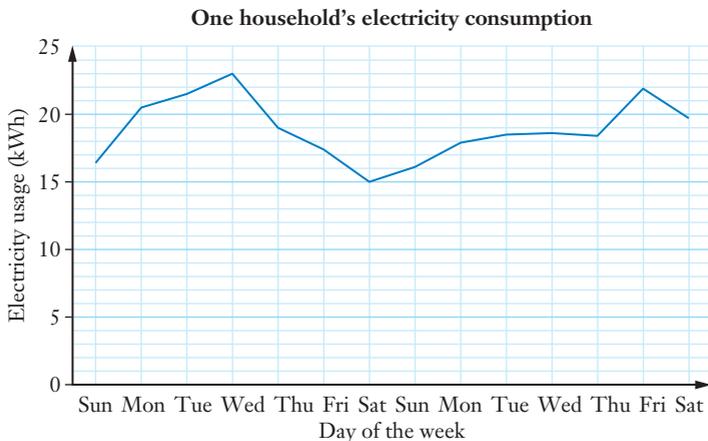
a What was the lowest daily rate of electricity usage?

b What was the highest daily rate of electricity usage?

c The usage is above 20 kWh for 4 days in the fortnight. Which 4 days were these?

9 A **conversion graph** is used to convert from one unit to another. This graph shows conversions between degrees Fahrenheit and degrees Celsius.

Fahrenheit–Celsius conversion graph
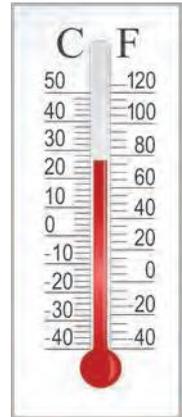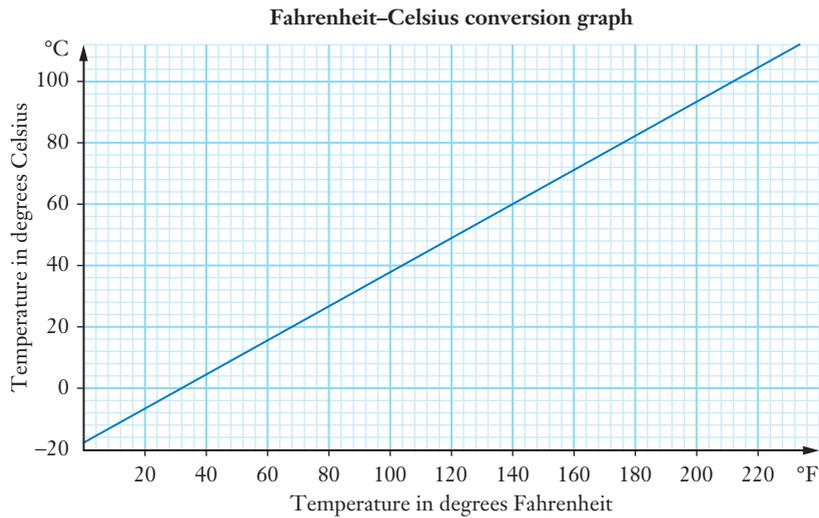
a Convert a temperature of 68°F to °C.

b Water boils at 100°C. What Fahrenheit temperature is this?

c Water freezes at 0°C. What Fahrenheit temperature is this?

d When Australian temperatures were measured in Fahrenheit, a day when the temperature reached 100°F, or a century, was considered a very hot day. What is this temperature in degrees Celsius?

10 This conversion graph can be used to convert Australian dollars to euros (€), the currency used in Europe.

Australian dollars to Euros
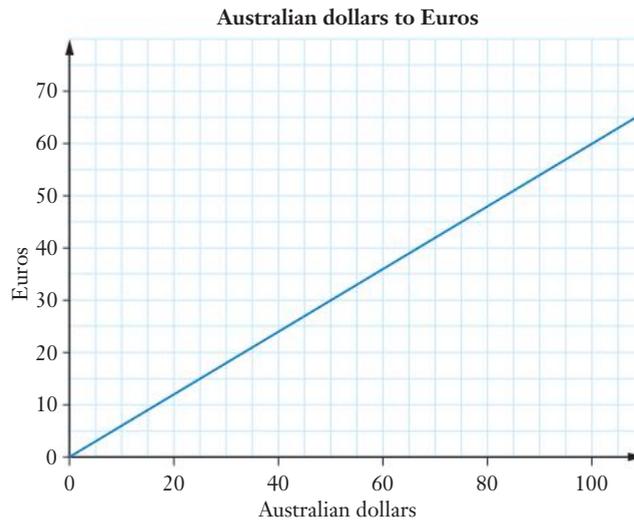
a Convert $15 to euros.

b Convert €50 to Australian dollars.

c A meal in Paris costs €35. What is this in Australian dollars?

d Gustav is visiting Australia. He has €25 left on his debit card. Is this enough to pay for a $25 meal at the local club?

e Calculate how many euros you would get for $220.

11 This conversion graph converts between calories and kilojoules, units of energy used in food nutrition.

Calories to kilojoules
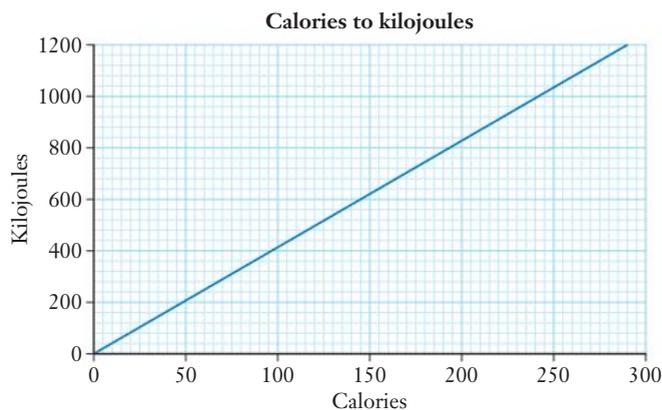
a Convert 100 calories to kilojoules.

b Nami's muesli bar contains 700 kJ of energy. How many calories is this?

c Jordan burned 500 calories working out at the gym. How many kilojoules is this?

d The average daily allowance for a healthy diet is 8700 kJ. How many calories is this?

12 A **step graph** is a line graph of 'broken' horizontal intervals that look like steps.

Prem repairs air conditioners. This step graph shows his charges according to the hours of work.

a How much does Prem charge for any time under an hour?

b How much does he charge for exactly 2 hours?

c How much would Prem charge for working at your house for 4.5 hours?

d How much does he charge for each additional hour he stays to make repairs?

e Why does he charge a lot more for the first hour than for additional hours?

Air conditioner repair rates
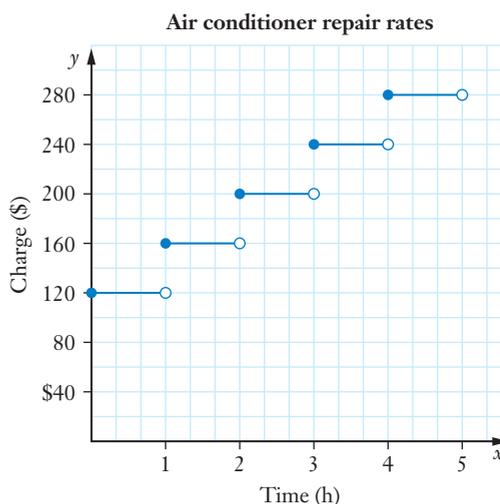
Remember: read the amount with the filled circle, not the open circle.

13 This graph shows the charges for parking at an airport.

Airport parking charges
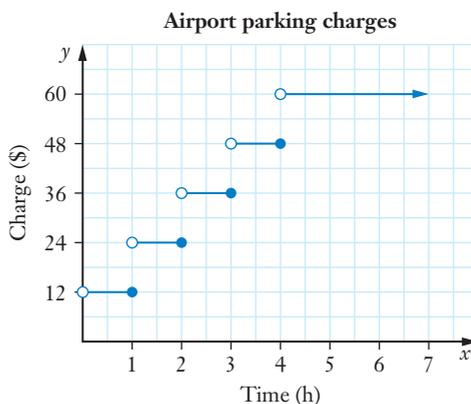
a How much does the airport charge for 2 hours of parking?

b Anh parked for 3 hours and 23 minutes. How much did his parking cost?

c When Madison went to the airport to pick up her mum, the plane was delayed. She had to park for 6 hours and 42 minutes. How much did this cost?

d According to this graph, what is the most you will have to pay for parking at the airport?

e What is the average charge per hour for parking at the airport for 6 hours?

14 This **pie graph** shows the results of a survey of Queensland people about their favourite sport to watch on TV.

a What is the most popular sport?

b What is the least popular sport?

c Which 2 sports have sectors approximately the same size?

d Rugby league was the favourite sport of 24% of the 3500 people surveyed. How many people preferred to watch rugby league on TV the most?

e Do you think the results of a survey like this would be different if the survey was taken in different places? Justify your answer.

Favourite sport watched on TV
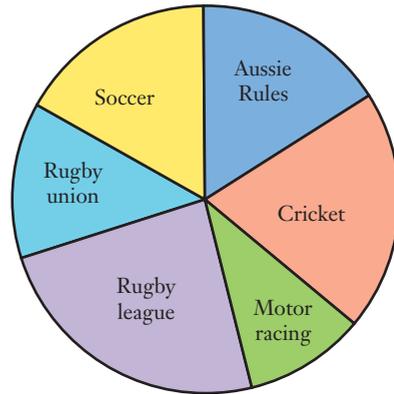
15 This graph shows the costs of producing a book as a percentage of the book price.

a Which is the highest cost in producing a book?

b List the costs in order from highest and lowest.

c Royalties to authors account for 15% of the cost of production.
A new textbook costs $65.

How much is the royalty payment?

Costs of producing a book
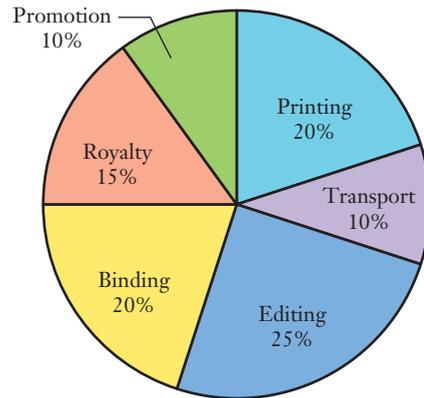
16 NelsonNet Airlines surveyed passengers on a flight from Perth to Melbourne on their reasons for travelling to Melbourne.

a What was the main reason people were travelling from Perth to Melbourne?

b Of the 176 passengers on this flight, how many were travelling for work/business?

c This survey was conducted on a Friday evening. Would you expect the same results if the survey was conducted on a Monday evening? Justify your answer.

Reasons for travel
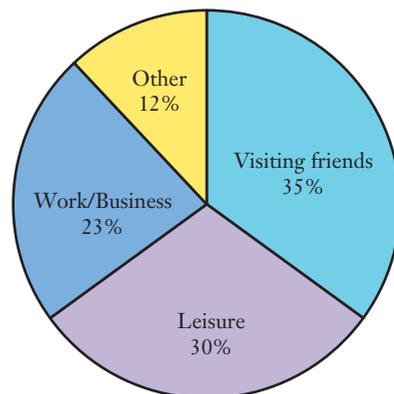
5.02 Two-way tables

Two-way tables show two characteristics of any set of data.

This two-way table shows the results of a survey on right/left-handedness and right/left-footedness.

	Right-footed	Left-footed	Total
Right-handed	50	10	60
Left-handed	12	8	20
Total	62	18	80

a What percentage of people in this survey are right-handed?

b What percentage of the right-handed people in this survey are left-footed? Answer correct to 1 decimal place.

> If you're not sure what number to put on the bottom of the fraction, look at the quantity following 'of' in the expression 'what percentage of …'.

Solution

a There are 80 people in the survey and 60 people are right-handed.

$$\text{Percentage} = \frac{60}{80} \times 100$$
$$= 75\%$$

b 60 people are right-handed and of those, 10 are left-footed.

$$\text{Percentage} = \frac{10}{60} \times 100$$
$$= 16.666...\%$$
$$\approx 16.7\%$$

Exercise 5.02 Two-way tables

1 Jarrod manages a muffin and scones shop. He surveyed locals on whether they preferred muffins or scones. The results are summarised in this table.

	Prefers muffins	Prefers scones	Total
People aged over 30	24	36	60
People aged 30 and younger	48	12	60
Total	72	48	120

a How many people did Jarrod survey?

b Which age group prefers scones to muffins?

c Overall, which item do Jarrod's customers prefer?

d How many of the people who prefer scones are over 30 years old?

e What percentage of people aged 30 or younger prefer muffins?

2 This table shows the smoking habits of the adult population of Nelson Waters.

	Men	Women	Total
Smoker	3500	2400	i
Non-smoker	7500	8600	ii
Total	iii	iv	v

a Copy the table and complete the missing values in **i** to **v**.

b What is the adult population of Nelson Waters?

c What fraction of the adults smoke?

d What percentage of the adults are non-smokers? Answer to 2 decimal places.

e What percentage of the adult women who live in Nelson Waters are smokers?

3 Simone runs a café. He recorded data about who buys hamburgers and chicken wraps.

	Hamburgers	Chicken wraps	Total
Male	77	43	i
Female	31	64	ii
Total	iii	107	iv

a Calculate the missing totals.

b How many customers were counted?

c How many females bought chicken wraps?

d What percentage of customers bought hamburgers? Answer to 2 decimal places.

e What percentage of men bought chicken wraps? Answer to 1 decimal place.

f Simone is expecting a busload of men's football teams to visit the café. Should she prepare more hamburgers or chicken wraps? Justify your answer.

4 Nick surveyed people from the local area about whether they exercise regularly.

	Men	Women	Total
Regular exercise	75	i	158
No regular exercise	iii	77	ii
Total	iv	v	345

a Copy the table and complete the missing values in **i** to **v**.

b What percentage of the people interviewed were women who exercised regularly? Answer correct to 2 decimal places.

c What percentage of the men interviewed have no regular exercise? Answer correct to 2 decimal places.

d If a local gym was aiming to encourage people who don't exercise to join the gym, should they aim the advertisement at men or women? Justify your answer.

5 Alannah surveyed a group of people for their opinion on changing the Australian flag.

	Aged under 35	Aged 35 and over	Total
Change the flag	2570	1060	**i**
Keep the flag	6350	2780	**ii**
Total	**iii**	**iv**	**v**

a Copy the table and complete the missing values in **i** to **v**.

b What percentage of those surveyed wanted to keep the flag? Answer correct to 2 decimal places.

c What percentage of those under 35 wanted to change the flag? Answer correct to 2 decimal places.

d Based on this survey, should the Government change the Australian flag? Justify your answer.

6 Police are testing a new lie detector machine. The results are shown in this table.

	Machine judged as true	Machine judged as a lie	Total
True statements	65	15	**i**
False statements	**ii**	30	40
Total	**iii**	**iv**	**v**

a Copy the table and complete the missing values in **i** to **v**.

b On how many statements did the police test the machine?

c For how many statements did the machine correctly determine whether the statement was true or false?

d What percentage is this? Answer correct to 1 decimal place.

e What percentage of *true* statements were incorrectly identified by the machine? Answer correct to 1 decimal place.
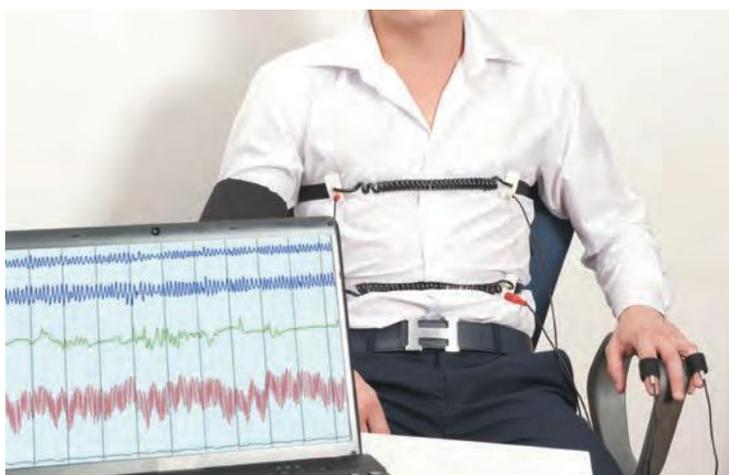
Shutterstock.com/Andrey Burmakin

5.03 Everyday graphs

Exercise 5.03 Everyday graphs

1 This type of graph commonly appears on a phone bill.

Monthly bill history
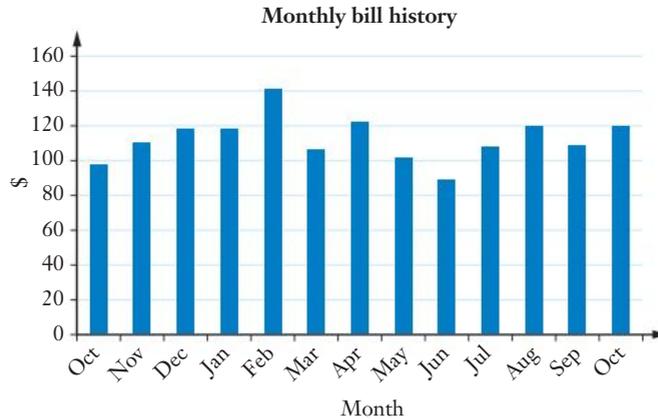
a How much is the most recent bill?
b How does this compare with the same time last year?
c What is the lowest amount paid for one month?
d Why would the telephone company include this graph on your telephone bill?

2 This is a typical electricity bill graph.

Quarterly bill history
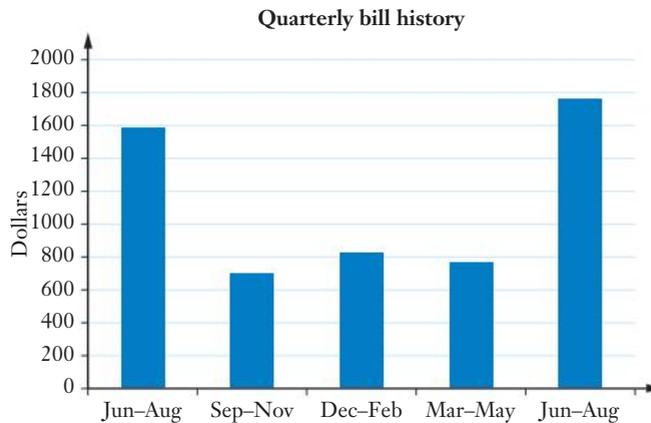
a How many months does each bill cover?
b What is the most recent amount paid?
c Give a reason why the amounts in June to August are much bigger than for the other months.
d Why is this type of graph useful to customers?

3 Gas bills usually show 'Your average daily gas usage' measured in megajoules (MJ).

Average gas usage per day
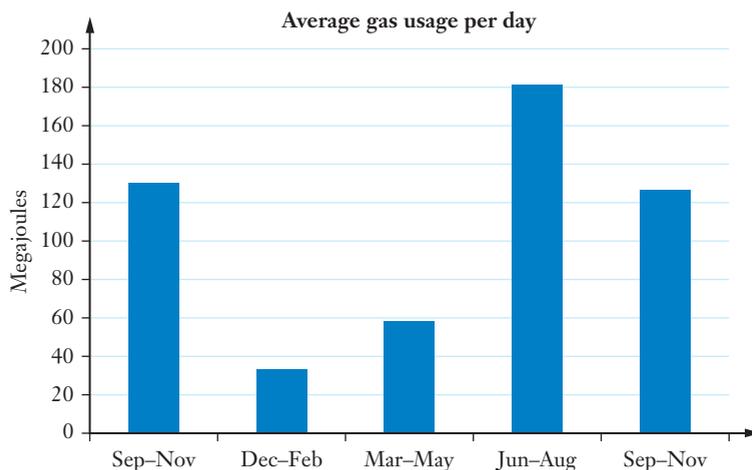
a How many months in total does this graph cover?
b What is the highest average daily gas usage?
c At what time of year is the most amount of gas used? Why might this occur at this time of year?
d Why is this type of graph useful to customers?

4 This table shows the interest rates offered by NelsonNet Bank for term deposits over differing periods of time. With a term deposit, the money must stay in the account for the whole time and interest is paid at the end.

Minimum deposit	No of months.												
	1	2	3	4	5	6	7	8	9	10	11	12	24
$1000	2.05	2.05	2.05	2.05	2.05	2.05	2.05	2.05	2.05	2.05	2.05	2.05	2.05
$5000	2.05	2.05	2.55	2.30	2.30	2.75	2.30	2.30	2.30	2.30	2.30	2.75	3.15
$20 000	2.05	2.05	2.55	2.30	2.30	2.75	2.30	2.30	2.30	2.30	2.30	2.75	3.15
$50 000	2.05	2.05	2.55	2.30	2.30	2.75	2.30	2.30	2.30	2.30	2.30	2.75	3.15
$100 000	2.05	2.05	2.55	2.30	2.30	2.75	2.30	2.30	2.30	2.30	2.30	2.75	3.15

a What is the lowest interest rate offered?
b Regina has $5000 that she wants to spend on a holiday in 10 months. What is the best interest rate available to her?
c Stephen invests $20 000 for 12 months. How much interest does he earn?
d What are the disadvantages of putting your money in a term deposit for 24 months?

5 This graph shows the number of sunny days per month last year in Broome, Western Australia.

Sunny days per month: Broome
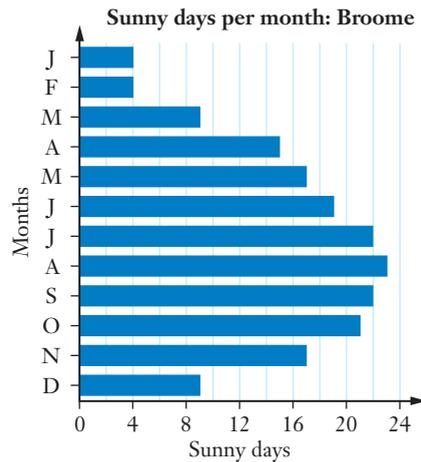
a Which month had the most sunny days?

b Which month had the least sunny days?

c List 3 pairs of months that had approximately the same number of sunny days.

d How many months of the year had 16 or more sunny days?

e Andrea is getting married in Broome.
She would like a sunny day for her wedding. In which 3-month period should she plan her wedding to be most likely to get a sunny day?

f Give another reason why this graph might be useful.

6 A **climate graph** combines temperature and rainfall information. The climate graph below is for Darwin.

Darwin's climate graph
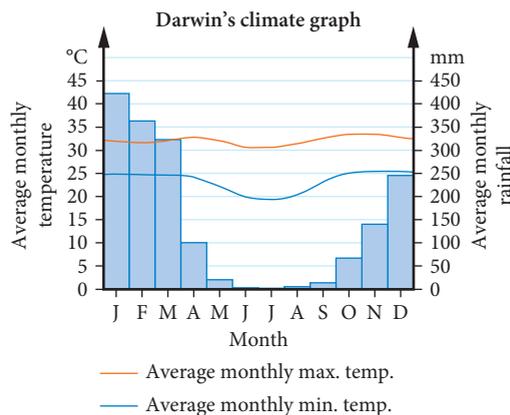
a What is the average maximum temperature in Darwin in December?

b Which 3 months have the coldest minimum temperatures?

c Describe Darwin average monthly rainfall pattern.

7 This is the climate graph for Toowoomba, Queensland.

Toowoomba's climate

— Average monthly max. temp.
— Average monthly min. temp.
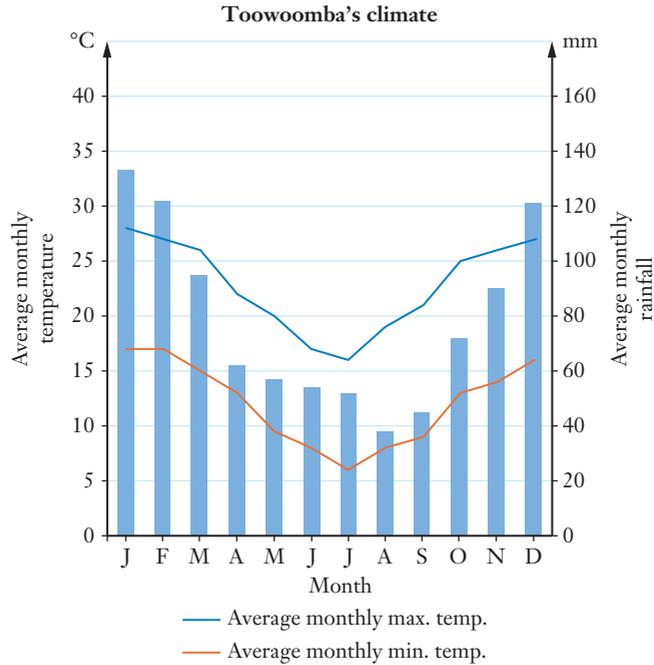
a Which 4 months have the lowest rainfall?

b What is the difference between the average maximum and minimum temperatures in Toowoomba in February?

c How much more rain falls during October than during July?

d Explain why it would be useful to have a graph like this for any place you might consider moving to.

8 Is Happy Valley in the northern hemisphere or the southern hemisphere? Explain your answer.

Happy Valley's climate

— Average monthly max. temp.
— Average monthly min. temp.
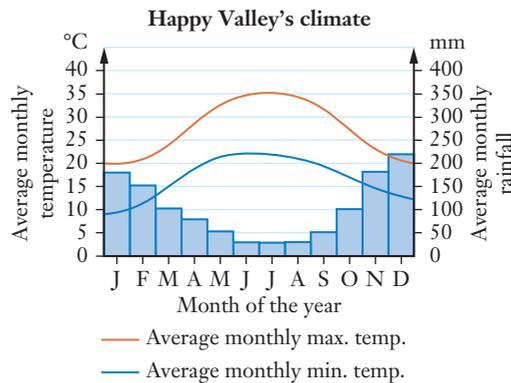
9 This picture graph was published by the Australian Red Cross Blood Service.

The red cells from your donation are being used in the following ways:
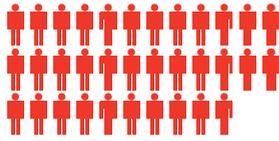
34% Cancer and blood diseases
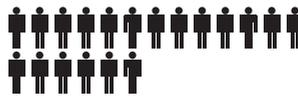
19% Other causes of anaemia
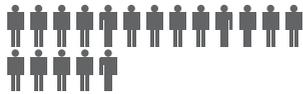
18% Surgical patients including open heart surgery and burns

13% Other medical problems including heart, stomach and kidney disease

10% Orthopaedic patients including fractures and joint replacements

4% Obstetrics, including pregnant women, new mothers and young children

2% Trauma including road accidents

Source: Bloodhound Study Monash Institute of Health Services Research 2007

Source: Bloodhound Study Monash Institute of Health Services Research 2007. With permission from Australian Red Cross Blood Service.

a What does each person symbol stand for?

b Explain how this graph helps you understand how blood donations are used.

c Is there any information in this graph that surprises you? Explain your answer.

d Does this graph make you more likely to donate blood?

e If 27 000 litres of blood are collected in one week, how much of it goes to help patients with cancer and blood diseases?

INVESTIGATION

GRAPHS IN OTHER SUBJECTS

Graphs are used to record and present data across all subject areas. For each of the subjects you study other than Mathematics:

- find examples of graphs used in the subject (find as many different types as possible)
- name the types of graphs used.

Which is the most common type of graph used across different subjects? Suggest a reason why this type of graph is used frequently.

Write a short paragraph on the uses of graphs in your areas of study. Explain the similarities and differences. Suggest reasons why different subjects use different types of graphs.

Present your findings as a PowerPoint presentation or wall chart.

5.04 Choosing the best graph

We use different graphs for different types of data. In this exercise, you will learn some hints to help you choose the best graph for each type of data.

Exercise 5.04 Choosing the best graph

1 Categorical data is often represented by a **column graph**. Draw a column graph for the following data showing the make of car owned by the families of a group of Year 11 students.

Make of car	Frequency
Toyota	12
Hyundai	10
Holden	7
Mazda	5
Ford	8
Other	3

2 The media often use a **picture graph** because it is an attractive graph. They are best used when the data is not too spread out and precise accuracy isn't required.

The Cairns Tourism Board wants to increase its number of tourists in winter. It published the number of rainy days in June for a number of cities. Graph the data as a picture graph, using the symbol 🌧 to represent 4 rainy days.

City	Rainy days in June
Cairns	10
Melbourne	18
Adelaide	24
Sydney	15
Hobart	17
Perth	16
Brisbane	15

3 A **pie graph** is used to show each category as a fraction of the whole. This pie graph shows the causes of children's deaths one year in Australia.

Causes of death in children

  a What percentage of the deaths were caused by drowning?

  b What was the most common cause of death?

  c Drowning, assault and traffic incidents are considered preventable causes of death. What percentage of deaths are from something that could have been prevented?

  d If there were 1769 child deaths in total, how many were preventable?
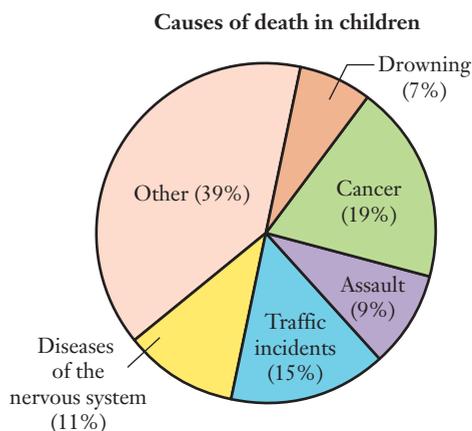
4 A survey of 1080 workers in central Melbourne were asked how they travelled to work.

a Copy and complete the following table which calculates the angle for each sector in a pie graph. Round each answer to the nearest degree.

Method of transport	Frequency	Angle for sector graph
Train	220	$\frac{220}{1080} \times 360 =$
Tram	280	$\frac{280}{1080} \times 360 =$
Bus	130	$\frac{130}{1080} \times 360 =$
Car	230	$\frac{230}{1080} \times 360 =$
Walk	80	$\frac{80}{1080} \times 360 =$
Cycle	140	$\frac{140}{1080} \times 360 =$
Total	1080	

b Draw a pie graph for this data.

5 This **line graph** charts Kate's height over her first 15 years. At birth, Kate was 48 cm long.

a What was Kate's height:
  i on her first birthday?
  ii at age 10?

b At what age did Kate reach:
  i 1 metre?
  ii 150 cm?

c Between which 2 birthdays did Kate grow the most?

d How long did it take Kate to double her height from birth?

e What do you think the graph would look like from age 15 to 20 years?

Kate's height
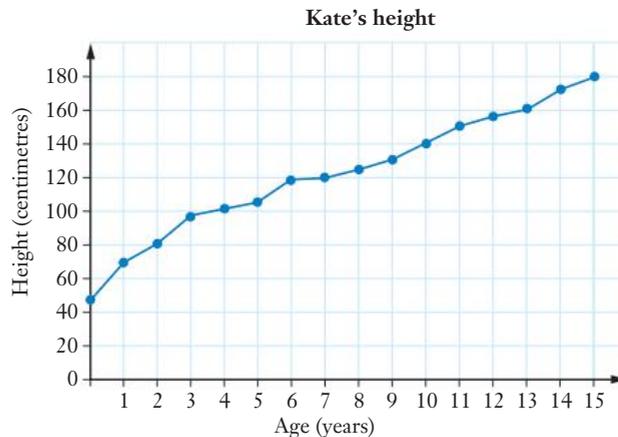
6 This table shows the temperatures over 24 hours in Alice Springs in November.

Time	Noon	3 p.m.	6 p.m.	9 p.m.	Midnight	3 a.m.	6 a.m.	9 a.m.	Noon
Temperature	32°C	35°C	33°C	29°C	26°C	24°C	23°C	29°C	34°C

Draw a line graph for this data.

7 This data shows the monthly number of burglaries over 3 years in an inner-city region.

54, 41, 55, 49, 37, 38,
37, 48, 51, 44, 52, 44,
58, 70, 60, 46, 63, 54,
45, 43, 46, 55, 55, 67,
49, 66, 90, 45, 66, 62,
51, 51, 53, 53, 38, 52

Stem	Leaf
3	
4	
5	
6	
7	
8	
9	

Copy and complete the **stem-and-leaf plot** for this data.

> Remember: a stem-and-leaf plot has the tens digit as the stem and the units digit as the leaves.

8 We use a **frequency histogram** or a **frequency polygon** to see the shape of the data. A group of students was given a maths test and the test marks out of 80 were grouped into class intervals, then graphed on this frequency histogram and polygon.

Test marks (histogram with x-axis "Score out of 80" marked 13, 28, 43, 58, 73 and y-axis "Frequency")
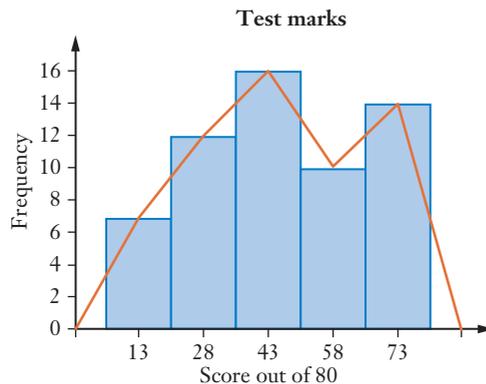
Test marks	Frequency
6–20	
21–35	
36–50	
51–65	
66–80	
Total	

a Copy and complete the frequency table using the graph.

b How many students sat the test?

c What was the most common class interval of test marks?

d How many students scored less than 36 in this test?

9 The water level of a canal was measured daily over 43 days.

Draw a **frequency histogram** for this data.

Water level (cm)	Frequency
152	5
153	6
154	8
155	12
156	4
157	8
Total	**43**

5.05 Graphs and spreadsheets

In this exercise you will use a spreadsheet to produce some graphs. Ask your teacher to download the 'Statistical graphs' spreadsheet with the data for this exercise from NelsonNet. You should save this spreadsheet to your own computer.

Statistical graphs

Exercise 5.05 Graphs and spreadsheets

1 **Column graph**

   To draw a column graph that shows the numbers of people immigrating to Australia by their region of origin in 1988–9:

   - select all of the cells from A3 to B8
   - select the **Insert** tab at the top
   - under **Charts**, select **Column** and then the first of the 2D column types
   - click on the chart title, highlight the text '1988–9' and change it to 'Immigration by region of origin'
   - ensure the chart is selected (**Chart Tools** appears at the top of the sheet), select the **Layout** tab, then axis titles, go to **Primary Vertical Axis Title** and select **Rotated Title**. This will insert vertical script on the vertical axis. Highlight this script and change it to 'thousands'.
   - with the chart selected, choose the **Design** tab and pick **Move Chart**. In the dialogue box, select the Object in option and immigration as the sheet and then OK. Move the whole chart to the top left of this sheet (click and hold the mouse on the chart border, move to the desired location and unclick).

2 **Clustered column graph**

   Several years of information can be provided in the one graph by using clustered columns. For example, data for both years 1998–9 and 2008–9 can be shown.

   - Return to the data sheet.
   - Select all cells from B3 to C8.
   - Select the **Insert** tab, and under **Charts** choose **Column** and select the first one of the 2D column types.
   - Go to the **Layout** tab, click **Chart Title** and select **Above Chart**. Change the title text to the same as for the previous chart.
   - Give the vertical axis the label 'thousands' as for the previous chart.
   - Move the chart to the immigration sheet as you did for the last one and place it just below the previous column chart.

3 Find the latest data for immigration by region of origin and add a third column to the data provided. Draw a clustered column graph for all 3 years. Place the graph on the immigration sheet.

4 Pie graphs

The same data will be used to draw sector charts of the immigration statistics to show the contribution from the various regions.

- Return to the data sheet and select cells A2 to B8.
- Select the **Insert** tab, and under **Charts**, choose **Pie** and select the first 2D pie type.
- Check out the different possible **Chart Layouts** (top of screen). Try them out and choose the chart that you think shows the most information in the way that looks best.
- Move the chart to the immigration sheet as you have done previously and place it just to the right of the first simple column chart.

  Now create another sector chart for the 2008–9 data. The steps are much the same as before, except the initial selections of cells is a little more complicated.

- Return to the data sheet. Select cells A3 to A8. Then press and hold the Ctrl button while you select C3 to C8 with the mouse.
- Insert the pie chart as before.
- This time the title needs to be changed. Click the cursor in front of 2008–9 in the title and add 'Immigration to Australia by Region of Origin' in front of it.
- When you are happy with its format, place it below the first sector chart on the immigration sheet.

5 Line graphs

Use the data for temperatures during a spring day in Launceston in cells A24 to J25 of the data sheet.

- Select cells A24 to J25
- Choose **Insert**, **Line** and select the first of the 2D chart types.
- Go to the **Layout** tab, go to **Chart Title** and select **Above Chart**. Replace the words Chart Title with 'Temperatures in Launceston'.
- Place the graph in the 'lines' worksheet.

6 Use the vehicle and home theft figures in cells A10 to F13 of the data sheet. Both will be plotted on the same graph. Draw a line graph for this data. Place the graph in the 'lines' worksheet.

7 Use the data on Bazza's gym from the data sheet (A17 to M20). Draw a line graph for this data. Place the graph in the 'lines' worksheet.

5.06 Line graphs

Line graphs are usually used to graph data that changes over time. They can also be used to compare 2 or more sets of data.

Exercise 5.06 Line graphs

1 Simon was born weighing 4.3 kg. This line graph shows his weight over his first 12 months.

Simon's weight

  a What did Simon weigh at:
     i 2 months?   **ii** 7 months?

  b When did Simon weigh:
     i 10 kg?   **ii** 12 kg?

  c Between which 2 months did Simon gain the most weight?

  d Approximately how long did it take Simon to double his birth weight?

  e Suggest what this graph might look like over the next 12 months. Give reasons for your suggestion.
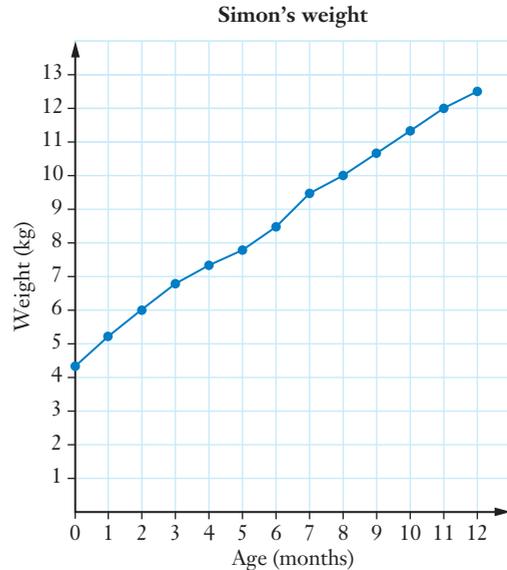
2 These graphs show the percentages of deaths from cancer and heart disease at different ages.

Cancer
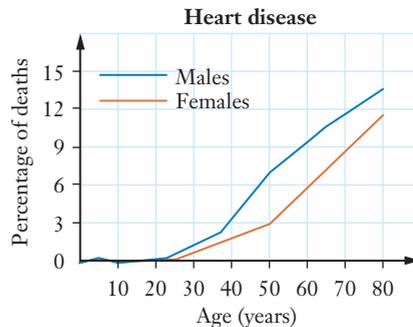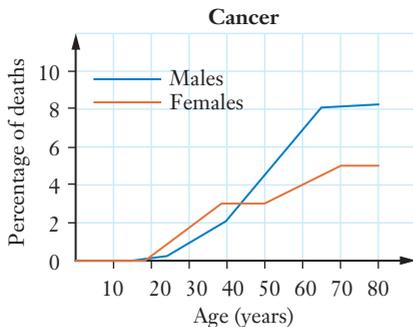
Heart disease

  a For males aged 70, what percentage of deaths are due to cancer?

  b Between what 2 ages do 3% of women die of cancer?

  c For males aged 50, what percentage of deaths are caused by heart disease?

  d Generally, according to both graphs, what happens as people get older?

  e Is the statement 'More men die of heart disease than women' true or false? Suggest a reason why.

  f At what age does the rate of cancer-related death in men increase?

  g Between what ages do a higher percentage of women die of cancer than men? Discuss why.

3 The 8 graphs below illustrate the average maximum (orange) and minimum (blue) monthly temperatures of the Australian state capitals (Adelaide, Brisbane, Canberra, Darwin, Hobart, Melbourne, Perth and Sydney) over a 12-month period, but they are presented in jumbled order.
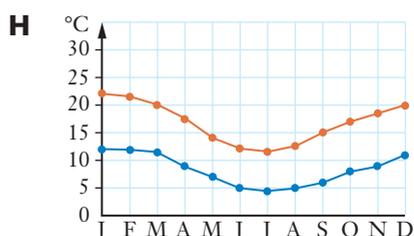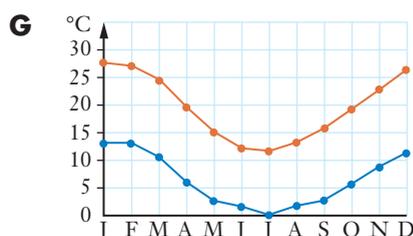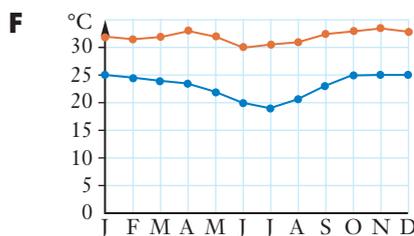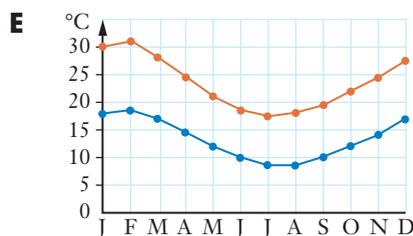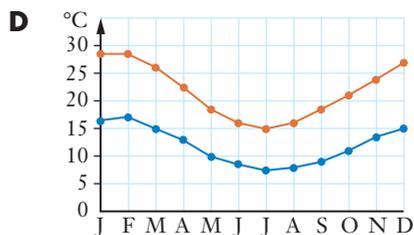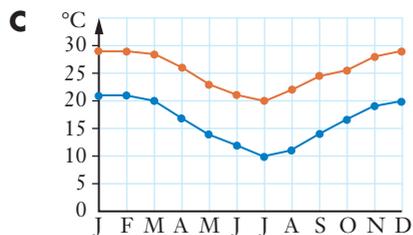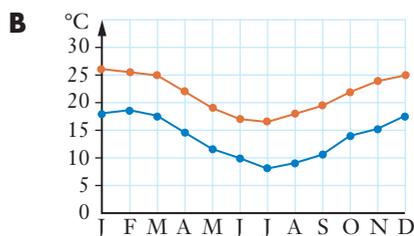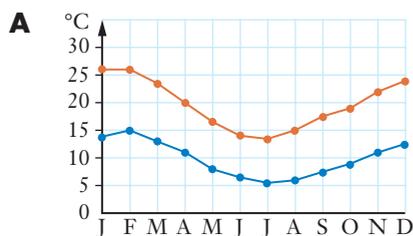
a From your knowledge of geography and climate, decide which graph belongs to which city.

b For graph G, list the maximum temperature of each month.

c Graph D has two months with exactly the same minimum temperature. Which months are they?

d Find which graphs have one month with a minimum of 10°C. For each graph, state which month it is.

e Which graph has all the maximum temperatures approximately the same?

f Which graph has the greatest difference between the highest maximum temperature and the lowest minimum temperature for one month? What is this difference?

g Find the highest maximum temperature and state which graph shows it and in which month it occurs.

h Find the lowest minimum temperature and state which graph shows it and in which month it occurs.

4 This line graph shows the midday temperature for the last 20 days of April.

Temperature in April
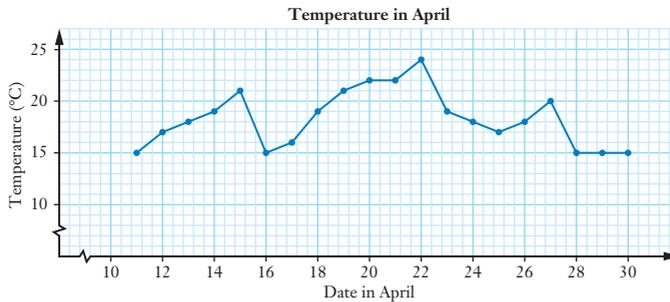
a On what date was the highest temperature, and what was that temperature?

b What was the lowest temperature?

c What was the range (the difference between the highest temperature and the lowest temperature)?

d What is the scale shown on the vertical axis?

e What was the temperature on 17 April?

f On what days was the temperature 22°C?

g Which day experienced the biggest drop in temperature?

h On how many days was it colder than the day before?

5 Sarah is in hospital recovering from having her tonsils removed.

Sarah's temperature

a What does each unit represent on:

   i the time scale?

   ii the temperature scale?

b What was Sarah's temperature at 0800 Friday?

c When did Sarah's temperature first reach 38.3°C?

d What was Sarah's maximum temperature?

e How long was her temperature at this maximum value?

f Increases in temperature can indicate an infection. Sarah's doctor prescribed some antibiotics. When did her temperature return to the normal 37°C?
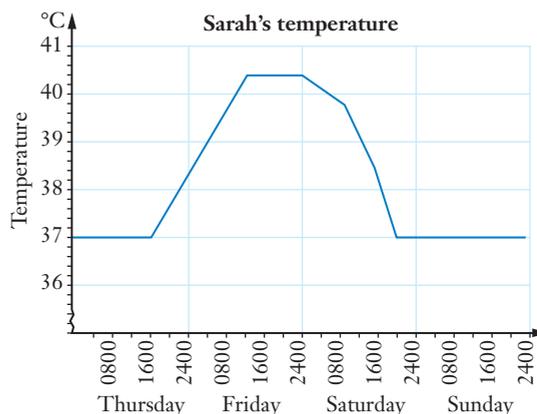
6 Angelina was admitted to hospital at 10 p.m. with a high temperature. This table shows her temperature each hour for the next 12 hours.

Time	10 p.m.	11	12	1 a.m.	2	3	4	5	6	7	8	9	10 a.m.
Temperature (°C)	42	42	41	40	40	41	39	40	38	39	37	37	37

Draw a line graph showing this information.

7 Jacob and Evan have decided to both diet and exercise in order to lose weight. The table records their weight loss over a 10-week period.

a Copy and complete the table below.

	Week	Start	1	2	3	4	5	6	7	8	9	10
Jacob	Weight loss (kg)		4	7	5.5	12		5	6.5	8.5	3	
	Weight (kg)	183					152					125
Evan	Weight loss (kg)		2.5	4.5	1.1		6.4	3	4.6	5	5	
	Weight (kg)	137			125							99

b On one graph, draw two line graphs showing Jacob and Evan's weight loss over 10 weeks. Make each line graph a different colour.

c On one graph, draw two line graphs of Jacob and Evan's actual weight over 10 weeks. Make each line graph a different colour.

d By looking at both graphs you have drawn, who do you think was more successful at losing weight? Justify your choice.

e What is the total weight loss for

i Jacob?   **ii** Evan?

f Calculate the total weight loss as a percentage of the starting weight for both Jacob and Evan. Give your answer correct to 1 decimal place.

5.07 Misleading graphs

Sometimes graphs are deliberately drawn to give a false impression, like the one below. This can be done by:

- not having a scale on the vertical axis

- showing only part of the scale or an irregular scale

- not showing zero on the vertical scale or only showing a small part of the vertical axis

- using pictures or three-dimensional figures on the graph to exaggerate the differences

The graph shows the cost of a 30-second call on three different mobile phone plans. If you view the graph quickly, it appears that the calls are much cheaper on the Green plan than on the other two plans, but a closer look will show that there really isn't a big difference in cost between the three plans. While the information on the graph is correct, it gives a **misleading** impression.

Only showing a small part of the vertical axis on a graph is the most common way to create a misleading impression. As you work through the questions in the next exercise, you will learn about other ways to create misleading impressions.

Cost of a 30-second call
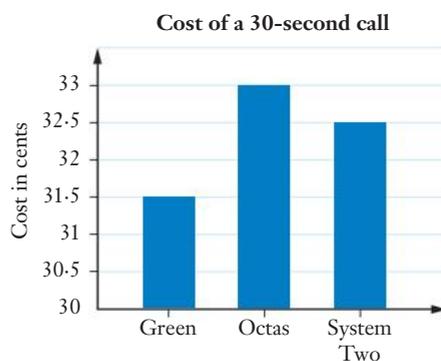
Exercise 5.07 Misleading graphs

1 Use the misleading graph above to answer the following questions.

    a How much does a 30-second mobile phone call cost on each of the 3 plans?

    b How much cheaper is a call on the Green plan than on the System Two plan?

    c This graph shows the same information as the misleading graph.

       In which graph does the cost of a call on the Green plan look much cheaper than the cost on the other plans?

    d Write a sentence to describe how the scales on the vertical axes are different on the 2 graphs.

    e Which company do you think produced the misleading graph? Give a reason for your answer.

Cost of a 30-second call
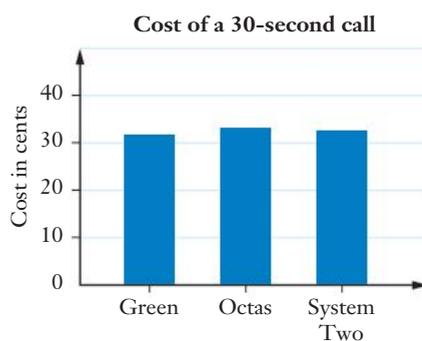
2 David drew a column graph to show the average cost of a litre of petrol in 6 capital cities.

Cost of 1 L of petrol

a In which city is the price of petrol the cheapest?

b Which city has the highest petrol price?

c Use the graph to estimate the price of petrol in Brisbane.

d Approximately how many cents cheaper is the price of petrol in Brisbane than in Darwin?

e David included this graph in an advertisement for motoring holidays in Brisbane. He claimed that the graph shows that petrol prices are much lower in Brisbane than they are in other capital cities. Explain what David did to the graph to make the price of petrol look a lot cheaper in Brisbane.
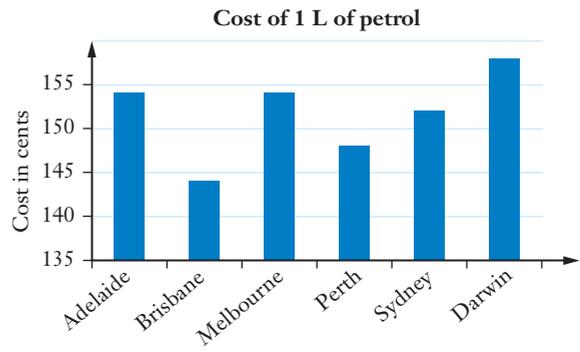
3 This table shows the price of a brand of coffee in 2010 to 2015, with the data graphed in 2 different ways on the next page.

Year	2010	2011	2012	2013	2014	2015
Price of coffee	$6.15	$6.60	$7.30	$8.05	$8.90	$9.65
Increase since 2010	$0	$0.45	$1.15	$1.90	$2.75	$3.50

Price of coffee since 2010

Increase in price of coffee since 2010
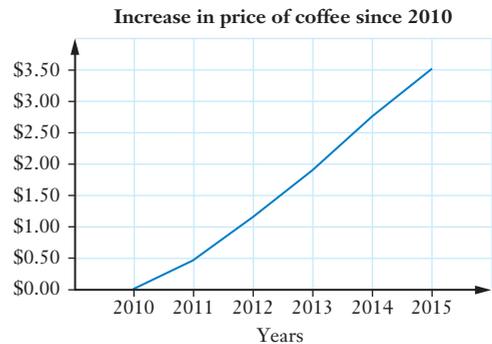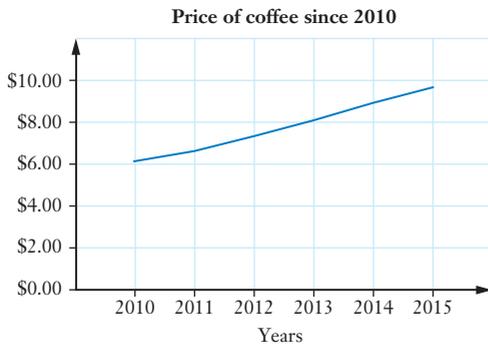
The 2 graphs illustrate how graphs can make **increases** look small or big. Imagine that you want to draw a graph to show how the population in your area has increased. Describe how you could make the increase look small and how you could make it look big.

4 Scott thinks that oil companies have been ripping people off. He decided to investigate the historical prices of petrol and the cost of crude oil.

Petrol and crude oil prices
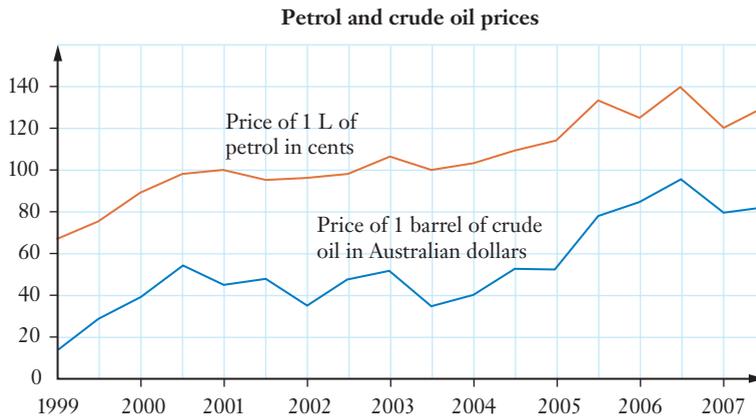
a What was the price of 1 L of petrol in 2007?

b How much did a barrel of crude oil cost in 2007?

c Profit = selling price – cost price. The graph shows the barrel cost at 56 and the petrol cost at 104 in 2003, giving the impression that the profit is 104 – 56 = 48. Explain why this impression is completely false.

d What relationship does the graph show between the price of petrol and the price of crude oil?

5 This graph compares the average weekly wages in Malvolia ($700) and Australia ($1400).

Average weekly wages

Malvolia   Australia
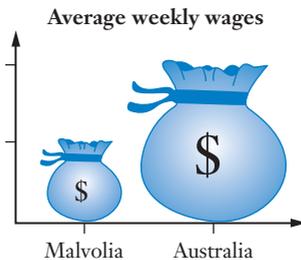
a What misleading impression does this graph give?

b Explain two things that are wrong about this graph.

c What should be drawn on the graph instead of pictures?

d Redraw this graph correctly.

6 This question uses data from the spreadsheet from Exercise 5.05. It uses the results of a survey of households about their favourite commercial television network. The data are in cells A37 to B41.

a Select cells A38 to B41 and make a basic column chart from the data.

b Select **Layout**, then **Axes**, **Primary Vertical Axis**, **More Primary Vertical Axis**, **Options**.

c In the dialogue box for **Minimum**, select **Fixed** and enter 3700 next to it. Close the dialogue box.

d Give the graph the obvious title it deserves 'Nine blitzes the other networks' and put it in the misleading sheet.

e Do the same again but in the vertical axis dialogue box make the minimum zero. Close the box.

f This is the same data but the impression is very different. Give this graph a title that explains the situation seen.

g Move it to the misleading sheet directly beneath the first one.

Chapter problem

You've covered the skills required to solve the chapter problem. Can you solve it now?

KEYWORD ACTIVITY

FEATURES OF GRAPHS

In your own words, summarise the important features of each type of graph.

1 Column graph

2 Climate graph

3 Clustered column graph

4 Conversion graph

5 Histogram

6 Line graph

7 Picture graph

8 Pie graph

9 Stem-and-leaf plot

SOLUTION ᵀᴼ ᵀᴴᴱ CHAPTER PROBLEM

Problem

During a drought, the water authority produced a graph to show the decreasing supply of water in a dam due to the water usage of local residents. Is the decrease in water supply as bad as the graph shows? If the graph gives a false impression, identify what has been done to create this impression.

Water in the dam
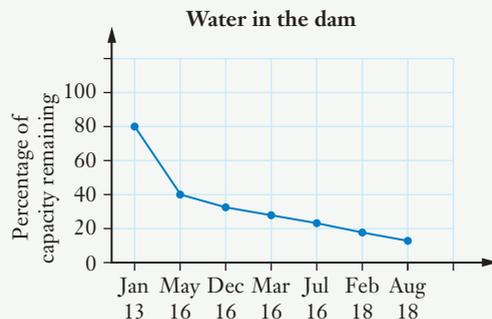
Solution

This graph is misleading because the scale on the horizontal axis isn't consistent. The horizontal scale jumps from 2013 to 2016 and then various months from 2016 and 2018.

The big drop in dam levels between January 2013 and May 2016, compared with the small drop between February and August in 2018, gives the impression that water was being wasted from 2013 to 2016.

The graph below shows the same information in a non-misleading way.

Water in the dam

Show me the graph

Qz
Practice quiz
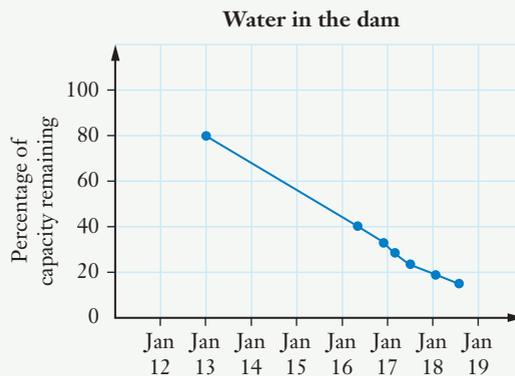
Use the graphs in Exercise 5.01 on pages 112–119 to answer questions **1** to **5**.

Exercise
5.01

1 Use the picture graph in question **1**.
   a How many cars passed the school gate between 8 a.m. and 10 a.m.?
   b During which time period did 5 cars pass the school gate?

Exercise
5.01

2 Use the column graph in question **3**.
   a Estimate the population of Perth from the graph.
   b Estimate the difference between the populations of Perth and Melbourne.

Exercise
5.01

3 Use the line graph in question **7**.
   a What was the home loan interest rate in June 1991?
   b By how much did the home loan interest rate rise from 1994 to 1995?

Exercise
5.01

4 Use the conversion graph in question **10**.
   a Convert $60 to euros.
   b Convert 60 euros to Australian dollars.

Exercise
5.01

5 Use the pie graph in question **14** of Exercise 5.01.
   a Which sport has the smallest sector?
   b Soccer was the favourite sport of 17% of those surveyed. 3500 people were surveyed. How many people preferred to watch soccer on TV?

Exercise
5.02

6 The government gathered information about people's internet access by undertaking a survey. The following table shows the results of that survey.

	High-speed internet	No high-speed internet	
City	105	38	**i**
Country	89	42	**ii**
	iii	**iv**	**v**

   a Copy the table and complete the missing values **i** to **v**.
   b How many country people were surveyed?
   c What percentage of city people have high-speed internet?
   d What percentage of the whole sample do not have high-speed internet?

Use the graphs in Exercise 5.03 on pages 123–127 to answer questions **7** to **9**.

7 Use the telephone bill graph in question **1**.

   a How much was the bill in August?

   b What is the difference between the highest telephone bill and the lowest telephone bill over this 13 months?

8 Use the gas bill in question **3**.

   a What is the lowest usage per day for gas shown on this graph?

   b When did this occur?

   c Suggest why the gas usage would be lowest at this time.

9 Use the table of interest rates in question **4**.

   a What is the highest interest rate offered?

   b Annabel invests $50 000 for 6 months. How much interest does she earn?

10 Copy and complete this paragraph:

A column graph is often used for _____ data. When we are showing parts of a whole, we use a _____ graph. A line graph is used to show _____ over _____. An advantage of a stem-and-leaf plot is _____. To see the shape of a data set, we use a _____.

11 This table gives the daily minimum temperature over a fortnight in Adelaide.

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Temp (°C)	20	19	21	21	20	19	18	20	17	16	19	17	16	14

Draw a line graph showing this information.

12 Redraw the misleading graph in Exercise 5.07, question **2** on page 138 so that it isn't misleading.

6.

HEALTHY FIGURES

Chapter problem

For morning tea, Renee had a chocolate muffin (825 kJ) and some coffee with milk and sugar (295 kJ). Afterwards, she goes for a walk, using 23 kJ of energy per minute. How long will Renee have to walk to use all the energy she consumed at morning tea?

WHAT WILL WE DO IN THIS CHAPTER?

- Identify and simplify rates
- Convert between kilojoules (kJ) and calories (Cal) as units of energy
- Apply units of energy and rates to solve a variety of problems involving food, exercise and electricity
- Measure energy consumption in electrical appliances
- Measure and calculate heart rates

HOW ARE WE EVER GOING TO USE THIS?

- Exercising adequately to maintain a healthy weight
- Consuming an appropriate level of food for our nutritional needs
- Keeping our bodies healthy and fit
- Using efficient electrical appliances in the home

6.01 Rates

A **rate** shows how one quantity changes with another quantity. We write a rate using a '/' symbol in the form 'something *per* something else'. For example:

- the price of petrol is stated in cents per litre, or c/L
- your heart beats at a rate measured in beats per minute, or beats/min
- the speed of a car is measured in kilometres per hour, or km/h.

A rate compares 2 quantities measured in different units.

The word 'per' means 'for each' so we express a rate '*per* single unit'. For instance, travelling at a rate of 50 km/h means travelling 50 km in *each* hour.

Shutterstock.com/lzf

EXAMPLE 1

Write each statement as a simplified rate.

a A factory produces 87 cars in 3 hours

b Ham costs $50 for 8 kg

Solution

a The production rate would be expressed in cars per hour. We can write a rate as a fraction: divide the number of cars by the number of hours.

$$\text{Production rate} = \frac{87 \text{ cars}}{3 \text{ hours}}$$
$$= 29 \text{ cars/hour}$$

b The cost would be expressed in dollars per kilogram. Divide the number of dollars by the number of kilograms.

$$\text{Cost} = \frac{\$50}{8 \text{ kg}}$$
$$= \$6.25/\text{kg}$$

Exercise 6.01 Rates

1 Write the units suitable for each rate below, in the form _____/_____.

- **a** typing speed
- **b** heart rate
- **c** cost of a mobile phone call
- **d** cost of bananas
- **e** a person's wage
- **f** cost of petrol
- **g** population growth
- **h** the cost of water
- **i** population density

2 Write each statement as a simplified rate.

- **a** 51 sheep in 3 hours
- **b** $10.75 for 2.5 kg
- **c** 208 students for 8 teachers
- **d** 136 points in 4 games
- **e** 546 words in 6 minutes
- **f** 34 articles in 4 hours
- **g** 72 cars in 15 days
- **h** 5040 boxes in 8 hours
- **i** 259 metres in 7 seconds
- **j** 46 000 bottles in 50 hours
- **k** 7944 revolutions in 6 minutes
- **l** $175 for 5 hours
- **m** 448 km in 8 hours
- **n** $16.50 for 6 kg
- **o** 114 runs in 24 overs
- **p** 243 km using 30 litres
- **q** $126 for 12 hours
- **r** 2520 kg for 60 hectares

3 The cost of sending a 5.5 kg parcel to Malaysia is $88. What is the postage rate?

4 In your own words, explain what is meant by each rate.

- **a** A speed of 100 km/h
- **b** A traffic flow of 150 cars/h
- **c** Petrol consumption of 10.3 L/100 km
- **d** A farmer keeping 60 sheep/hectare

5 A lift should carry no more than 1600 kg or 20 people. What is this weight allowance, in kg/person?

6 A pulp mill clears 27 000 hectares of forest in 15 years. At what rate, in hectares/year, does the mill clear the forest?

7 The cost of 53 litres of petrol is $73.67. Express this cost in c/L.

8 A complaints hotline took 2190 calls in one year. Calculate the number of calls per month.

6.02 Burning energy

Kilojoules (kJ) are metric units of energy. If we use more energy than we eat, we lose body weight. However, if we eat more energy than we use, this energy is stored as fat.

This table shows the amount of energy our body needs each day, depending on our age group, sex and level of activity.

Age	Lifestyle	Men kJ/day	Women kJ/day
18–35	inactive	10 500	8000
	active	12 500	9000
	very active	14 800	10 500
36–70	inactive	10 000	8000
	active	11 800	8800
	very active	14 300	10 400
Pregnant women			10 100
Breast-feeding women			11 800

EXAMPLE 2

Kylie is 18 years old, works in an office and has an inactive lifestyle. Every day on her way to work she has a cappuccino at the coffee shop. The cappuccino contains 940 kJ.

a How many kilojoules of energy does Kylie need each day?

b What percentage of her daily energy needs does Kylie have in her morning cappuccino?

Solution

a Kylie is 18, a female, and has an inactive lifestyle. Her energy needs are shown in the top row and right column in the table.

8000
Kylie needs 8000 kJ per day.

b $\dfrac{\text{kJ in the cappuccino}}{\text{kJ per day}} \times 100\%$

$\dfrac{940}{8000} \times 100\% = 11.75\%$

Kylie's cappuccino contains 11.75% of her daily energy needs.

Calories (Cal) are an older unit of energy. Calories are bigger than kilojoules.

$$1 \text{ Cal} = 4.2 \text{ kJ}$$

EXAMPLE 3

A 500 mL chai tea latte with full cream milk contains 240 calories.
How many kilojoules is this?

Solution

Kilojoules are smaller than calories. To change to a smaller unit, multiply by the conversion factor.

$$240 \text{ Cal} = 240 \times 4.2 \text{ kJ}$$
$$= 1008 \text{ kJ}$$

Exercise 6.02 Burning energy

1 Mark is a 20-year-old bricklayer and has a very active lifestyle.

  a According to the table on the previous page, how many kilojoules does he require per day?

  b Mark eats a hearty breakfast containing 3250 kJ to give him energy for the day's work. What percentage (to the nearest whole number) of his daily energy requirements does Mark have for breakfast?

2 Stella is 36 years old. During the week she is inactive and on the weekend she is very active.

  a How much energy does she need each day during the week?

  b How much more energy does she require per day on the weekend than during the week?

3 Courtney, aged 18, is very thin and refuses to eat more than 6000 kJ per day. Every afternoon she works out at the gym for 2 hours. Courtney's mother is worried and knows that the type of gym workout Courtney does burns 2500 kJ/hour.

  a How much energy does Courtney use at the gym each day?

  b How much energy does Courtney have left from her diet for the remaining 22 hours in the day?

4 Use the conversion 1 Cal = 4.2 kJ to copy and complete each statement. Answer to the nearest whole number.

  a 500 Cal = ___ kJ   **b** 360 kJ = ____ Cal   **c** 68 Cal = ___ kJ

  d 25 kJ = ____ Cal   **e** 2460 kJ = ___ Cal   **f** 10 800 kJ = ___ Cal

Example **2**

Example **3**

5 a The treadmill at the gym shows that Samantha has used 550 Cal.
How many kilojoules is this?

b Samantha wants to use 2500 kJ on the machine. How many more calories does she have to burn?

6 This graph shows children's daily energy requirements.

Children's daily energy requirements
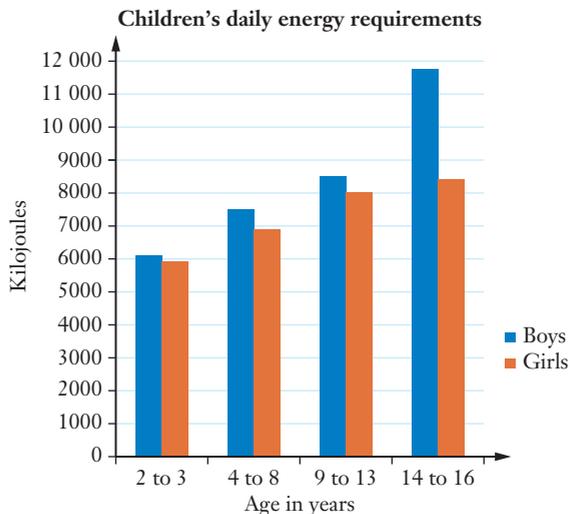
a Do boys or girls need more energy per day?

b At what age do boys and girls need approximately the same amount of energy per day?

c How many more kJ/day do 16-year-old boys need than 16-year-old girls?

d At what age do boys require approximately 7500 kJ/day?

e Calculate the weekly energy requirements for a 12-year-old girl.

f Jon is an 8-year-old boy who usually eats 8600 kJ of food per day. Is he eating an appropriate amount?

g If Jon continues to eat 8600 kJ/day, will Jon's weight increase or decrease?

7 This table shows the average length of time it takes an 18-year-old to burn up 1000 kJ for different activities.

Activity	Time required to use 1000 kJ
Sleeping	4 hours
Eating	3 hours
Working in class Studying Watching TV	2 hours 30 minutes
Walking	1 hour
Bike riding	50 minutes
Swimming	30 minutes

a How much energy does Scott use swimming for 1 hour?

b How long will it take Jessica to use 500 kJ while she is sleeping?

c Suzie, aged 18, leads a very active life. This pie chart shows the number of hours each day that she spends on different activities.

Hours Suzie spends on different activities per day
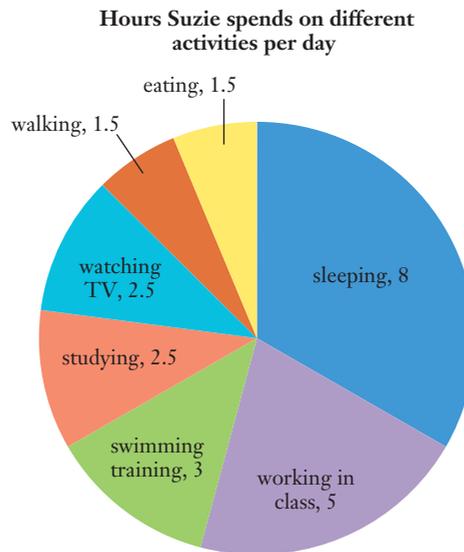
i According to the table on page 148, how much energy does Suzie need per day?

ii Use the chart and the table on the previous page to calculate the amount of energy Suzie uses per day.

iii If Suzie eats food that provides the energy requirement given in part **i**, is it enough for what she uses per day?

iv What recommendations would you give Suzie concerning her lifestyle?

6.03 Energy in food

WS

Investigating
fast food

The food we eat supplies us with energy. This table shows the amount of energy stored in some normal-sized serves of food.

Food	kJ	Food	kJ	Food	kJ
Roast lamb, gravy	1064	Apple pie	1380	Apple	243
Potato bake	1175	One slice of buttered bread	520	Large tomato	120
				Small tomato	30
Mixed grill	2600	Yoghurt	315	Chocolate biscuit	493
Steak	3900	Muesli	1470	Can of soft drink	372
Bacon (2 slices)	640	Eggs (2)	735	Orange juice	206
Fish	340	Cheese	115	Milk (glass)	628
Grilled chicken breast	1264	Ham (2 slices)	224	Milk for cereal	400
Chips	1425	Mixed nuts (100 g)	2640	Coffee with milk and sugar	295
Ice cream	810	Broccoli	98	Banana	546
Sauce for steak or chicken	246	Sauce for fish	265	Beef sausage	176

EXAMPLE 4

On a plane, Lucas was served a meal of grilled chicken breast with sauce, chips and broccoli. How many kilojoules were in this meal?

agefotostock.com/Sylvain Grandadam

Solution

Use the table to look up the kJ content of each food item.

Chicken breast: 1264

Sauce: 246

Chips: 1425

Broccoli: 98

Add them.

Total kJ = 1264 + 246 + 1425 + 98

= 3033

Write your answer.

The meal contained 3033 kJ.

Marna had 200 g of mixed nuts. How long will it take her to use the energy from them when she is working out at the gym at the rate of 30 kJ/minute?

Solution

200 g of nuts = 2 serves (from the table).	Total energy = 2640×2
	= 5280 kJ
Divide the number of kJ by the rate to find the time.	Time = $5280 \div 30$
	= 176 minutes
	= 2 hours 56 minutes
Write your answer.	Marna will work out for 2 h 56 min to use the energy from the mixed nuts.

Athletes running at 15 km/h use 75 kJ/h per kg of their body weight. Claire's body weight is 58 kg. How much energy does she use when she runs for 30 minutes at 15 km/h?

Solution

Claire burns 75 kJ per hour per kg of her body weight. She weighs 58 kg, so each hour she burns 75×58.	Energy burned per hour = $75 \text{ kJ} \times 58$
	= 4350 kJ
30 minutes is half of an hour. Divide by 2.	Energy burned in 30 minutes = $4350 \div 2$
	= 2175 kJ
Write your answer.	Claire burns 2175 kJ when she runs for 30 minutes.

Exercise 6.03 Energy in food

1 Calculate the energy content of each meal.

a Dani's breakfast contains a serving of muesli with milk, an apple and a banana.

b Felix's breakfast comprises 2 slices of ham, 2 beef sausages, one egg and one slice of buttered bread.

c Milan ate a steak with sauce, a large tomato and a serving of chips for his lunch.

d Emma had some grilled fish with sauce and a large sliced tomato for her lunch.

2 George is 16 years old. The menu shows what he eats in a typical day.

a Calculate the total number of kilojoules George eats in a typical day.

b An average 16-year-old boy should eat 11 800 kJ per day. What effect will George's typical day's food have on his body weight?

MENU

Breakfast
- 2 slices of bacon
- 2 eggs
- muesli with milk
- 2 slices of toast with butter
- Glass of orange juice

Dinner
- mixed grill
- chips
- broccoli
- potato bake
- apple pie
- ice cream
- coffee, milk, sugar

Lunch
- ham sandwich with 2 slices of ham
- cheese sandwich
- apple
- 2 chocolate biscuits
- yoghurt
- can of soft drink
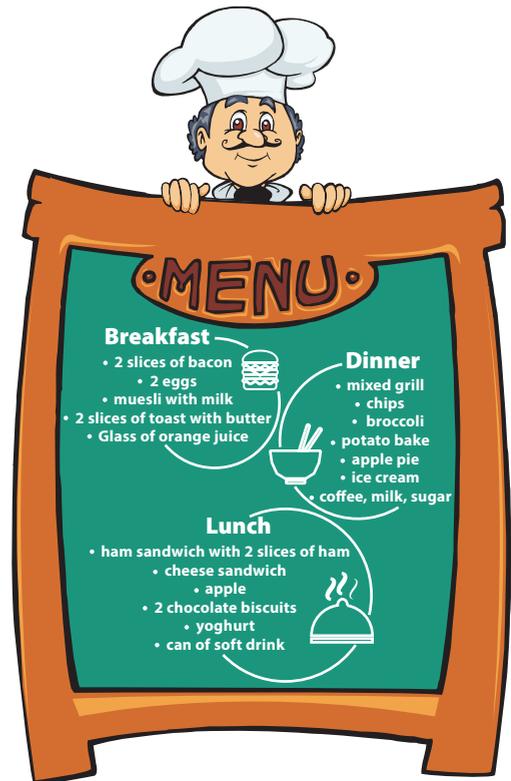
3 Amanda requires a daily diet of 8800 kJ. Use the food items in the table on page 152 to plan a healthy day's menu for Amanda.

4 A large chocolate cake contains 27 600 kJ. Suyen cut the cake into 8 equal slices.

   a How many kilojoules are in each slice of cake?

   b How many minutes of gym work, at 30 kJ/minute, will it take to use the energy in one slice of the cake?

5 This table shows the energy an average person uses per minute for different activities. Calculate the amount of energy an average person uses when:

Activity	kJ/minute
Sleeping	4
Cleaning	15
Ironing	17
Bricklaying	17
Playing tennis	31
Gardening	23
Circuit training	53
Walking	23

   a gardening for 30 minutes

   b ironing for 45 minutes

   c bricklaying for an hour

   d circuit training for $1\frac{1}{4}$ hours

   e sleeping for 8 hours

   f walking for 50 minutes every day for a week

6 The more you weigh, the more kilojoules you will burn doing different activities. The table shows the amount of energy per kg of body weight that teens and adults use in one hour in various activities.

   a Lisa weighs 45 kg. How much energy does she use during a 1-hour maths lesson?

Activity	kJ used per hour per kg of weight
Sleeping	3.7
Driving a car	6.4
Schoolwork	6.8
Walking	18
Skiing (15 km/h)	43
Swimming (45-second laps)	29

   b Ali's body mass is 75 kg. How many more kilojoules does he use in 8 hours sleep than Lisa?

   c Marko started walking every day to try to lose weight. He currently weighs 128 kg. How much energy does he use when he walks for 30 minutes?

   d Filomena is a keen skier who weighs 63 kg. One Saturday she drove her car for 3 hours to the snowfields. Then she skied at an average speed of 15 km/h for 5 hours. How many kJ of energy did she use in the 8 hours?

   e Every morning Scott spends an hour swimming 45-second laps of the pool as part of his training routine. During the hour, Scott uses approximately 2200 kJ. What is Scott's approximate body weight?

Chapter problem

You've covered the skills required to solve the chapter problem. Can you solve it now?

WS

Household
energy costs

WS

Power
problems

▶

Energy
consumption

6.04 Energy in electricity

Units of electricity

- A **watt** (abbreviation **W**) is a unit of electrical **power**.

- 1 **kilowatt (kW)** = 1000 watts.

- Electrical energy is measured in **kilowatt-hours (kWh)**, which is the amount of electricity used by a 1000 W load drawing power for one hour.

The running costs of different appliances can be calculated if you know the power rating or wattage of the appliance, your usage time and the electricity tariff (costs) for your area.

EXAMPLE 7

A washing machine uses 372 kWh of electricity per year. If electricity costs 28.327c/kWh, how much will it cost for the electricity to run this washing machine for 1 year?

Solution

Energy used: 372 kWh

Cost: $0.28327 per kWh

$$\text{Total cost} = 372 \times \$0.28327$$
$$= \$105.37644$$
$$\approx \$105.38$$

Write the answer.

The annual cost of running the washing machine is $105.38.

EXAMPLE 8

Lina has a 200 W TV that she uses for 6 hours per day. The domestic tariff for electricity is 34 cents per kilowatt-hour, written as 34 c/kWh.

a How many kWh of electricity will Lina's TV use each day?

b How much will the electricity cost?

Solution

a First change 200 W to kW by dividing by 1000.

$$200 \text{ W} = 200 \div 1000$$
$$= 0.2 \text{ kW}$$

Find the electricity usage by multiplying by the number of hours.

$$\text{Electricity usage} = 0.2 \text{ kW} \times 6 \text{ h}$$
$$= 1.2 \text{ kWh}$$

b Find the electricity cost by multiplying by the rate.

$$\text{Electricity cost} = 1.2 \text{ kWh} \times 34\text{c}$$
$$= 40.8 \text{ c}$$

Shutterstock.com/Ksander

Exercise 6.04 Energy in electricity

1 Calculate the yearly cost of operating each appliance given their annual energy consumption in kWh. The cost of electricity is 28.327c/kWh.

   a Refrigerator 461 kWh   **b** Clothes dryer 582 kWh

   c Dishwasher 327 kWh

2 Maddie is going to buy a new washing machine. Simpsung uses 180 kWh of electricity per year, Purlwool 380 kWh per year.

   a Which machine is the more energy-efficient?

   b Calculate the annual cost of electricity for both machines using 29c/kWh as the price of electricity.

   c How much would Maddie save per year in electricity costs if she bought the more energy-efficient machine?

   d The more energy efficient machine costs $430 more than the other one. How many years would Maddie have to own the more expensive machine for the electricity savings to pay for the additional purchase price?

   e If you were Maddie, which machine would you buy? Justify your answer.

3 Lachlan's home has an electricity smart meter, which means that the cost of his electricity depends on the time of day he uses it.

Charge	Price	Time of day
Peak	53.9c/kWh	3 p.m. to 9 p.m.
Weekday shoulder	28.2c/kWh	7 a.m. to 3 p.m.
Weekday off-peak	14.8c/kWh	9 p.m. to 7 a.m.

Lachlan's swimming pool pump uses 637 kWh of electricity annually. How much will he save in electricity costs if he programs his pool filter to run during shoulder times rather than peak time?

4 Suzie has a 21-panel solar electricity system on the roof of her house. Each day, each panel produces 1.5 kWh of electricity.

   a How much electricity does Suzie's system produce annually? Express your answer correct to the nearest 100 kWh.

   b Each day, Suzie's household only uses an average of 11 kWh of electricity and the remainder is exported to the grid. How much electricity does Suzie's system export annually? Answer to the nearest 100 kWh.

   c Suzie's receives 7c/kWh for electricity she exports to the grid. Calculate the annual amount Suzie receives for exporting electricity from her solar system.

   d If Suzie didn't have solar power, she would be paying 28c/kWh for electricity. At an average price of 28c/kWh, calculate the annual value of the solar electricity Suzie's system supplies for her to use. (Remember, she uses 11 kWh of electricity each day.)

5 Copy and complete this table to calculate the typical daily and monthly costs of some home appliances. Assume electricity costs are 34 cents per kWh and that there are 30 days in a month.

	Appliance	Power rating (W)	Hours used per day	kWh per day	Daily cost (cents)	Monthly cost ($)
a	Fridge (600 L)	800	24			
b	Clothes dryer	2400	1.5			
c	Washing machine	900	0.5			
d	Bathroom/fan/heater/light	1100	1			
e	Normal light globe	100	6			
f	Food processor	380	0.5			
g	Electric kettle	1500	1			
h	Hotplate (max setting)	1500	0.25			
i	Dishwasher	1900	1			
j	Toaster	650	0.5			
k	Vacuum cleaner	950	0.25			
l	Stereo system	40	5			
m	Hair dryer	1400	0.5			
n	TV (med to large)	550	6			
o	Iron	950	0.75			

6 Which of the appliances from question **5** are in your household? How many are there of each appliance?

7 Use the information from question **5** to calculate the approximate cost of electricity for running these appliances in your household for one year.

8 How close is your calculation here to your household's electricity bill? Give reasons why your calculation might be different to your actual bill.

THE ENERGY RATING SYSTEM

Some household appliances now display **energy rating labels** to help people choose energy-efficient appliances. These labels contain a star rating to show how efficient the appliance is – the more stars, the more efficient the energy use. The label also gives an estimate of the energy the appliance will use over a year.

Use the Internet to research the answers to these questions.

1 What information does the energy rating label on electrical appliances provide?

2 What does it mean for an appliance to have more stars than another?

3 Apart from the number of stars, what other important information is printed on the label?

4 There are 8 appliances that are required to carry energy rating labels. List them.

5 The 2 key features of the label are:

  a the star rating band: how many stars can this have and what does the coloured section indicate?

  b the energy consumption box: what does the number in this box indicate?

6 For all star-rated appliances other than air conditioners, the energy consumption figure is given in what units and for what period?

7 How is the information given for air conditioners?

8 Write down how the energy consumption figure can be used to calculate the annual electricity cost of the appliance.

9 Calculate the annual cost of running a refrigerator rated at 750 kWh/year if the electricity tariff is 34 cents/kWh.
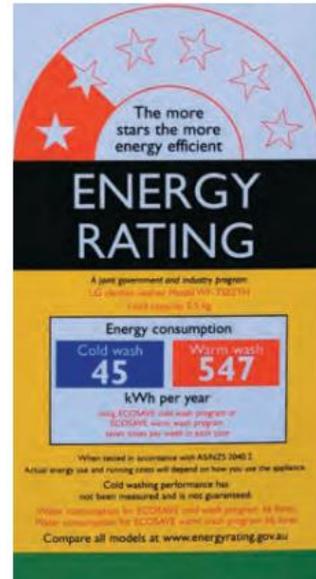
COMPARING ENERGY RATINGS

The government website Energy Rating allows us to compare the star and energy ratings of different brands and models of appliances.

1 Visit the website and select **Consumers** and scroll down to **Search the Registration database**.

2 Search for all 2-door refrigerator/freezers with a capacity of 400 – 500 litres.

3 Find the most efficient and the least efficient refrigerator/freezer (they may be on different pages). Copy and complete this table, including calculating their annual running cost based on a tariff of 28 cents per kWh.

	Brand	Model	Star rating	Energy consumption (kWh/year)	Annual cost ($/year)
Most efficient					
Least efficient					

4 Calculate the annual cost difference between the two refrigerator/freezers you found.

5 Repeat questions **1** to **4** for 90–110 cm LCD TVs.

6 Repeat questions **1** to **4** for an 8 kg load, top-loading washing machine.

7 Is the cost of running an appliance the only factor in deciding what appliance to buy? List other considerations. What is the most important factor in your opinion? Justify your answer.

Energy rating

6.05 Heart rates

The heart is a large muscle that pumps blood around our body. If it stops beating for more than a few minutes, we die. Our hearts beat faster during exercise. After exercise, the time it takes for our heart to return to its resting rate is a measure of our fitness.

Our **heart rate** or **pulse** is measured in **beats per minute**. The average pulse is 72 beats/min.

If we want to live long and healthy lives, we must look after our hearts.

WS

Heartbeat rates

Heart rate

$$\text{Pulse in beats per minute} = \frac{\text{number of beats}}{\text{time in seconds}} \times 60$$

EXAMPLE 9

Darren takes his pulse during exercise and counts 52 beats in 20 seconds. Calculate his heart rate in beats per minute.

Solution

Pulse in beats per minute $= \dfrac{\text{number of beats}}{\text{time in seconds}} \times 60$

$$\text{Pulse} = \dfrac{52}{20} \times 60$$
$$= 156 \text{ beats/min}$$

Write the answer.

Darren's heart rate is 156 beats/minute.

EXAMPLE 10

Emma exercised at an intensity that caused a pulse rate of 140 beats/minute. How many times did her heart beat during her 50-minute workout?

Solution

Multiply the number of beats per minute by the number of minutes.

Number of beats $= 140 \times 50$
$$= 7000$$

Write the answer.

Emma's heart beat 7000 times during the workout.

Exercise 6.05 Heart rates

Example **9**

1 When Jessica was jogging, she checked her pulse. She counted 39 beats in 20 seconds. Calculate Jessica's pulse in beats/minute.

2 Calculate the pulse of each person in a fun run.

		Number of heart beats	Time in seconds	Pulse in beats/minute
a	James	63	30	
b	Kim	15	10	
c	Abduh	37	15	
d	Xander	51	20	
e	Jabir	65	25	
f	Fenella	78	30	

Example **10**

3 During a 40-minute jog, Brigit's average heart rate was 123 beats/minute. How many times did her heart beat during the jog?

4 During a panic attack, Daniel's heart was beating at 42 beats/15 seconds.

  a Calculate Daniel's heart rate in beats/minute.

  b Daniel's normal resting pulse is 76 beats/minute. During the 6-minute panic attack, how many more times did his heart beat than while he was resting?

5 This table shows normal pulse rates for healthy people of different ages.

  a How many times does a healthy 5-year old's heart beat in 20 seconds?

  b Remy is a healthy young boy. His heart rate is 29 beats in 15 seconds. Approximately how old is Remy?

  c Bella's teacher sent her to sick bay. The school nurse measured Bella's heart rate at 19 beats in 20 seconds. Bella is 8 years old. Does Bella's pulse indicate that she could be ill? Use a calculation to justify your answer.

Age	Pulse rate in beats/minute
3 to 4	80 – 120
5 to 6	75 – 114
7 to 9	70 – 110
10 or more	60 – 100

6 Before a baby is born, it is called a fetus. This table shows some fetal heart rates. The value for 8 weeks is missing.

  a From the age of 5 weeks to 9 weeks, the fetal heart rate increases at approximately 3.3 beats/minute per day. Calculate an approximate average heart rate for a 8-week-old fetus.

  b A fetus' heart rate can be used to estimate its age. How many days old is a fetus whose heart beats 27 times in 15 seconds?

  c Use a spreadsheet or pen-and-paper to construct a line graph to show fetal heart rates at different fetal ages. Put the 'Age in weeks' on the horizontal axis and 'Heart rate' on the vertical axis.

Fetal age (weeks)	Average heart rate in beats/minute
5	80
6	103
7	126
8	
9	175
11	150
12 – 41	140

7 A full-term pregnancy is 41 weeks long. If a baby is born before 41 weeks, it is called premature or preterm. The heart rates of premature and full-term babies are different during labour.

	Average heart rate during labour
Full-term baby	140 beats/minute
Premature baby	155 beats/minute

During his birth, baby Dillan's heart beat 39 times every 15 seconds. Is Dillan a full-term or premature baby? Justify your answer.

6. Healthy figures

RESTING VS EXERCISE PULSE

For this activity, you will need to work in groups with a stopwatch and access to some stairs.

1 Use YouTube to search for a video on how to take your pulse on your wrist.

2 Measure your resting pulse by counting the number of times your heart beats in 15 seconds.

3 Convert your resting pulse to a rate measured in beats/minute.

4 Exercise for 2 minutes by walking up and down stairs.

5 Measure your exercise pulse in beats/minute.

6 Copy and complete the table for members of your group by measuring your pulse at 1 minute, 2 minutes, 5 minutes and 10 minutes after exercise.

Name	Resting pulse	Exercise pulse	Pulse after exercise			
			1 minute	2 minutes	5 minutes	10 minutes

7 Graph each person's exercise pulse and their pulse for up to 10 minutes after exercise.

8 Who had the lowest resting pulse? Who had the highest?

9 How does a resting pulse change during 2 minutes of stair-climbing?

10 Whose pulse changed the most during the stair-climbing exercise?

11 Whose pulse was the quickest to return to the resting rate after exercise?

12 Some people claim that the lower a person's resting pulse is, the quicker the exercise pulse returns to a resting pulse. Does the data support this claim? Why or why not?

13 Resting pulse rates in beats/minute are one measure of health. This table shows a resting-pulse health rating for 16 to 25-year-olds.

Excellent	Good	Concern	Worrying
55 – 60	60 to 65	66 to 80	More than 80

Assess your current health according to the data in this table.

DEFINITIONS

Match the terms in the left column with their meaning on the right.

	Term			Meaning
1	calorie		**a**	A word used in rates that means 'for each'.
2	kilowatt-hour		**b**	A unit for measuring electrical power, equal to 1000 watts.
3	kilojoule		**c**	The rate measured in beats/minute.
4	kilowatt		**d**	An old unit for measuring the energy in food.
5	speed		**e**	A measurement involving 2 different types of units.
6	per		**f**	The metric unit for measuring energy in food.
7	pulse		**g**	A rate that compares distance travelled with the time taken to travel that distance.
8	rate		**h**	A unit for measuring electrical energy.

SOLUTION TO THE
CHAPTER PROBLEM

Problem

For morning tea, Renee had a chocolate muffin (825 kJ) and some coffee with milk and sugar (295 kJ). Afterwards, Renee goes for a walk, using 23 kJ of energy per minute. How long will Renee have to walk to use all the energy she consumed at morning tea?

Solution

Total energy Renee consumed = 825 + 295
$$= 1120 \text{ kJ}$$

Number of minutes walking   = 1120 ÷ 23
$$= 48.7 \text{ minutes}$$
$$\approx 50 \text{ minutes}$$

Renee should walk for about 50 minutes to use up the energy she had at morning tea.

Healthy figures

1 Write each statement as a rate in simplified form.

    a $10.50 for 3 kg   **b**   220 km in 2 hours

    c $56.40 for 4 hours   **d**   260 runs in 50 overs

2 Use the conversion 1 Cal = 4.2 kJ to complete each statement.

    a   250 Cal = _____ kJ   **b**   5754 kJ = _____ Cal

3 When riding a bike, Alex takes 50 minutes to burn 1000 kJ.

    a   How many kJ does Alex use riding a bike for 25 minutes?

    b   How long does it take Alex to use 3500 kJ when bike riding?

4 Kelly is an active pregnant woman aged 24.

    a   Use the table on page 148 to calculate how many more kilojoules she requires per day when she is pregnant than when she is not.

    b   Use the table on page 152 to suggest foods Kelly could add to her diet to make up the kilojoules she requires while she is pregnant.

5 Marc ate a mixed grill and apple pie with ice cream for his dinner.
Use the table on page 152 to calculate the number of kilojoules in Marc's dinner.

6 Adults running at 15 km/h use 75 kJ/h per kilogram of their body weight. Kristy's body weight is 64 kg. How many kilojoules does she use when she runs for 45 minutes at 15 km/h?

7 Calculate the annual cost of the electricity used to run a TV that uses 248 kWh per year if electricity costs 28.7c/kWh. Answer correct to the nearest cent.

8 How much electricity is used (in kWh) when a 100 W light globe is on for 5 hours?

9 Tamara takes about $1\frac{1}{2}$ hours per week to iron her clothes. If she uses a 200 W iron and the cost of electricity is 28 c/kWh, calculate the cost of using the iron each week.

10 Lenny's heart beats 11 times in 10 seconds. Calculate his pulse in beats per minute.

11 Charlie's heart beats 81 times per minute. How many times will it beat in an hour?

7.

TURN UP THE VOLUME

Chapter problem

A supermarket shelf is stacked with fruit juice packets 4 levels high, 6 packets wide and 8 packets deep. How many juice packets are on the shelf?

WHAT WILL WE DO IN THIS CHAPTER?

- Choose appropriate metric units of mass, volume and capacity and convert between them
- Estimate and measure mass, volume and capacity
- Read information from food labels and use rates to solve problems involving them
- Calculate the volume and capacity of prisms
- Measure the volume of food items and capacity of containers

HOW ARE WE EVER GOING TO USE THIS?

- When comparing the quantities inside different-sized food containers
- When identifying the quantities of ingredients in packaged foods
- When calculating the quantity of materials for a job, for example, the amount of soil or mulch needed in our garden
- When adding chemicals to or monitoring the water inside a fish tank or swimming pool

7.01 Measuring mass

Unit	Relationships
milligram (mg)	
gram (g)	1 g = 1000 mg
kilogram (kg)	1 kg = 1000 g
tonne (t)	1 t = 1000 kg

The **gram** is the basic unit for **mass** and all other mass units were based on the gram.

To change from a small unit to a bigger unit, **divide** by the conversion factor.

To change from a big unit to a smaller unit, **multiply** by the conversion factor.

EXAMPLE 1

Convert 750 kg to

a grams   **b** tonnes

Solution

a There are 1000 g in 1 kg. Changing from kg to g is changing to a smaller unit, so multiply by the conversion factor.

$$750 \text{ kg} = 750 \times 1000 \text{ g}$$
$$= 750\,000 \text{ g}$$

b There are 1000 kg in 1 t. Changing from kg to t is changing to a larger unit, so divide by the conversion factor.

$$750 \text{ kg} = 750 \div 1000 \text{ t}$$
$$= 0.75 \text{ t}$$

Sometimes we need to be able to convert between non-metric and metric units of mass.

EXAMPLE 2

Rachel is catching a flight from Mexico City to Monterey, California. She wants to take her baby stroller on the plane, but the airline only allows strollers with a mass of 20 pounds or less. Rachel's stroller has a mass of 8.5 kg. Will she be able to take the stroller on the flight? (1 kg = 2.2 pounds)

Shutterstock.com/Mila Supinskaya Glashchenko

Solution

Convert 8.5 kg to pounds.	8.5 kg = 8.5 × 2.2 pounds
1 kg = 2.2 pounds.	= 18.7 pounds
Changing from kg to pounds is changing to a smaller unit, so multiply by the conversion factor.	Rachel's stroller is 18.7 pounds, which is less than the airline's limit of 20 pounds. She can take it on the flight.
OR Convert 20 kg to pounds by dividing by 2.2.	20 pounds = 20 ÷ 2.2 kg
	≈ 9.09 kg
	The airline's limit is 9.09 kg and Rachel's stroller is 8.5 kg and less than this. She can take it on the flight.

Exercise 7.01 Measuring mass

1 Copy and complete each conversion.

Example 1

   a 3 kg = ___ g   **b** 12 t = _____ kg   **c** 1500 g = ___ kg

   d 2400 kg = ___ t   **e** 850 kg = _____ g   **f** 900 g = _____ kg

   g 2.5 g = _____ mg   **h** 500 mg = ___ g

2 A hospital pharmacist ordered 2000 tablets. Each tablet has a mass of 5 mg.

   a Calculate the total mass of the tablets in mg.

   b What is the total mass in grams?

3 Vitamin C powder contains 90% ascorbic acid and 10% calcium.

   a What mass of calcium is in 40 milligrams of vitamin C?

   b What mass of ascorbic acid is in 60 milligrams of vitamin C?

   c Calculate the number of milligrams of ascorbic acid in 2.4 grams of vitamin C.

4 The gross mass of a bottle of 500 tablets is 155 g. The mass of the bottle only is 20 g.

> gross mass = total mass including bottle
> net mass = mass of tablets only

   a Calculate the net mass of the tablets.

   b What is the net mass of the tablets in mg?

   c What is the mass of one tablet in mg?

5 How many 50 mg injections can a nurse make from a 1 g container of streptomycin medicine?

6 List 3 items whose mass you would measure in

   a tonnes   **b** kilograms   **c** grams   **d** milligrams

7 We measure the size of precious stones in carats. Erin's engagement ring contains a 1.8 carat diamond. What is the mass of the diamond in mg? (1 carat = 200 mg).

Example 2

8 Nelsonlink Airlines has a carry-on luggage limit of 12 pounds. Karen's bag is 5 kg.

 a Calculate the mass of Karen's bag in pounds. 1 kg = 2.2 pounds.

 b Is Karen's bag light enough to take on the flight? Justify your answer.

9 Jettison Air has two sets of restrictions on the size of bags it allows on flights.

 • The mass of the bag must be 50 pounds or less.

 • The sum of the bag's dimensions (length + width + height) must be less than 62 inches.

Orlando's bag is 50 cm long, 19 cm high, 32 cm wide and has a mass of 24 kg.

1 kg = 2.2 pounds and 1 inch = 2.5 cm.

Is Orlando's bag allowed on the flight? Justify your answer.

10 A standard house brick has a mass of 2.7 kg.

 a A pallet of bricks contains 500 bricks. Calculate the mass of one pallet of bricks.

 b A truck carries 8 pallets of bricks. Calculate the weight of the bricks in tonnes.

11 In China, the mass of tea leaves is measured in 'jins'. One jin = 500 g. Calculate in grams the mass of a packet of tea that is 3.2 jin. Answer to one decimal place.

12 We measure the mass of precious metals in troy ounces (1 troy ounce = 31.103 g). Gazi bought a 1 kg gold bar as an investment. How much was Gazi's gold bar worth on the day when gold was valued at $1331 per troy ounce?

WORTH YOUR WEIGHT IN GOLD

You need a set of bathroom scales.

Have you heard the expression 'You're worth your weight in gold'? In this investigation, you are going to calculate the monetary value of your friend, your maths teacher or even yourself if they are 'worth their weight in gold'.

What you have to do

1 Measure the mass of the person you are going to value in kg.

2 Multiply the person's mass by 32.15 to convert their mass to troy ounces.

3 Use the Internet to research today's price for 1 troy ounce of gold, for example, $1553.22 (AUD = Australian dollars).

4 Multiply the person's mass in troy ounces by the price of 1 troy ounce of gold. How much is the person worth?

ESTIMATING MASS

You will need a set of kitchen scales (for measuring small masses) and a set of bathroom scales (for larger masses). You also need some items so that you can estimate and measure their mass.

The table shows some common items and their approximate mass.

Mass	Items with this approximate mass
1 mg	A grain of sand
	A tiny insect like a sandfly
1 g	A paperclip
100 g	An iPhone without a case
1 kg	1 litre of water
	5 medium-sized oranges
71 kg	An average Australian woman
84 kg	An average Australian man

What you have to do

1 Choose an item, for example, a library card.

2 Select an item in the right column of the table that has a similar mass. For example, a library card is similar in mass to a 5c coin.

3 Compare the two items and estimate the mass of the unknown item. A library card is about twice as heavy as a 5c coin, so it should be about 4 g.

4 Use the scales to check the accuracy of your estimate.

7.02 What's in our food?

Australian law requires food manufacturers to provide specific information in labels. All food packaging must contain the following information.

Name and description of food	Nutrition labelling
Country of origin	Ingredients list
Date mark	Allergy statement
Food additives	Food recall information
Storage requirements	Percentage labelling

All manufacturers are required to list the **ingredients** of their foods in descending order of mass.

EXAMPLE 3

The label next page appears on a can of evaporated milk.

a How many mL does the can contain?

b According to the label, what is the recommended daily amount of fat?

c How many servings of the milk do we need to consume more than 1 g of calcium?

LIGHT & DELICIOUS

NUTRITIONAL INFORMATION

SERVINGS PER PACK: 3.75   SERVING SIZE: 100mL

AVERAGE QUANTITY	PER SERVING	%DI* & RDI** PER SERVING	PER 100mL
ENERGY	410kJ	5%	410kJ
-CALORIES	98 Cal		98Cal
PROTEIN	8.0g	16%	8.0g
FAT, TOTAL	1.6g	2%	1.6g
-SATURATED	1.1g	5%	1.1g
CARBOHYDRATE	12.6g	4%	12.6g
-SUGARS	12.6g	14%	12.6g
SODIUM	100mg	4%	100mg
CALCIUM	240mg	30%**	240mg

*PERCENTAGE DAILY INTAKES ARE BASED ON AN AVERAGE ADULT DIET OF 8700KJ. YOUR DAILY INTAKE MAY BE HIGHER OR LOWER DEPENDING ON YOUR ENERY NEEDS.

**RECOMMENDED DIETARY INTAKE (AUST/NZ)

Solution

a There are 3.75 servings per pack and each serving is 100 mL.

Amount in the can $= 3.75 \times 100$ mL

$= 375$ mL

b One serving contains 1.6 g of fat and this is 2% of the recommended daily amount. From this, we need to find 100% of the recommended daily amount of fat.

2% of daily amount $= 1.6$ g

1% of daily amount $= 1.6$ g $\div 2$

$= 0.8$ g

100% of daily amount $= 0.8$ g $\times 100$

$= 80$ g

The recommended daily amount of fat is 80 g.

c Each serving contains 240 mg of calcium. 1 g = 1000 mg. Divide 1000 by 240.

Number of servings $= 1000 \div 240$

≈ 4.17

We need more than 4 servings. We need 5 servings to consume more than 1 g of calcium.

Exercise 7.02 What's in our food?

1 This label is from a can of soup. Read the label to obtain the information to answer each question.

  a Does the soup contain any artificial flavours?

  b What are the code numbers of the food colours added to the soup?

  c What vegetables are in the soup?

  d How many servings are in the can?

  e How many grams of protein are in a serving of this soup?

  f Lycopene is an antioxidant that may be beneficial for health. It is the substance that gives the red colouring to tomatoes. The recommended daily intake of lycopene for women is 6 mg. How many servings of this soup does a woman need to consume in a day to obtain her recommended amount of lycopene?

INGREDIENTS

Vegetables (45%) (Potatoes, Blue Peas, Onion, Tomatoes, Green Beans), Water, Marinated Angus Beef (16%) (Angus Beef, Marinade (Salt, Mineral Salts (450, 451), Dextrose Monohydrate, Thickeners (1422, 415))), Maize Thickener (1422), Potato Starch, Yeast Extracts (from Barley). Natural Flavours, Salt, Soy Sauce (Contains Wheat), Pepper, Hydrolysed Vegetable Protein, Colours (150c, 160v), Herb Extract.

NUTRITION INFORMATION

SERVINGS PER PACKAGE: 2
SERVING SIZE: 265G

	AVG QUANTITY PER SERVING	AVG QUANTITY PER 100g
ENERGY	675kJ	255kJ
PROTEIN	13.5g	5.1g
FAT, TOTAL	3.2g	1.2g
- SATURATED	1.6g	0.6g
CARBOHYDRATE	18.3g	6.9g
- SUGARS	3.2g	1.2g
DIETARY FIBRE	2.7g	1.0g
SODIUM	760mg	290mg
LYCOPENE	1.2mg	0.4mg

No Artificial Flavours
No Preservatives

2 Katja is reading this label on a can of tuna.

TUNA | 98% FAT FREE | Wild caught in the Western Central Pacific Ocean

TUNA - *spicy deli*

Ingredients: Purse-seine caught Skipjack Tuna (*Katsuwonus pelamis*) (56%), Water, Chilli Sauce [Water, Chilli (1.7%), Sugar, Garlic, Vinegar, Salt, Tapioca Thickener (1442)], Sugar, Onion, Whole Chilli (2.2%), Sunflower Oil, Salt Natural Colour (Paprika Extract), Traces of Wheat, Milk, Egg, Soy, Crustacea & Sesame.

PACKED FOR: E.M. FISH CO. AUST. LTD
80 DORCAS ST,
SOUTH MELBOURNE, VICTORIA
3205, AUSTRALIA.
FREECALL: 1800 037 000 (Aust. only)
DISTRIBUTED IN NEW ZEALAND BY
EM TUNAFISH LIMITED
456 GEORGE ST,
HASTINGS 4122, NEW ZEALAND.
FREECALL: 0800 653 000 (NZ only)
For more information about
sustainability, visit www.tuna.com.au
MADE IN THAILAND FROM IMPORTED
AND LOCAL INGREDIENTS.

NUTRITION INFORMATION
SERVINGS PER PACKAGE: 1
SERVING SIZE: 95g

	AVERAGE QUANTITY PER SERVING	AVERAGE QUANTITY PER 100g
ENERGY	380kJ	400kJ
PROTEIN	14.0g	14.7g
FAT, TOTAL	1.7g	1.8g
-SATURATED	0.4g	0.4g
-TRANS	0g	0g
-POLYUNSATURATED	0.8g	0.9g
-OMEGA-3	170mg	180mg
-EPA	30mg	30mg
-DHA	140mg	145mg
-MONOUNSATURATED	0.5g	0.5g
CARBOHYDRATE	4.7g	4.9g
-SUGARS	4.4g	4.6g
SODIUM	370mg	390mg

  a Where was the tuna made?

  b Does the tuna contain any sugar?

  c How many grams of protein are contained in a serving?

  d How many mg of saturated fat are in a serving?

  e Katja is allergic to wheat. Can she eat the tuna?

3 The label shows nutritional information about a serving of Thai green curry chicken.

a How many kilojoules are in a serving?

b How much less than 1 g of sodium is included in a serving?

c What percentage of the fat in a serving is saturated fat?

d The meal may contain traces (tiny amounts) of five substances that might give some people an allergic reaction. What are they?

Ingredients when prepared as directed: Cooked Rice (50%) (Water, Milled Jasmine Rice, Rice Bran Oil), Sauce (Chicken (15%), Coconut Milk (12%), Water, Vegetables (6%) (Long Bean, Garlic, Shallot), **Fish Sauce** (**Anchovy**), Sugar, Chili, Lemongrass, Galangal, Basil, **Soybean Oil**, **Shrimp Paste** (**Crustacea**), Spices, Salt, Modified Maize Starch (1422).

Contains Crutacea, Fish, and Soybean Products.
Made on a production line that also produces foods containing: Peanuts, Tree Nuts, Sesame Seeds, Egg and Milk products.

NUTRITION INFORMATION		
SERVINGS PER PACKAGE: 1		SERVINGS SIZE: 320 g
AVG QTY PER SERVING		AVG QTY PER 100 g
ENERGY	1830 kJ (438 Cal)	571 kJ (137 Cal)
PROTEIN, TOTAL	15.4 g	4.8 g
-GLUTEN	0 mg	0 mg
FAT, TOTAL	10.2 g	3.2 g
-SATURATED	7.0 g	2.2 g
CARBOHYDRATE	68.5 g	21.4 g
-SUGARS	4.5 g	1.4 g
DIETARY FIBRE	2.9 g	0.9 g
SODIUM	830 mg	260 mg
POTASSIUM	290 mg	90 mg

4 This label appeared on a bottle of BBQ sauce.

a How many servings are in the bottle?

b How big is each serving?

c How much BBQ sauce does the bottle contain?

d Calculate the total energy contained in the bottle.

e How many grams of non-sugar carbohydrate are there in one serving?

Servings per packet: 12	Serving size: 30 mL	
	Per serving	**Per 100 mL**
Energy	273 kJ	911 kJ
Protein	0.3 g	1.1 g
Fat	0.1 g	0.2 g
Carbohydrate – total – sugars	16.1 g 13.7 g	53.6 g 45.5 g
Cholesterol	nil	nil
Sodium	300 mg	1000 mg
Potassium	36 mg	118 mg

f Is there more protein or sodium in a serving? Explain your answer.

g What percentage of the carbohydrate in the sauce is sugar?

h How much salt (sodium) is in the bottle? Answer in grams.

i The bottle contains *no cholesterol*, but this does not necessarily mean that the food is low in fat. How much fat is contained in the bottle?

5 This label on a milk drink includes information about the recommended daily allowances of vitamins and minerals.

	Per serving	Percentage of recommended daily allowance
Iron	2.7 mg	20%
Calcium	110 mg	50%
Vitamin B1	0.18 mg	20%
Vitamin B2	0.14 mg	25%
Sodium	49 mg	10%
Potassium	120 mg	10%

Matthew explained how he calculated the recommended daily allowance of iron correctly: 'I divided 2.7 by 20 to find out 1%, then I multiplied by 100 to get 100%'

Recommended daily allowance of iron $= 2.7 \div 20 \times 100$

$$= 13.5 \text{ mg}$$

Use this method to calculate the recommended daily allowance of:

a calcium

b vitamin B2, correct to 1 decimal place

c potassium, in grams.

INVESTIGATION

WHAT'S IN MY FAVOURITE FOOD?

You are what you eat. Are you sure you know what you're eating?

What you have to do

- Find the nutritional information from the packets of 5 of your favourite packaged foods.

- List any food allergies included in the information.

- List any preservatives, artificial flavourings and colours in the food items.

- Record the name of any ingredient that surprises you.

- Calculate the total amount of fat and sugar in the package.

- Calculate the percentage of the mass of the contents that is protein, sugar and sodium.

- Healthy food has low amounts of fat, sugar, preservatives, sodium, artificial colours and flavourings and high amounts of protein. List the 5 food items in order from the most healthy to the least healthy.

7.03 Measuring volume

The amount of wheat a silo can hold, the quantity of sand in a truck and the amount of concrete required for a driveway are examples of **volume**.

The **volume** of a solid is the amount of space occupied by the solid. Volume is measured in cubic units.

Volume unit	The size of a cube of length:	Approximately the size of:
cubic millimetre (mm^3)	1 mm	a grain of raw sugar or rock salt
cubic centimetre (cm^3)	1 cm	a tooth or a pain relief tablet
cubic metre (m^3)	1 m	two washing machines

These diagrams compare a cubic millimetre with a cubic centimetre.

1 cubic centimetre

1 cubic millimetre

1 cm

1 cm

1 cm

1000 mm^3

10 mm

10 mm

10 mm

$$1\ cm^3 = 10\ mm \times 10\ mm \times 10\ mm$$
$$= 1000\ mm^3$$
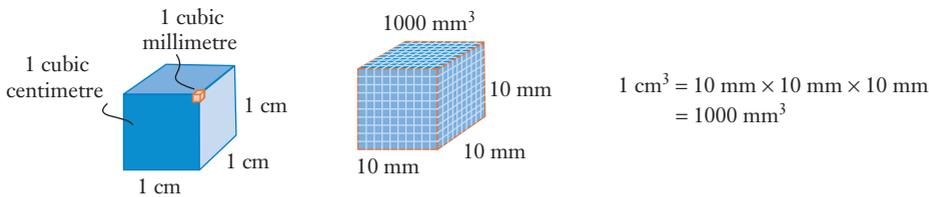
This diagram compares a cubic centimetre with a cubic metre.

100 cm (or 1 m)

100 cm (or 1 m)

100 cm (or 1 m)

1 m^3

$$1\ m^3 = 100\ cm \times 100\ cm \times 100\ cm$$
$$= 1\ 000\ 000\ cm^3$$

One cubic metre
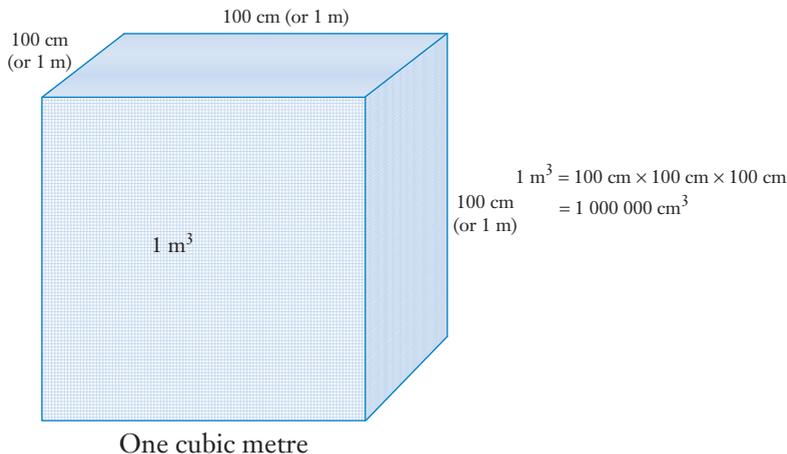
When converting area units in Chapter 3, *Measuring length and area*, we had to convert the length unit twice. When converting volume units, we have to convert the length unit three times. We *cube* the simple linear conversion factor to get the area conversion factor.

For example, to change from m to cm, multiply by 100,

but to change from m^3 to cm^3, multiply by $100^3 = 1\,000\,000$.

Metric units of volume

$1 \text{ cm}^3 = 1000 \text{ mm}^3$

$1 \text{ m}^3 = 1\,000\,000 \text{ cm}^3$

To change from a small unit to a bigger unit, **divide** by the conversion factor.

To change from a big unit to a smaller unit, **multiply** by the conversion factor.

EXAMPLE 4

Convert:

a 36 cm^3 to mm^3

b $84\,000\,000 \text{ cm}^3$ to m^3

Solution

a cm^3 to mm^3, large to small unit: $\times 1000$.

$36 \text{ cm}^3 = 36 \times 1000 \text{ mm}^3$
$= 36\,000 \text{ mm}^3$

b cm^3 to m^3, small to large unit: $\div 1\,000\,000$.

$84\,000\,000 \text{ cm}^3 = 84\,000\,000 \div 1\,000\,000 \text{ m}^3$
$= 84 \text{ m}^3$

Exercise 7.03 Measuring volume

1   What units would you use (m^3, cm^3 or mm^3) to measure the volume of each object?

a	A bedroom	**b**	A backpack
c	A mobile phone	**d**	A matchbox
e	A concert hall	**f**	A swimming pool
g	Your calculator	**h**	A car
i	A driver's licence	**j**	A glass of water
k	A USB drive	**l**	A box of laundry powder

2 Match the correct volume (**A** to **G**) with each of the items (**a** to **g**) listed.

a	bottle of nail polish	**A**	200 m^3
b	box of tissues	**B**	3980 m^3
c	glass of fruit juice	**C**	1250 cm^3
d	bottle of lemonade	**D**	5000 cm^3
e	classroom	**E**	20 000 mm^3
f	school hall	**F**	250 cm^3
g	box of cereal	**G**	2200 cm^3

Hint: You may find it helpful to put the items in descending order of volume and then choose the measurements.

3 Copy and complete each conversion.

Example **4**

a 5000 cm^3 = _____ mm^3 **b** 1.6 m^3 = _____ cm^3

c 6000 cm^3 = _____ m^3 **d** 4000 mm^3 = _____ cm^3

e 160 000 cm^3 = _____ m^3 **f** 250 mm^3 = _____ cm^3

g 0.18 m^3 = _____ cm^3 **h** 0.12 cm^3 = _____ mm^3

i 4 m^3 = _____ mm^3 **j** 9 600 000 mm^3 = _____ m^3

4 Arrange in ascending order: 42 cm^3, 4210 mm^3, 0.0042 m^3

5 Arrange in descending order: 65 000 cm^3, 0.6 m^3, 7 000 000 mm^3

6 The volume of Marty's chest of drawers is 306 000 cm^3. What is this in cubic metres?

7 Ruchi's lunchbox has a volume of 2520 cm^3. What is the volume of her lunchbox in cubic millimetres?

8 Hans ordered 1 m^3 of pine bark to mulch his vegetable garden. After he finished putting the mulch on his garden, he had 20% of the original amount left. How many cubic centimetres of mulch were left over?

Shutterstock.com/Alison Hancock

VOLUME OF A RECTANGULAR PRISM

1 Count the volume of each rectangular prism, constructed from 1 cm^3 blocks.

a   **b**   **c**
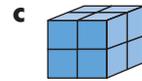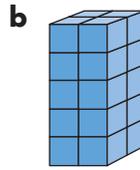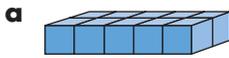
2 Copy and complete this table if each rectangular prism is built from 1 cm^3 blocks. The first row is completed as an example.

	Length	Width	Height	Volume
	3 cm	2 cm	4 cm	24 cm^3
	a	b	c	d
	e	f	g	h
	i	j	k	l
	m	n	o	p
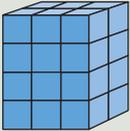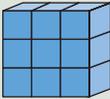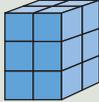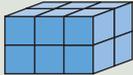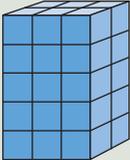
3 From your answers to Question **2**, what relationship can you see between the dimensions of each rectangular prism and its volume?

4 Calculate the volume of a rectangular prism with length 10 cm, width 5 cm and height 7 cm.

5 Calculate the volume of a cube with length 6 m.

7.04 Volumes of prisms

These diagrams show some solids with identical ends and some solids that don't have identical ends.

Examples of solids with identical ends
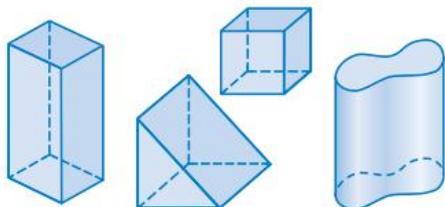
Examples of solids that don't have identical ends

WS

Converting volume units
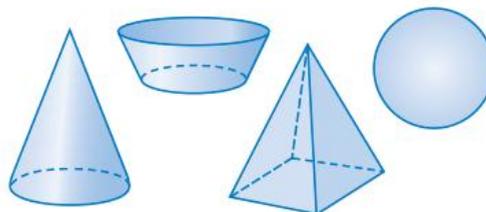
A solid with identical ends and flat sides is called a **prism**. The 3 prisms shown above on the left are a rectangular prism, triangular prism and cube. The ends of a prism are shapes with straight sides (rectangles, triangles or any other polygon) and is part of the name of the prism, for example, rectangular prism, **triangular prism**.

Volumes of prisms and other solids with identical ends

The volume of a solid with identical ends $= A \times h$

where A is the area of the end or **base** and h is the height.

EXAMPLE 5

The area of the base of this solid is 65 cm^2. What is the volume of the solid?

8 cm

Area of base = 65 cm^2
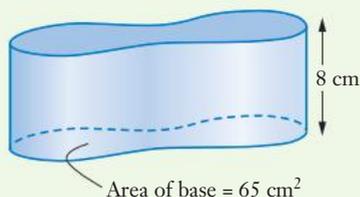
Solution

Both ends of the solid are identical, so we can use the formula $V = A \times h$.

$A = 65$ and $h = 8$.

$$\text{Volume} = 65 \times 8$$
$$= 520 \text{ cm}^3$$

Volume of a rectangular prism

For a **rectangular prism**, the base is a rectangle so $A = l \times w$ and the formula becomes $V = l \times w \times h = lwh$

Volume of a rectangular prism

$V = lwh$

where l = length, w = width, h = height
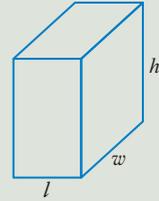
Volume of a cube

$V = s^3$

where s = side length.
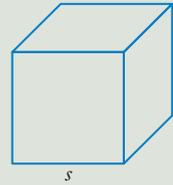
EXAMPLE 6

Find the volume of each prism.

a

12 mm

9 mm

40 mm

b

6.5 cm
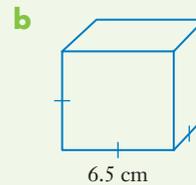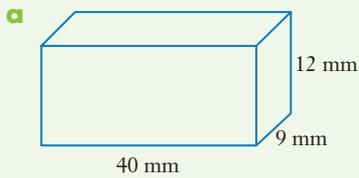
Solution

a Use the formula $V = lwh$

$V = 40 \times 9 \times 12$

$= 4320 \text{ mm}^3$

b This is a cube, a special type of rectangular prism. $V = s^3$.

$V = 6.5 \times 6.5 \times 6.5$

$= 6.5^3$

$= 274.625 \text{ cm}^3$

Find the volume of this triangular prism.
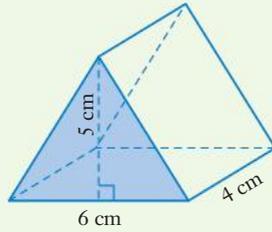
Solution

For a triangular prism, $A = \dfrac{1}{2} bh$.

$b = 6, h = 5$.

$V = (\dfrac{1}{2} \times 6 \times 5) \times 4$

$= 60 \text{ cm}^3$

Exercise 7.04 Volumes of prisms

1 Find the volume of each prism.

a

6 cm

$A = 18.5 \text{ cm}^2$

b

2 m

$A = 1.25 \text{ m}^2$

c

$A = 32 \text{ m}^2$

8 m

d

$A = 40.2 \text{ cm}^2$

12.1 cm

2 Find the volume of each prism.

a

85 cm

180 cm

70 cm

b

4.5 cm

4.5 cm

4.5 cm

c

28 mm

d

2.3 cm

16.5 cm

6.8 cm
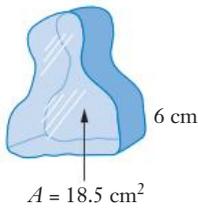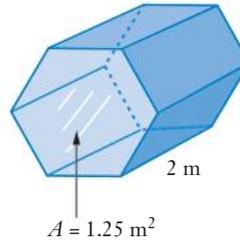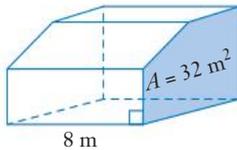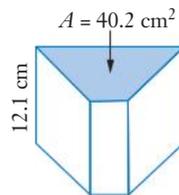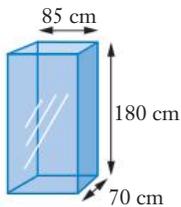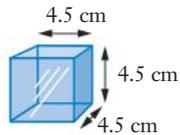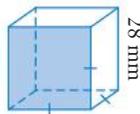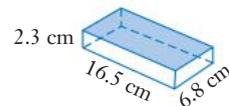
Example
7

3 Find the volume of each triangular prism.

a

4 cm

6 cm

7 cm

b

8 cm

6 cm   10 cm
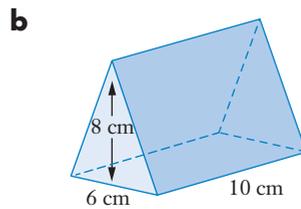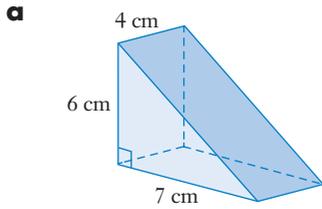
4 Concrete blocks are used to build houses.

a If each concrete block measures 45 cm by 17 cm by 21 cm, calculate the volume of one block.

b A wall is made from 80 concrete blocks. Calculate the volume of the wall.

5 These storage cubes have a side length of 35 cm.

a Calculate the volume of one cube.

b Inga has a stack of 11 cubes in her bedroom to store books. What volume of books can she store?

c Inga's books have an average volume of 1425 cm^3 each. Approximately how many books can she store?

Shutterstock.com/Leszek Glasner

6 Calculate the volume of each food box.

a

ENTERTAINMINT

12 cm

6 cm   9 cm

b

OATBRITS

19 cm

20 cm   9 cm

c

8 Chicken & Vegetable

16.5 cm

18.5 cm   3.5 cm

d

Dessert Cups

19 cm

6 cm   9 cm

e

TOBLERONE

18.7 cm

8.5 cm

10 cm
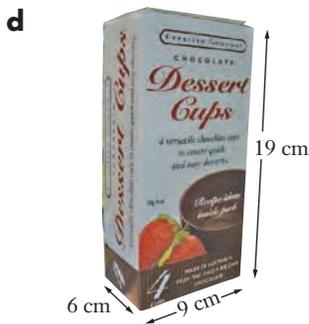
Alamy Stock Photo/Martin Lee

7 Michael is laying pavers for a new rectangular outdoor area, 4.2 m by 2.7 m. Each paver is 300 mm by 300 mm and 50 mm thick.

  a How many pavers will he need?

  b Calculate the volume of one paver.

  c Calculate the volume for the total number of pavers required for this job.

  d Pavers come in boxes of 10. How many boxes will Michael need to purchase?

  e Each box costs $56.70. How much will the pavers cost?

Remember to have all your measurements in the same units!

8 This concrete ramp was built at Hawk's Garden beach to give easy access to the beach. Calculate the volume of concrete required for this ramp.

4 m

20 m

5 m
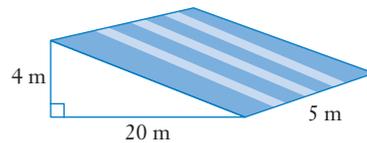
9 Nazneen plans to install air-conditioning inside her house. The air conditioner is available in 4 sizes.

Nazneen's house is in the shape of a rectangular prism, with the dimensions shown on the photograph.

Air conditioner size	Volume of air in house
Small	210 m^3
Medium	350 m^3
Large	500 m^3
Extra large	720 m^3

2·8 m

30 m

5 m

Photo courtesy Sue Thomson

What size air conditioner will Nazneen need?

10 Rhianna won the 'Star Performance' award at her school concert. Find the volume of glass used to make this trophy.
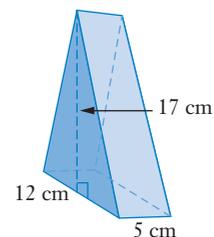
17 cm

12 cm

5 cm

Chapter problem

You've covered the skills required to solve the chapter problem. Can you solve it now?

PRACTICAL ACTIVITY

ESTIMATING AREA AND VOLUME

It takes practice to become good at estimating. Complete these practical estimation activities to develop your estimation skills.

To complete these activities, each group will need:

- 4 metre rulers or tape measures
- Paper, pencils and scissors
- The worksheet 'Estimating area and volume', which can be downloaded from NelsonNet.

Estimating area and volume					
Names	Group members' estimates				Real measurement
Footprints in a square metre					
Handprints in a square metre					
Area of a car number plate in square centimetres					
Volume of a car boot in cubic metres					
Volume of a car in cubic metres					

Activity 1: Footprints in a square metre

Imagine you are going to cover a square metre with your footprints. How many footprints will fit inside 1 m^2 without any overlaps? Record your group's estimates on the record sheet.
How good was your estimate?

iStockphoto/ studyoritim

- Make a template of your foot. Put a piece of paper under your foot and trace around the outside. Use scissors to cut out the template. Make several templates.

- Make a square on the floor with 4 metre rulers to outline 1 m^2.

- Systematically place your foot template in the 1 m^2 and count the number required to cover the square.
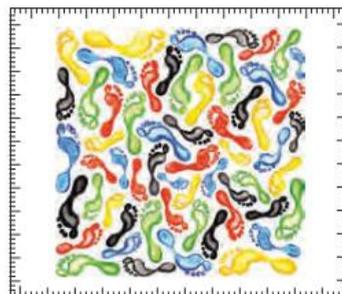
Activity 2: Handprints in a square metre

Now imagine that you are going to cover a square metre with your handprints, without any overlaps. How many handprints will you need?

Use a similar method to that for checking footprints in a square metre to check the accuracy of your group's handprint estimates.

Activity 3: The area of a car number plate

Estimate the area covered by a standard car number plate.

To check your estimate, measure the length and the height of a number plate, then use the formula Area $= l \times w$ to calculate its area.

Alamy Stock Photo/
imageBROKER/Tom Mueller

Activity 4: The volume of a car boot

Luggage compartments of cars come in different sizes. Before your group starts this activity, select an appropriate car.

Record the group's estimates for the volume, then measure the width, depth and height of the car boot in metres. Then calculate the volume in m^3.

Shutterstock.com/kilukilu

Activity 5: The volume of a car

The volume of most cars can be modelled by using 2 or 3 rectangular prisms.

Shutterstock.com/Vibrant Image Studio

Record the estimates, then measure the width, depth and height of the sections of the car in metres. Then calculate the volume in m^3 of each section. Then add the sections to determine the total volume.

7.05 Packaging our food

Exercise 7.05 Packaging our food

1 The end of this loaf of bread is a rectangle 9 cm by 9.5 cm.

    a   What is the area of the end of the loaf of bread?

    b   The loaf is 26 cm long. Calculate the volume of the loaf of bread.

    c   The loaf contains 22 slices of bread. Calculate the average volume of a slice of bread, correct to the nearest cm^3.
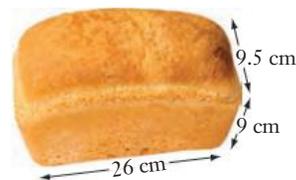
2 The image below shows the contents of a box of breakfast cereal.

    a   Use the formula $V = lwh$ to calculate the volume of the box.

    b   What is the volume of the cereal contents?

    c   How many cubic centimetres of space are in the box?

    d   Approximately what percentage of the volume of the box is space?

3 The formula for the volume of a prism is $V = Ah$, where $A =$ the area of the end or base and $h =$ the height. Find the volume of this chocolate box, correct to the nearest cubic centimetre.
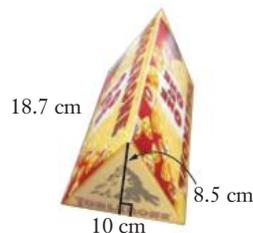
4 The formula $V = \dfrac{11h(b+t)^2}{56}$ gives the volume of a tapered, round food container. In the formula, $b =$ the diameter of the circular base, $t =$ the diameter of the circular top and $h =$ the height.

    Use the formula to calculate the volume of this yoghurt container.

5 Kris bought coffee beans in a container that is in the shape of a hexagonal prism. The prism is 12 cm long and the base is a regular hexagon with sides 1.5 cm as shown.

Six equilateral triangles make the base of the prism.

10 cm^3 of coffee has a mass of 4 grams. By measuring appropriate parts of the triangles in the diagram, determine the volume of the container and the weight of coffee beans that it can hold.
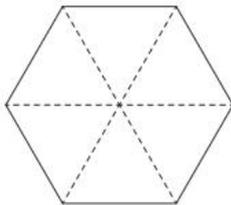
6 The oil in a bottle is 15 cm deep and the area of the bottom of the bottle is 35.5 cm^2. Calculate the volume of oil in the bottle.

INVESTIGATION

THE SPACE IN A CEREAL BOX

You need 3 different-sized boxes of breakfast cereal and a ruler.

Manufacturers leave space in the boxes of cereal to help prevent the contents from being squashed or damaged. Your task is to determine whether there is a relationship between the volume of the box and the amount of space left in the box.

What you need to do

1 Measure each box and the unopened contents.

2 Determine the volume of each box and the amount of space left in each box.

3 Express the amount of space as a percentage of the size of the box. You can use the formula $\dfrac{\text{amount of space in cm}^3}{\text{volume of the box in cm}^3} \times 100\%$ to make this calculation.

4 Which size box contains the greatest percentage of space?

DESIGNING A SMALLER CAN

Changing the dimensions of a package is one method that manufacturers use to disguise price rises. Keeping the price the same but reducing the size of the contents is equivalent to increasing the price.

The formula $V = 3.14r^2h$, where r = the radius of the base and h = the height, can be used to calculate the volume of this can of dog food.

This can has a base radius of 5 cm and a height of 10 cm and it contains 785 cm^3.

Design a can that looks almost the same size, but contains about 20% less volume.

Hints

- How much is 20% less than 785 cm^3?

- Reduce the radius or the height, or both, by a small amount and calculate the volume. Is it in the range you want? If not, try some other values for the radius and height.

Dlibrary/Mars Petcare Australia

7.06 Volume and capacity

Volume measures the amount of space inside a container, while **capacity** measures the amount of liquid or gas a container will hold.

Capacity unit	Approximately the size of:
millilitre (mL)	a large drop of water
litre (L)	a tall carton of milk
kilolitre (kL)	a small rainwater tank
megalitre (ML)	half an Olympic-sized swimming pool

Metric units of capacity

1 L = 1000 mL

1 kL = 1000 L

1 ML = 1000 kL

      = 1 000 000 L

1 cm^3 holds 1 mL

1 m^3 holds 1000 L or 1 kL

$\times 1\,000\,000$

$\times 1000$ $\times 1000$ $\times 1000$

ML   **1 kL**   **1 L**   **1 mL**

$\div 1000$ $\div 1000$ $\div 1000$

$\div 1\,000\,000$

1 mL

1 cm^3

1 m^3 = 1 kL
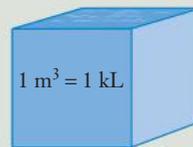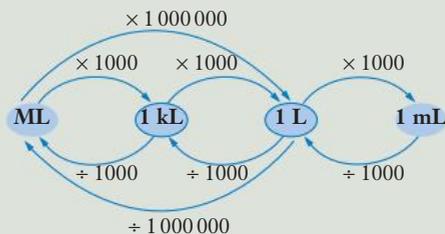
EXAMPLE 8

Convert:

a   5 cm^3 to mL

b   1850 mL to litres

Solution

a   1 cm^3 holds 1 mL. The number of cm^3 and mL are always the same.

  5 cm^3 holds 5 mL

b   mL to L: small to large unit: ÷ 1000.

  1850 mL = 1850 ÷ 1000 L

  = 1.85 L

EXAMPLE 9

The volume of a large fishpond is 3.4 m^3. How many litres of water does it hold?

Shutterstock.com/Ron Zmiri

Solution

1 m^3 holds 1000 L. Multiply the number of m^3 by 1000.

  3.4 m^3 holds 3.4 × 1000 L = 3400 L

Write your answer.

  The fishpond holds 3400 L of water.

Exercise 7.06 Volume and capacity

1   State what unit of capacity you would use to measure the size of:

  a   a glass of milk

  b   a dam

  c   a car's petrol tank

  d   a bottle of medicine

  e   an office water cooler

  f   a swimming pool

iStock.com/Redzaal

2 Match the correct capacity (**A** to **J**) with the items (**a** to **j**) listed.

a	car petrol tank	**A**	200 mL
b	a cup of flour	**B**	23 kL
c	bathtub	**C**	5 mL
d	bucket of water	**D**	70 L
e	can of drink	**E**	1250 mL
f	glass of water	**F**	1.875 ML
g	Olympic swimming pool	**G**	250 mL
h	bottle of lemonade	**H**	9 L
i	teaspoon	**I**	375 mL
j	water storage tank	**J**	180 L

Example 8

3 Convert each measurement to mL.

  a $8\ cm^3$ **b** $1500\ cm^3$ **c** $425\ cm^3$

4 Convert each measurement to litres.

  a 2000 mL   **b** 3500 mL   **c** 250 mL

Example 9

5 a The volume of a large container is $5000\ cm^3$. How many millilitres does the container hold?

  b How many litres will a container with a volume of $5000\ cm^3$ hold?

6 How many litres can a $2\ m^3$ container hold?

7 How many litres of water does a water truck with a volume of $4\ m^3$ hold?

8 Liam is pouring $1500\ cm^3$ of liquid chlorine into the swimming pool. Express this quantity in litres.

9 What is the volume of a carton that holds 1 L of milk?

10 What is the volume in cubic centimetres of a 1.25-litre soft drink bottle?

11 Each can in a box of 24 cans of soft drink holds 375 mL. How many litres of soft drink are contained in the box?

12 This inflatable children's pool contains water 20 cm deep. How many litres of water are in the pool?

Make sure you convert 20 cm to metres before you start the calculations!

1.4 m

1.8 m

123RF Stock Photo/smikeymikey1

13 A tap leaks 10 mL of water every 50 seconds. How much water will the tap lose in:

    a   1 second?   **b**   1 minute?   **c**   3 hours?   **d**   1 day?

14 Zina's swimming pool is 5.8 m long and 3.2 m wide. Hot, dry winds from Central Australia caused 11 cm of water in the pool to evaporate.

    a   What solid shape could be used to represent the volume of water that evaporated from Zina's pool?

    b   How many cubic metres of water evaporated from the pool?

    c   How many litres of water are required to top up Zina's pool?

    d   The pump on Zina's water tank delivers 105 L per minute. For how long will she need to pump water from the tank into her pool to replace the evaporated water? Express your answer correct to the nearest minute.

15 This bucket has a square base with sides of 21 cm.

    a   The sides of the bucket are 23 cm high. Calculate the volume of the bucket in cm^3.

    b   How many whole litres of water can the bucket hold?

    c   One litre of water weighs 1 kg. Approximately how much will the bucket weigh when it is half-full of water?

23 cm

21 cm

16 The size of a refrigerator is its capacity in litres. Calculate the size of a refrigerator that is 85 cm wide, 170 cm tall and 55 cm deep. Express the capacity correct to the nearest litre.

17 Claire wants to fertilise the plants in her fish tank. The tank is 120 cm long, 55 cm high and 45 cm deep.

    a   How many litres of water does the tank hold?

    b   Claire needs to add 5 mL of liquid fertiliser for every 38 litres of water. How much liquid fertiliser should she add? Express the quantity correct to the nearest mL.

INVESTIGATION

PACKAGING CASKS

Garry works in the delivery section of a supermarket. He has a 1 m^3 package of 5-litre casks of fruit juice. Your group's task is to determine the number of casks in the package.

COLLECTING RAINWATER

Water is a precious resource. Every time it rains, we can collect water if the building's roof is connected to a rainwater tank.

Number of litres collected $= A \times R$,

where $A =$ the area of the roof in square metres

$\quad\quad R =$ the rainfall in mm

How much water could you collect from your classroom roof annually?

- Measure your classroom and calculate the area of the roof.

- Use the Internet to find the annual rainfall in your local area.

- Use the formula to calculate the amount of rainwater that falls on your classroom roof per year. Is this water being saved? If not, what could you do about it?

KEYWORD ACTIVITY

DEFINITIONS MATCH

Match each word in the left column to its correct meaning in the right column.

	Word		**Meaning**
1	area	**A**	A 3-dimensional object with flat sides and identical ends.
2	capacity	**B**	The distance around the outside of a shape.
3	cube	**C**	The amount of space occupied by a solid object.
4	litre	**D**	Measures the amount of liquid a container can hold.
5	mass	**E**	A way we measure liquid. One unit is equivalent to 1000 cm^3.
6	perimeter		
7	prism	**F**	The amount of matter contained in an object. It is usually measured in grams, kilograms or tonnes.
8	triangular prism	**G**	A solid shape with flat sides. At each end the surface is the same triangle.
9	volume	**H**	The amount of surface or region occupied by a flat object.
		I	A solid shape with flat sides. All the sides have the same length.

SOLUTION ^{TO THE} CHAPTER PROBLEM

Problem

A supermarket shelf is stacked with fruit juice packets 4 levels high, 6 packets wide and 8 packets deep. How many juice packets are on the shelf?

Solution

Number of packets = number wide × number high × number deep

$$= 4 \times 6 \times 8$$

$$= 192$$

There are 192 juice packets on the shelf.

Qz

Practice quiz

Turn up the volume

Exercise **7.01**

1 Copy and complete each conversion.

a   5 kg = _____ g

b   200 g = _____ kg

c   1.4 t = _____ kg

d   3.5 g = _____ mg

e   7500 kg = _____ t

Exercise **7.02**

2 The label on a can of light coconut milk shows the following nutritional information.

Nutritional information			
Servings per packet: 3.85 Serving size: 70 mL			
	Average quantity Per serving	Average quantity Per 100 mL	Regular coconut milk Per 100 mL
Energy	498 kJ	711 kJ	1025 kJ
Protein	1.4 g	____ g	2.6 g
Fat – total	11.7 g	16.7 g	25.05 g
saturated	10.4 g	14.8 g	22.2 g
Carbohydrate	2.2 g	3.1 g	3.9 g
Sugars	_____ g	1.7 g	1.6 g
Sodium	34 mg	49 mg	24 mg

a   How many kJ are in one serving?

b   How many mg of carbohydrate are in one serving?

c   Use a calculation to show that regular coconut milk contains 50% more fat than light coconut milk.

d   Explain how you know that 10 mL of light coconut milk contains 0.2 g of protein, then complete the missing value for the protein in an average 100 mL.

e   How many grams of sugar are in an average serve?

f   Use a calculation to show that the can contains approximately 270 mL.

Exercise **7.03**

3 Copy and complete each conversion.

a $5 \text{ cm}^3 =$ ____ mm^3

b $2 \text{ m}^3 =$ _____ cm^3

c $500 \text{ mm}^3 =$ ___ cm^3

d $0.25 \text{ m}^3 =$ ____ cm^3

e $24\,000 \text{ cm}^3 =$ ___ m^3

f $36\,000 \text{ mm}^3 =$ ___ cm^3

4 Calculate the volume of each solid.

a

1.5 cm

6.2 cm

1.2 cm

b   Cube

4 m

c

8.5 cm

12 cm

3 cm

d

4 cm

Area of shaded base = 12 cm^2
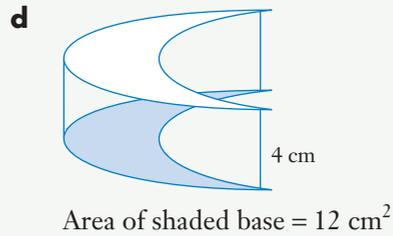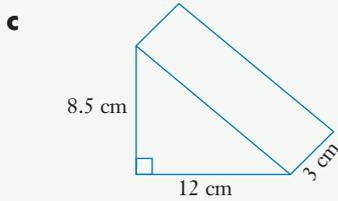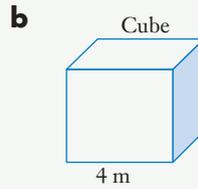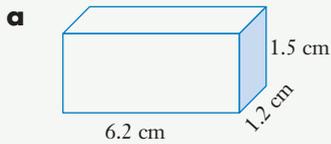
5 This is the container Donna designed to hold the chocolates she makes and sells.

30 cm^2

5 cm
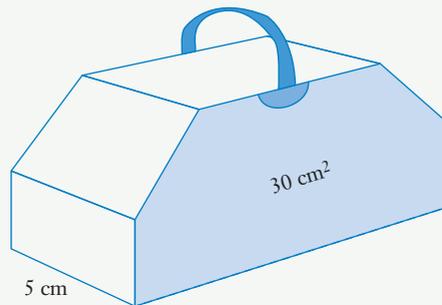
a   Calculate the volume of the box.

b   Express the capacity of the box in litres.

6 Complete each statement.

a   A container with a volume of 24 cm^3 holds _____ mL.

b   The volume of a container with a capacity of 6 L is _____.

7 The volume of a small wine barrel is 0.7 m^3. How many litres does the barrel hold?

Shutterstock.com/ellaro69

8.

EARNING MONEY

Chapter problem

Hugo earns $17.04 per hour for a 37-hour week in his job in a wholesale plant nursery. He is paid time-and-a-half for the first 5 hours of overtime per week and double time after that. If he is required to work any unscheduled overtime, he receives a $10.68 meal allowance per shift. In addition, he receives a $1.60 allowance per hour when he is required to work in wet areas.

In the week ending 29 May, he worked 43 hours, which included one unscheduled overtime shift and 6 hours working in a wet area.

Hugo thinks his pay for the week ending 29 May is wrong. Is his gross pay correct?

Pay slip: Hugo Mendozia	
Week ending 29 May	
Normal pay	$630.48
Overtime	$153.36
Allowances	$20.28
Gross pay	$804.12

WHAT WILL WE DO IN THIS CHAPTER?

- Calculate wages and salaries
- Calculate overtime payments, annual leave loading, bonuses and allowances
- Determine payments from commission, piecework and royalties
- Calculate government allowances and pensions
- Prepare a household budget

HOW ARE WE EVER GOING TO USE THIS?

- Checking pay is correct
- Checking holiday loading
- Applying for Centrelink payments and checking payments
- Managing a budget

8.01 Wages and salaries

A **wage** is an amount paid for each hour worked.

A **salary** is a fixed amount per year that does not depend upon the number of hours worked. Teachers and other professionals earn a salary.

> **PROFILE**
>
> **KRISTINE** – CHILDCARE WORKER
>
> When I was at school I earned money by babysitting. It was a job and it was fun. When I left school I decided to go into childcare. There are lots of jobs in childcare because most mums need to go to work. I did a Certificate III in Childcare at TAFE and now I have a job I love. The best part of my job is helping children learn.

EXAMPLE 1

Kristine earns $18.23 per hour working in a long-day childcare centre. She works a 38-hour week.

a How much does Kristine earn per fortnight?

b Calculate the amount Kristine earns per year.

Solution

a Calculate Kristine's earnings for 1 week.

Amount Kristine earns per week $= 38 \times \$18.23$
$= \$692.74$

A fortnight is 2 weeks.

Amount Kristine earns per fortnight $= 2 \times \$692.74$
$= \$1385.48$

Each fortnight, Kristine earns $1385.48.

b There are 52 weeks in a year.

Amount Kristine earns per year $= 52 \times \$692.74$
$= \$36\ 022.48$

Each year, Kristine earns $36 022.48.

Madeleine is a social worker. Her annual salary is $59 000. Calculate:

a her monthly pay

b her fortnightly pay.

Solution

a There are 12 months in a year.

'Annual' means per year.

Monthly pay = $59 000 ÷ 12

= $4916.67

b There are 26 fortnights in a year.

Fortnightly pay = $59 000 ÷ 26

= $2269.23

---

1 year = 12 months

1 year = 52 weeks

1 year = 26 fortnights

Watch out! 1 month is not 4 weeks and 1 year is not 48 weeks. This is a common mistake and it's WRONG.

PROFILE

PAUL – AN AUSTRALIAN VOLUNTEER ABROAD

I completed a building apprenticeship when I left school, but when I finished my trade I wasn't ready to settle down. I wanted to travel and see the world. I saw a news report about volunteers helping in developing countries and I decided to do my bit to help others. The aid agency paid my travel costs and provides my accommodation and the equipment I need. They also pay me a modest stipend. As a volunteer, I'm making a difference in this community.

Shutterstock.com/Mihai Speteanu

A **stipend** (pronounced 'sty-pend') is similar to a salary but it is usually for a relatively small amount. People in religious orders and some volunteers receive a stipend.

Exercise 8.01 Wages and salaries

1 Scott is a qualified ambulance paramedic. He is paid $35 per hour for a 38-hour week.

    a How much does Scott earn per week?

    b How much is Scott paid per fortnight?

    c Calculate Scott's annual pay.

2 Suzanne is a solicitor. Her salary is $82 500 p.a.   ←   p.a. = per annum = per year

    a How much does Suzanne earn per month?

    b Calculate Suzanne's fortnightly pay.

    c How much does Suzanne earn per week?

3 Lance is paid a salary for being an office IT manager. Each week he earns $1300.

    a Calculate Lance's annual salary.

    b Explain why Lance's monthly pay is ***not*** 1300×4.

    c Divide Lance's annual salary by 12 to calculate his monthly pay.

    d Lance's salary is based on 7 hours work per day, 5 days per week and 52 weeks per year. Calculate the pay rate per hour that is the basis of Lance's salary.

4 Zheng earns $15.61 per hour at a Chinese take-away store.

    a Last week, Zheng worked 16 hours. How much did he earn?

    b Today, Zheng earned $70.25. How long did he work?

5 Ulla receives a yearly stipend of $22 860 from the university to assist her with her postgraduate study and research.

    a How much does Ulla receive per fortnight from the stipend?

    b The stipend isn't enough to cover all of Ulla's living expenses. She also works as a waitress for 4 hours per night, 2 nights per week. She earns $18.20 per hour as a waitress. Calculate Ulla's total fortnightly income.

6 The minimum wage for a trainee pest inspector is $595.70 for a 38-hour week. What is the minimum pay per hour for a trainee pest inspector?

7 Carlos earns $320 per day as a relief teacher. The table shows the number of days he worked during 5 weeks.

How much did Carlos earn over the 5 weeks?

Dates	Number of days worked
30 April – 4 May	2
7 May – 11 May	1
14 May – 18 May	5
21 May – 25 May	3
28 May – 1 June	2

8 Ashok is a casual office worker. He is paid $178 per day irrespective of the number of hours he works. Usually, he works about 12 days per month.

    a   How much did Ashok earn for working from 8 a.m. to 1 p.m. on Monday?

    b   During February, Ashok earned $1958. How many days did he work in February?

    c   The office offers Ashok a permanent 38-hour a week job at $16 per hour. Do you think he should take the permanent job? Why or why not?

9 Tori is trying to decide which one of three jobs to take.

	Conditions	Pay
Job 1	38-hour week, 5 days per week, possibility of overtime	$19/hour
Job 2	75 hours per fortnight, work 9 days per fortnight	$1450 per fortnight
Job 3	Salary, based on a 35-hour week	$38 800 p.a.

    a   Ignoring any overtime, which job pays the most per year?

    b   If you were Tori, which job would you take? Why?

INVESTIGATION

AWARD WAGES

Fair Work

Log onto the **Fair Work** website and search for A-Z list of awards.

• Research the minimum wage for three jobs that interest you.

• Calculate the minimum weekly pay in each job.

WAGES BY SPREADSHEET

Ask your teacher to download the 'Wages' spreadsheet from the NelsonNet website.

1 Jessica doesn't work on Mondays or Tuesdays. Each day from Wednesday to Sunday she works from 7 a.m. to 2.30 p.m. and she has an unpaid, 30-minute lunch break. Jessica's wage is $17.60 per hour. Enter the information about Jessica's job in the spreadsheet and determine her total weekly pay.

2 a One of the formulas used in the spreadsheet is **=SUM(F11:F17)**. What is this formula calculating?

  b What spreadsheet formula in cell F19 could be used to determine the total amount Jessica is paid each week?

3 The following table shows the hours worked during the first week in February and the corresponding pay rates for the employees in a small office.

Employee	Pay rate per hour	Number of hours worked	Pay
Imran	$12.51	20	
Sofia	$15.25	35	
Cathy	$20.70	35	
Mike	$16.30	40	
Anita	$16.30	32	
		Total wages bill	

  a The hours each employee works per week and their hourly rate of pay could change. Construct a spreadsheet that will allow you to calculate each employee's wage and the total office wage bill when the number of hours worked and the rates of pay could change.

  b During the second week in February, each employee received a $4 per hour wage increase. Imran worked 32 hours and the other employees worked for the same number of hours as in the previous week. Use the spreadsheet you constructed to determine the total wages bill for the second week in February.

8.02 Working overtime

Overtime is working beyond usual working hours or days, and is paid at a higher rate such as 1.5 times the normal pay (**time-and-a-half**) or twice the normal pay (**double time**). Only people who work for a wage are paid for overtime (it doesn't apply to salary earners).

Overtime

PROFILE

ALYSSA – AN AGED CARE WORKER

I helped my mum look after my grandfather who has dementia when I couldn't get a job after I left school. When we took Pa for a one-week holiday in a respite centre, the centre manager told me that I had the right attitude and I could consider working in the care service industry. I didn't need any special training because the employer provided on-the-job training and, with Australia's ageing population, there are lots of jobs to choose from. The best thing about my job is the variety. I deal with different clients and do different things every day.

EXAMPLE 3

Alyssa's normal rate of pay is $16.81 per hour. She is paid time-and-a-half on Saturdays and double time on Sundays.

a   How much does Alyssa earn per hour on Saturdays?

b   Calculate the amount Alyssa will earn for working 4 hours on a Sunday.

Solution

a   When she works on a Saturday, Alyssa is paid $1\frac{1}{2}$ times her normal rate.

Pay per hour at time-and-a-half $= 1.5 \times \$16.81$
$= \$25.22$

b   When Alyssa works on Sunday, she earns $2 \times \$16.81$, or $33.62 per hour.

Pay for 4 hours on Sunday $= 4 \times \$33.62$
$= \$134.48.$

Overtime pay

Time-and-a-half is $1\frac{1}{2}$ times normal pay.

Double time is 2 times normal pay.

EXAMPLE 4

Hasid earns $18 per hour.

a   How much will he earn for working a 35-hour week?

b   When Hasid works for more than 7 hours per day he is paid overtime. For the first 3 hours he works overtime he is paid time-and-a-half. Any additional overtime hours are paid at double time. How much will Hasid earn for working 12 hours in one day?

Solution

a   Multiply hourly rate by 35.

Pay for a 35-hour week $= 35 \times \$18$

$= \$630$

b   When Hasid works for 12 hours in one day, his time is broken into 7 hours normal + 3 hours at time-and-a-half + 2 hours at double time.

Pay $= 7 \times \$18 + 3 \times 1.5 \times \$18 + 2 \times 2 \times \$18$

$= \$279$

Hasid's pay for a 12-hour day is $279.

Exercise 8.02 Working overtime

Example 3

1   Complete the missing values in the table.

Normal pay per hour	Pay per hour at time-and-a-half	Pay per hour at double time
$17.20	**a**	**b**
$14.36	**c**	**d**
$24.60	**e**	**f**
$31.25	**g**	**h**

2   Jenny's normal pay is $16.40 per hour. How much will she earn when she works 5 hours at time-and-a-half?

3   Mike's normal pay is $15.30. How much will he earn when he works for 4 hours on a Sunday at double time?

4   How much will Sancia earn when she works 3 hours at time-and-a-half and 4 hours at double time? Her normal pay is $21.80 per hour.

5 Tuan is a plumber's assistant. He works a 35-hour week at $22.80 per hour. His overtime is paid at time-and-a-half for the first 5 hours overtime in a week and double time for any hours after that. This week, Tuan worked 42 hours.

 a How many hours did Tuan work at double time?

 b Calculate Tuan's pay for the week.

6 Mercia has a holiday job supervising children in a resort. She earns $19 per hour Monday to Friday, time-and-a-half on Saturday and double time on Sunday.

 a The table shows the times Mercia worked during one week in January. What are the missing values in the table?

Day	Hours worked	Pay rate per hour	Pay
Weekdays	21	i	iv
Saturday	4	ii	v
Sunday	6	iii	vi

 b Calculate Mercia's pay for the week.

7 a Casey earned $108 when he worked for 3 hours at double time. What is Casey's normal pay per hour?

 b How much will Casey earn when he works for 3 hours at time-and-a-half?

8 Elise earned $120 when she worked on Sunday for 4 hours at double time. How much does Elise earn for a normal 7-hour day?

9 Callum works for the council. He looks after the grass in parks and at sporting venues. Callum doesn't work any overtime on Monday to Friday. All of the hours he works on Saturday are paid at time-and-a-half and Sunday work is at double time. For Callum's time and pay sheet below, find the values of **a**, **b**, **c**, **d**, **e** and **f**.

Time and pay calculation sheet				
Callum			Normal pay per hour	$16.90
Day	**Start**	**Finish**	**Unpaid breaks**	**Pay**
Monday	7 a.m.	3:30 p.m.	30 minutes	a
Tuesday	b	5:30 p.m.	1 hour	$152.10
Wednesday	–	–		
Thursday	8 a.m.	4 p.m.	c	$118.30
Friday	6:30 a.m.	d	1 hour	$135.20
Saturday	7 a.m.	11 a.m.	Nil	e
Sunday	8 a.m.	f	Nil	$101.40

8.03 Bonuses and allowances

Some jobs include **allowances** for doing unpleasant work, for working under difficult conditions, or to cover expenses such as uniform and travel.

Some jobs pay **bonuses** (extra pay) for doing good work, meeting targets or deadlines.

> **PROFILE**
>
> **KAITLYN** – COOK IN THE AUSTRALIAN NAVY
>
> I joined the navy because I didn't want a 9-to-5 job and I wanted to travel. I get good pay and conditions as well as job security. I'm a fully qualified cook and the navy provided all my training and arranged my TAFE qualifications. I've got good friends in the navy and I've been around the world. I was surprised at the variety of jobs in the navy; jobs I'd never considered like being a waiter or a chaplain. The navy even has permanent jobs for musicians in the navy bands!

EXAMPLE 5

Kaitlyn's basic salary in the navy is $43 434 and she receives an annual $12 128 service allowance as well as an annual $419 uniform maintenance allowance. When she's at sea she receives an additional $11 758 annually.

a Calculate Kaitlyn's weekly pay when she is working on land.

b How much does Kaitlyn earn per fortnight when she's at sea?

Solution

a Kaitlyn's annual salary on land = basic salary + service allowance + uniform allowance.

Salary = $43 434 + $12 128 + $419
$\qquad = \$55\ 981$

Divide by 52 for weekly pay.

Weekly pay on land = $55 981 ÷ 52
$\qquad\qquad\qquad \approx \$1076.56$

b Kaitlyn's annual pay at sea = basic salary + service allowance + uniform allowance + sea allowance.

Salary = $43 434 + $12 128 + $419 + $11 758
$\qquad = \$67\ 739$

Divide by 26 for fortnightly pay.

Fortnightly pay at sea = $67 739 ÷ 26
$\qquad\qquad\qquad\qquad \approx \$2605.35$

EXAMPLE 6

Sonia is paid $15.48 per hour for her work as a security guard. Each week, she receives an additional $61.05 for her guard dog and $6.75 for her torch. She receives $14.15 per shift travel allowance.

Sonia works a 4-hour shift, 6 nights per week. How much is she paid per week?

Solution

Sonia's total weekly pay = wages + allowances + dog + torch

Wages $= 4 \times 6 \times \$15.48$

$\quad = \$371.52$

Travel allowance $= 6 \times \$14.15$

$\quad = \$84.90$

Sonia's total weekly pay $= \$371.52 + \$84.90$

$\quad + \$61.05 + \$6.75$

$\quad = \$524.22$

Exercise 8.03 Bonuses and allowances

1 Tristan's base salary as an air force trainee is $37 485 p.a. In addition, he receives the Australian Defence Force annual allowance of $12 128 and an annual $419 uniform allowance. He also receives $9531 p.a. when he is deployed overseas.

    a Calculate Tristan's weekly pay when he is working in Australia.

    b Determine Tristan's fortnightly pay when he is deployed overseas.

Example 5

2 Zoran works for a pest control company. He is paid $14.93 per hour and receives an extra $2.81 per day for handling poisons. Zoran works for 8 hours per day, 5 days per week. Calculate his weekly pay.

Example 6

3 Ryan earns $721 per week as a mobile mechanic. In addition, he receives $29 per week for work-related mobile phone calls and $0.60 per kilometre for work-related travel. Calculate Ryan's pay for a week in which he drove 420 km in his truck for work.

4 Kate is the manager of a fast food chain. She is paid $28 per hour for a 35-hour week plus $8.30 per week laundry allowance. She receives a $30 bonus for every accident-free week at the shop and another $95 bonus per week if the shop makes $100 000 or more in weekly sales.

Last week, the shop was accident-free and sales were $110 000. How much was Kate paid last week?

5 Zack drives a furniture removal truck. He is paid $15.12 per hour Monday to Friday, time-and-a-quarter on Saturday and double time on Sunday. In addition, he receives a flat fee of $12.59 per day for handling heavy furniture. Calculate Zack's pay for a week when he delivered heavy furniture for 33 hours Monday to Friday, 6 hours on Saturday and 3 hours on Sunday.

6 Raina has a job driving disabled children to school. She is paid $16.20 per hour plus $3.65 per day for assisting children. In addition, she receives 65 cents for every work-related kilometre she drives in her car. Calculate Raina's pay for a week when she worked 4 hours each day from Monday to Friday and she used her car for 360 work-related kilometres.

7 Sam is a casual junior baker at a hot bread shop. A casual junior baker earns $12.32 per hour. From midnight Friday to midnight Saturday all bakers receive their normal pay plus 50%. From midnight on Saturday to midnight on Sunday casual bakers receive 98% more than their normal pay per hour.

a The table shows the times Sam worked last week. Find the missing values **i** to **xii**.

Shift	Starting time	Finishing time	Unpaid breaks	Number of hours worked	Pay per hour	Pay
1	Thursday 10 p.m.	Friday 6:30 a.m.	30 minutes	**i**	**v**	**ix**
2	Saturday midnight	8 a.m.	1 hour	**ii**	**vi**	**x**
3	Saturday 8 p.m.	Midnight	0	**iii**	**vii**	**xi**
4	Sunday 6:30 p.m.	Midnight	30 minutes	**iv**	**viii**	**xii**

b Calculate Sam's total pay.

INVESTIGATION

MY FUTURE CAREER

Earning an income can occupy a lot of your time, so it's important to find a job that you are going to enjoy. In this investigation, you are going to complete some online questionnaires to help you determine the type of occupation that suits your skills and interests.

My Future

1 Visit the **My Future** website.

2 You will need to 'Sign up' as a new user in order to enter the website, and then log in each time you use the site. Remember your password.

3 In the 'My career profile' section of the website there are some questionnaires. Complete a questionnaire, then explore the careers that the website suggests might interest you in the 'Career insight' or 'Occupations' sections of the website. You may be unfamiliar with some of the careers to which you may be suited. Take the time to learn about these careers. It could be the best hour you ever spend!

Chapter problem

You've covered the skills required to solve the chapter problem. Can you solve it?

8.04 Annual leave loading

Annual leave loading or **holiday loading** is an extra payment to employees given at the start of their holidays. It is usually calculated as $17\frac{1}{2}\%$ of 4 weeks pay.

Percentage calculations

Mental percentages

········· **PROFILE** ··········

BRIANA – VET NURSE

There are lots of different things for vet nurses to do in a busy surgery. Most days, I take care of hospitalised animals and I help the vets during consultations and surgery. Sometimes, I do lab tests and sterilise equipment, but my favorite activity is running puppy preschool classes.

EXAMPLE 7

Briana earns $750 per week as a vet nurse. When she takes her 4 weeks annual holiday she receives an extra $17\frac{1}{2}\%$ of 4 weeks pay as holiday loading in addition to her normal 4 weeks pay.

a Calculate Briana's holiday loading.

b Determine the total value of Briana's holiday pay.

Solution

a Brianna receives $17\frac{1}{2}\%$ of 4 weeks pay.

$17\frac{1}{2}\% = 0.175$

Pay for 4 weeks $= \$750 \times 4$

$\qquad\qquad\qquad = \$3000$

Briana's holiday loading $= 0.175 \times \$3000$

$\qquad\qquad\qquad\qquad\quad = \$525$

b Holiday pay = 4 weeks pay + holiday loading

Briana's holiday pay $= \$3000 + \$525$

$\qquad\qquad\qquad\qquad = \$3525$

Exercise 8.04 Annual leave loading

1 Calculate $17\frac{1}{2}\%$ of each amount.

    a $350   **b** $1264   **c** $3325   **d** $6895

2 The Edmondson Park Motel pays its employees a $17\frac{1}{2}\%$ holiday loading on their 4 weeks annual leave.

    a Vicki, the chef, earns $695 per week. Calculate her annual leave loading.

    b James earns $565 per week as a barman at the hotel. How much will James be paid for his 4-week annual holiday?

3 Angus works part time and he earns $743 per week. For his holidays he receives a loading of $17\frac{1}{2}\%$ of 4 weeks pay. Calculate the total value of his 4-week holiday pay.

4 As a result of a wage claim based on an increase in the cost of living, all workers were granted a 4.2% increase in their pay.

    a Liam works in data processing and he earns a salary of $58 200 p.a. Calculate his new salary.

    b How much will Liam be paid for 4 weeks work after the wage rise?

    c Calculate Liam's new annual leave loading.

5 Phillipa's annual salary is $72 320. She receives a loading of $17\frac{1}{2}\%$ of 4 weeks pay with her holiday pay. Calculate the total value of Phillipa's holiday pay.

6 Linda earns $890 per week. She receives 6 weeks holidays at the end of each year, but her leave loading is only $17\frac{1}{2}\%$ of 4 weeks pay. Calculate Linda's holiday pay.

7 Jon's wage increased from $620 to $700 per week. By how much will his 4-week holiday pay, including $17\frac{1}{2}\%$ loading, increase?

8 P.L. Insurance had a very successful year. In addition to the normal $17\frac{1}{2}\%$ annual leave loading, they decided to pay their employees a 'thank-you' bonus based on the number of years of service. They paid this bonus at the same time as the loading.

Years of service	Bonus as a percentage of annual salary
1–5	0.4%
6–8	0.65%
Over 8	0.9%

Katrina is paid $2152 per fortnight and she has worked for the company for 7 years.

    a How much is Katrina's bonus?

    b Calculate the total amount Katrina was paid, before tax, for her 4 weeks holiday, including the bonus.

9 Nate earns $640 per week. At the end of the year, he receives 5 weeks holiday with a $17\frac{1}{2}\%$ loading on 4 weeks. How much more does Nate get paid for taking 5 weeks holidays than for working 5 weeks?

10 Ask your teacher to download the 'Holiday pay' spreadsheet from NelsonNet to answer this question.

Holiday pay

a Yasmin earns $11.25 per hour for a 35-hour week. If the annual leave loading increases from $17\frac{1}{2}\%$ to $22\frac{1}{2}\%$ of 4 weeks pay, by how much will Yasmin's 4-week holiday pay increase?

b What spreadsheet formula could be used to determine the value of the following amounts?

i normal pay for 1 week

ii normal pay for 4 weeks

iii leave loading for 4 weeks

8.05 Commission, piecework and royalties

Salespeople are often paid by **commission**, which is a percentage of the value of the items they've sold.

Piecework is a type of work where a person is paid per item produced or processed.

A **royalty** is a payment to an author, singer or artist for each copy of their work sold. Usually, a royalty is a percentage of the total sales amount.

Percentage calculations

Mental percentages

PROFILE

SARINA – SYDNEY ARTIST

It's great to be able to work doing something you love, but it hasn't always been easy. In the beginning, as an unknown artist, I had to work nights as a waitress because my art didn't pay very much. If I sold the same painting now as I did 10 years ago I'd get a lot more money for it. My current work involves projects where people ask me to paint something specific, and my agent negotiates a fee. I also earn royalties when my artwork is used on commercial items such as placemats, drink coasters, plates, cups, serviettes, calendars and T-shirts.

You can view some of Sarina's work at www.sarina.net.

Photo: Sue Thomson

EXAMPLE 8

Sarina receives a 5% royalty on the wholesale price of serviettes featuring her art. Packets of serviettes wholesale for $3.20 each and sell for $5.80. Calculate Sarina's royalty for the sale of 8000 packets of serviettes.

Solution

Find the value of the serviettes sold.

Wholesale value = $8000 \times \$3.20 = \$25\,600$

Calculate the royalty.

Sarina's royalty = 5% of $25\,600$

$= \$1280$

Shutterstock.com/Evgeniya863

EXAMPLE 9

Jordan is a used car salesman. He is paid a $170 monthly retainer plus 5% commission on his monthly sales over $50 000. Calculate his pay for a month when his sales totaled $80 000.

A **retainer** is the amount of money a salesperson is paid that does not depend on his sales.

Solution

Find the value of the sales for which he is paid commission.

Sales over $50\,000 = \$80\,000 - \$50\,000$

$= \$30\,000$

Calculate the commission.

Commission = 5% of $30\,000$

$= \$1500$

Total earnings = retainer + commission.

Total earnings = $\$170 + \$1500$

$= \$1670$

EXAMPLE 10

Danielle earns commission for selling cosmetics at the following rates:

Commission on monthly sales	
First $1000 of sales	5%
On the next $2000	4%
Remainder of sales	3.5%

These different rates are sometimes called a 'sliding scale'.

This month, Danielle's sales totalled $5200. Calculate her commission.

Solution

Commission on the first $1000 = $0.05 \times \$1000$

$$= \$50$$

Commission on the next $2000 = $0.04 \times \$2000$

$$= \$80$$

Danielle's remaining sales = $\$5200 - \$1000 - \$2000$

$$= \$2200$$

Commission on the remaining $2200 = $0.035 \times \$2200$

$$= \$77$$

Danielle's total commission = $\$50 + \$80 + \$77$

$$= \$207$$

Exercise 8.05 Commission, piecework and royalties

1 Calculate each percentage amount.

   a 9% of $25 000   **b** 5% of $800   **c** 2% of $300 000

   d $2\frac{1}{2}$% of $500 000   **e** $3\frac{3}{4}$% of $175 200   **f** 0.95% of $60 000

2 Marco earns 7% commission on all his sales. Find his commission on a sale of $1675.

3 Sarina receives a 3% royalty on the wholesale price of calendars featuring her art. How much royalty will she receive for 15 500 calendars with a wholesale price of $9.90?

Example 8

4 Assam sells window shutters and is paid a retainer of $120 per week to cover his expenses, and a commission of 15% of all sales he makes. Assam's sales for the first week in April totalled $2896. Calculate his pay for that week.

Example 9

5 In her job as a real estate agent, Pauline is paid a retainer of $600 per month plus a commission of 2% of her sales over $800 000. How much did Pauline earn for a month when her sales totalled $1 300 000?

Example
10

6 Tanika sells cosmetics. She earns commission at the following rates.

Calculate Tanika's commission for each of the following monthly sales figures.

Commission on Tanika's monthly sales	
First $500 of sales	5%
On the next $1000	4%
Remainder of sales	3.5%

a $360 **b** $1400 **c** $4200

7 Emily earns monthly commissions when she sells perfumes according to these rates.

Calculate Emily's commission in a month when her total sales were valued at:

Monthly sales	Commission
$800	5% of sales
$801 to $1200	$40 plus 4.5% of sales over $800
$1201 and over	$58 plus 4% of sales over $1200

a $360 **b** $998 **c** $5100.

8 Monique has hired Trevor to re-tile her home. Trevor told Monique she required 6 m^2 of tiles for the kitchen walls, 48 m^2 of slate for the lounge-room floor and 7 m^2 of slate for the stairs. How much will Trevor charge to lay the tiles and slate?

> **Trevor's Tiling Service**
> Bathrooms, Kitchens
>
> *All Quality Work*
> * Tiles $32 per m^2
> * Slate $36 per m^2
> * 25% extra for stairs

9 Holly enjoys cooking scones which she sells at the local Devonshire Tea shop. She buys her ingredients in bulk and it costs her $12 to make 5 dozen scones in 2 hours. She values her labour at $16 per hour. How much should Holly charge the Devonshire Tea shop for 10 dozen scones?

> 1 dozen = 12

10 Basam is selling his house for $420 000. The real estate agent's commission is 2% on the first $200 000 and 1.5% on the balance of the sale price. How much will Basam receive from the sale of his house?

11 Magda writes books that sell for $56 each. Each year, she receives 10% royalty on the first 4000 copies and 12.5% royalty on the remaining copies of sales of her books. Calculate the royalty Magda receives in a year when:
a 3650 copies of her books are sold
b 7000 copies of her books are sold.

12 Milan puts letters in envelopes and attaches postage stamps for a marketing company. He is paid 24 cents per letter. Milan can process 70 letters per hour.

    a How much does Milan earn per hour?

    b How much will he earn for processing 260 letters?

    c How many letters does Milan need to process in order to earn over $100?

13 Renuta is a self-employed antique furniture auctioneer. On every item she sells she charges 15% commission on the first $2000 of the sale price and 12.5% of the amount over $2000. How much will Renuta charge for selling an antique dining room suite that sold for $22 600?

14 The table shows the rates of royalty Sarina receives when her art is used on plates. The wholesale price of the plates is $3.40.

Number of plates sold	Royalty rate
First 2000	4% of the wholesale price
From 2001 to 10 000	$272 plus 3% of the wholesale price for the number of plates sold in excess of 2000
10 001 or more	$1088 plus 2.5% of the wholesale price for the number of plates sold in excess of 10 000

Calculate Sarina's royalty for the sale of the following numbers of plates.

    a 1500   **b** 8600   **c** 25 000

8.06 Government allowances and pensions

PROFILE

BEN – STUDENT

I have to look after my mum because there's just the two of us and she's got bipolar disorder. When she takes her medication she's OK, but I still need to do the shopping, cook our food and do the housework. It's really hard when I've got assignments and assessments, especially if Mum's unwell. I can't get a job because I have no spare time. Centrelink gives me a carer's pension and a carer's allowance. Mum receives sickness benefits and rent assistance.

iStock.com/bowdenimages

If you or someone you know is caring for someone, visit the Disability and Carers page on the Australian Government Department of Social Services website to access help for carers. The site provides information about support and assistance in your local area.

Department of Social Services

EXAMPLE 11

To receive a pension, you need to pass an income and assets test. Joan is a single, aged pensioner who owns her home. She is allowed to have assets up to $250 000 and retain a full pension of $808.30 per fortnight. For every $1000 over $250 000 in assets, her fortnightly pension reduces by $3. At present, Joan's assets are valued at $198 000 and she is about to inherit $75 000. What effect will the inheritance have on her pension?

Solution

Find Joan's assets after her inheritance.

Find the value of Joan's assets over $250 000.

For every $1000 over $250 000, Joan's pension reduces by $3.

Joan's assets = $198 000 + $75 000

$$= \$273\ 000$$

Amount = $273 000 − $250 000

$$= \$23\ 000$$

$23 000 ÷ $1000 = 23

Joan's pension = $808.30 − 23 × $3.00

$$= \$739.30$$

Inheriting $75 000 will decrease Joan's pension to $739.30 per fortnight.

Exercise 8.06 Government allowances and pensions

1 Cameron receives $244 per fortnight in youth allowance. He pays his mother $60 per week for board and his fortnightly public transport costs to travel to TAFE are $42. How much of his Youth Allowance is left each fortnight after Cameron pays his board and transport expenses?

2 The maximum fortnightly age pension payable to eligible people over the age of 65 is $808.30 for singles and $609.30 per person for couples. How much less does a couple receive per fortnight than two single people sharing accommodation?

3 Senior health care cardholders and pensioners are entitled to a government telephone payment. Every 3 months they receive a $28.20 phone allowance. Calculate the annual value of the phone allowance.

4 Jim receives a disability pension and he lives in a public housing, rent-subsidised unit. Jim has to pay 15% of his pension in rent. His pension is $609.30 per fortnight. How much rent does Jim pay per year?

5 Gail receives a disability pension because she is too sick to work. Her fortnightly pension is $797.90.

    a Calculate Gail's annual pension.

    b Gail's pension includes $6.20 per fortnight for medications and she pays $6.30 per prescription medicine. Gail takes a lot of medication, but after she has paid for 58 prescriptions per year, all further prescriptions are provided free. How much more than her fortnightly medication allowance does Gail have to pay for her medications each year?

6 The age pension payment for a single person is $808.30 but for every dollar of income they receive over $164 per fortnight the pension reduces by 50 cents.

Example
11

    a Doris is a single aged pensioner and she receives $290 per fortnight from renting out her granny flat. Calculate the value of Doris' fortnightly age pension.

    b Nanna thinks Centrelink is overpaying her for the age pension. For the last 8 weeks she has been receiving $520 per fortnight pension and she also receives a fortnightly income of $1070 from her investments. She knows that Centrelink will make her repay any overpayments she receives. How much will Nanna have to repay Centrelink?

7 All of the residents in a block of units are aged pensioners: 17 of them are single and 26 are couples. Use the information in Questions **2** and **3** to calculate the total maximum annual age pension they receive and the total annual phone allowance.

8 Bill and Rose are a couple both aged 20 years. Bill's fortnightly taxable income is $721.70 but Rose is unable to work and she receives a disability support pension of $201.35 per fortnight. Recently, Rose received a letter from Centrelink informing her that for the last year she has been overpaid. The details included in the letter are:

- Pension received: $5235.10

- Entitled: $3614.25

- Overpaid amount: $1620.85.

The maximum, fortnightly disability pension for a member of a couple aged under 21 years is $562.20 and this amount reduces by 50% of the couple's fortnightly taxable income.

Are the details included in the letter correct? Justify your answer.

INVESTIGATION

FINANCIAL SUPPORT THROUGH CENTRELINK

The Australian Government provides financial support and assistance to Australian citizens through social security. The staff at Centrelink are trained to assist Australians when they are in need.

In this activity, you are going to find out about your social security entitlements.

1 Go to the Centrelink website.

2 Click on the appropriate option to research the answers to the following questions.

3 a What is the maximum fortnightly Youth allowance Centrelink will pay a person who is under 18 years of age and living at home?

b What are 'approved activities'?

c Do you have to be involved in approved activities to receive a Youth allowance?

d What other assistance can someone receiving a Youth allowance receive?

e Is there an income or an asset test for the Youth allowance?

4 a If you are single with no dependent children, what is the maximum amount of rent assistance you can receive from Centrelink per week?

b If you are single and share a residence but have no dependent children, can you get rent assistance if your fortnightly rent is $190? If so, how much?

5 a Who can receive an ABSTUDY payment?

b Jake is an 18-year-old student who is going to live away from home to study at university. He is qualified to receive an ABSTUDY payment. How much will his fortnightly ABSTUDY payment be?

c Can Jake get any money from Centrelink in advance of his ABSTUDY payments? Explain your answer.

6 Melinda's grandmother died in her sleep while Melinda was living with her. Use the Centrelink website to find out what Melinda should do first.

8.07 Budgeting

Have you ever wondered what happens to your money? It's a good idea to have a plan so that you don't waste it. A **budget** lists your expected income and expenses, and can help you to manage your money.

Income covers all the money you might earn.

Expenses covers all the ways you might spend that money, and there are two types:

- **Fixed expenses** are costs that are essential and must be paid. Some are the same amount each time, such as rent. Others aren't always the same, such as food.

- **Discretionary expenses** are amounts that you often spend but which aren't essential, such as entertainment or magazines.

A budget needs to balance your income and expenses so that you have enough money for everything you require and some left over to save for special items, such as a car or holiday.

Budgeting scenarios

Budget grid

EXAMPLE 12

Ashleigh works part-time while studying. She receives an allowance from her parents of $100 per week and she earns $120 from her job. She pays $80 per week in rent and spends $30 per week on food. She averages $10 per week for her mobile phone and $20 per week on clothes. She divides the remainder equally between entertainment and savings.

a Create a budget for Ashleigh for a week.

b Ashleigh's rent is increased by $25 per week. How would she need to adjust her budget for this increased expense?

Solution

a List income and expenses and make sure total expenses equals total income.

Income		Expenses	
Allowance	$100	Rent	$80
Earnings	$120	Food	$30
		Mobile phone	$10
		Clothes	$20
		Entertainment	$40
		Savings	$40
Total income	**$220**	**Total expenses**	**$220**

Total of fixed expenses = $80 + $30 + $10 + $20 = $140

Remainder available for entertainment and savings = $220 − $140 = $80

Divided equally = $80 ÷ 2 = $40

b The $25 increase in rent means Ashleigh now has $25 less to spend on entertainment and savings. She has $80 − $25 = $55 to divide between entertainment and savings. She could still divide this amount equally between the two ($27.50 each) or she could spend less on entertainment to continue to save $40 per week.

Exercise 8.07 Budgeting

1 Lily owns a car and has the following expenses each year:
- registration $349
- Compulsory Third Party (CTP) insurance $795
- comprehensive insurance $1110
- maintenance bills of $790.

She spends $53 per week on petrol.

a How much does Lily spend on her car each year?

b How much should she set aside in her weekly budget to cover her car expenses?

Example
12

2 Mitchell works in an office during the week and in the bar at the local club on weekends. He earns $620 per week from the office job and $215 from the club. He pays $280 per week in rent and spends an average of $60 per week on food. His smartphone costs him $20 per week and travel expenses are $60 per week. The remainder of his income has to be divided between entertainment, clothes and savings.

a Create a budget for Mitchell for one week.

b Mitchell is considering buying a car. He would no longer have public transport expenses but he would need to allow $100 per week to pay off a loan and $75 for car expenses. Create a new budget for Mitchell.

3 Marko is an apprentice mechanic. His take-home pay is $790 per week. This table shows his weekly expenses.

a How much does Marko save each week?

b Calculate his net annual income.

c How much is Marko able to save each year?

Item	Amount
Board	$120
Mobile phone	$21
Clothes	$65
Car	$112
Entertainment	$72
Other expenses	$88
Savings	
Total	$790

4 This table shows Shania's monthly budget.

Income		Expenses	
Part-time job	$290	Clothes	$140
Babysitting	$130	School needs	$32
		Entertainment	$50
		Mobile phone	$55
		Fares	$23

a Calculate Shania's monthly income and expenses.

b Calculate the amount she is able to save each year.

c Shania would like to increase her savings so that she can go on an end-of-year holiday. Suggest three ways she could do this.

5 Sanjeev has taken a second job to save for a new car. His budget for a week is shown below.

Income		Expenses	
Main job	$750	Rent	$225
Second job		Travel	$56
		Food	$117
		Clothes	$55
		Entertainment	$75
		Bills	$157
		Savings	
Total	$908	Total	$908

a Calculate how much Sanjeev earns from his second job.

b Calculate how much he can save each week.

c If the car costs $25 000, how long would it take Sanjeev to save this money?

d Suggest ways Sanjeev could save more per week so that he can buy his car sooner. Create a new budget for Sanjeev.

Alamy Stock Photo/VDWI Automotive

MY BUDGET

In this investigation, you are going to prepare two budgets: one for a typical school leaver and one for yourself based on your own choice of job when you leave school.

Part A: Typical school leaver

INCOME:

- You have finished school.

- After school, you enrolled in a TAFE course for a year.

- You are now working and earn $27 040 p.a.

- You don't have a partner or children, but you need to move out of home.

- Your new home will be 4 km from where you work (fast 50-minute walk).

1 Download the 'My budget' worksheet from NelsonNet which contains the **Weekly tax tables**, **Budget guidelines** and the **Lifestyle costs** provided for this activity.

2 Copy and complete this budget form based on the information, or use the worksheet.

Weekly income		$
Gross weekly income	Equals yearly wage ÷ 52	
Deduct tax (weekly)	From table (tax-free threshold, no leave loading)	
Net weekly income		
Regular weekly expenses		**$**
Housing	Mortgage, rent or share	
Transport	Car running costs, registration, CTP insurance etc. or train, bike or walking	
Personal spending	Clothing	
	Hair, grooming, cosmetics etc.	
Food	Groceries, including pet food	
Utilities	Phone connection + landline calls, mobile phone expenses	
	Electricity, gas	

Total regular expenses		$
Discretionary weekly expenses		$
Insurance	Home and/or contents	
Insurance	Car – comprehensive	
Insurance	Health	
Entertainment	Pay TV, books, magazines, music, movies etc.	
Recreation	Sport, holidays	
Technology	Internet, laptop	
Total discretionary expenses		$
Net weekly income		
Total weekly expenses (regular + discretionary)		
BALANCE		$

Part B: You in your preferred occupation

Now you will repeat the activity in Part A but to create a budget based on your chosen occupation.

- The aim of a good budget is not simply to maximise savings.

- It is more to do with providing cost amounts that reflect the sort of lifestyle you want and ensuring these are within the income you have at your disposal.

- Your budget costing needs to cover the costs of the essentials of living (e.g. regular expenses such as food, shelter).

- For discretionary expenses, weekly amounts should allow you to afford the extra activities you wish to pursue, whether it is entertainment, holidays, fashion, or a more expensive car.

- You also need to consider carefully, within your budget, the pros and cons of taking out insurance of various types and explain the decisions you make.

- Consider carefully the advantages and disadvantages of taking out different types of insurance, whether you can afford them and explain the decisions you make.

- Assume you are single and have bought or are renting your new home, located 4 km from where you work (fast 50-minute walk).

1 Write your preferred occupation and determine the gross wage for that occupation as follows.

- Go to the My Future website.

My Future

- Click on **Occupations**, then find your occupation.

- Select **Prospects**, then **Full time weekly earnings**.

- Write the **Weekly income** into your budget.

2 Find the tax to be deducted from gross pay, using ATO *weekly* tax tables. These can be found on the 'My budget' worksheet or downloaded from the Australian Tax Office website and searching for the table of 'Weekly withholding amounts'.

3 Regular income and Weekly expenses (regular) *must* have an amount in the last column.

4 Weekly expenses (discretionary) can be left blank as a means of saving money, but you must explain and justify your decision.

5 For this exercise, you are *not* to make up your own figures; you *must* use the prices listed in the **Budget guidelines** and **Lifestyle costs**.

6 Some of the prices/costs are per week, others are per fortnight, per month, or per year. You must convert *all* amounts to a weekly cost.

For *every cost category* (both regular and discretionary), you will need to show:

- a short explanation of what choice you have made and why;
- the calculations/working you have done to arrive at the amount you have used.

KEYWORD ACTIVITY

DEFINITIONS MATCH

Match each word in the first column to its correct meaning in the second column.

	Word		**Meaning**
1	Allowance	**A**	Yearly
2	Annual leave loading	**B**	Pay based on the number of hours worked
3	Bonus	**C**	Pay based on the number of items made or processed
4	Double time	**D**	1.5 times the normal rate of pay
5	Income	**E**	A payment to authors, artists or others who create items
6	Overtime	**F**	Extra amount paid for holidays, usually 17.5% of 4 weeks pay
7	Per annum (p.a.)	**G**	Extra pay for doing good work
8	Piecework	**H**	A fixed amount paid per year
9	Royalty	**I**	Twice the normal rate of pay
10	Salary	**J**	Additional payment for work under difficult conditions or for doing unpleasant tasks
11	Time-and-a-half	**K**	Money that is received or gained, usually regularly
12	Wage	**L**	Working more hours per day or week than normally

SOLUTION TO THE CHAPTER PROBLEM

Problem

Hugo earns $17.04 per hour for a 37-hour week in his job in a wholesale plant nursery. He is paid time-and-a-half for the first 5 hours of overtime per week and double time after that. If he is required to work any unscheduled overtime, he receives a $10.68 meal allowance per shift. In addition, he receives a $1.60 allowance per hour when he is required to work in wet areas.

Pay slip: Hugo Mendozia	
Week ending 29 May	
Normal pay	$630.48
Overtime	$153.36
Allowances	$20.28
Gross pay	$804.12

In the week ending 29 May, he worked 43 hours, which included one unscheduled overtime shift and 6 hours working in a wet area.

Hugo thinks his pay for the week ending 29 May is wrong. Is his gross pay correct?

Solution

Hugo worked 37 hours normal time, 5 hours overtime at time-and-a-half and 1 hour at double time.

Normal pay	$37 \times \$17.04$	$630.48
Time-and-a-half	$5 \times 1.5 \times \$17.04$	$127.80
Double time	$1 \times 2 \times \$17.04$	$34.08
Total overtime	$127.80 + $34.08	$161.88
Wet area allowance	$6 \times \$1.60$	$9.60
Meal allowance		$10.68
Total allowances	$9.60 + $10.68	$20.28
Gross pay	$630.48 + $161.88 + $20.28	$812.64

The calculations for Hugo's normal pay and allowances are correct, but the overtime calculation is wrong. Hugo has been underpaid by $161.88 − $153.36 = $8.52 (or $812.64 − $804.12 = $8.52).

8. TEST YOURSELF

Earning money

1 Shelly earns $18.75 per hour for a 35-hour week.

  a How much does Shelly earn per week?

  b Calculate the amount she earns per fortnight.

  c What is Shelly's annual pay?

2 Marcus is an accountant. His annual salary is $96 000.

  a How much does Marcus earn per month?

  b Calculate Marcus' fortnightly pay.

3 Suyin works in an aged-care facility. Her normal pay is $20.24 per hour.

  a How much does she earn per hour when she works at time-and-a-half?

  b When Suyin works the night shift on weekends she is paid double time. Calculate her pay for working 7 hours on the late shift on a Saturday night.

4 George earned $168 for working 4 hours at double time. Calculate George's normal rate of pay.

5 Jamie is a plumber's assistant. His normal pay is $15.65 per hour but when he has to work in wet or muddy conditions he receives a $2.10 allowance per hour. Jamie worked 7 hours today and for three of the hours he was digging in mud. Calculate Jamie's pay for today.

6 Zoe is a plumber. For emergency late night call-outs, she charges a call-out fee of $500 and labour at $125 per hour. Last night, she attended an emergency call at 2 a.m. Calculate the amount she charges for working for 3 hours to fix the problem.

7 Nuala is employed as an early childhood music teacher. Her normal weekly pay is $1325. Calculate her holiday pay for a 4-week holiday including a 17.5% leave loading.

8 Izak is an artist whose work features on fun park admission tickets. He receives 5% commission on the sale of each ticket. How much commission will Izak receive from the sale of 18 000 tickets priced at $45 each?

9 Luke lays tiles for a living. He charges $46/square metre of tiles he lays. How much will Luke charge for laying 17 square metres of tiles?

10 The maximum age pension for a single person is $808.30 per fortnight. Calculate the maximum annual pension for a single person.

11 Every January, Julie has to register and insure her car. Each year, she has trouble paying these expenses because she is short of money after Christmas. This year, her January car registration and insurance costs totaled $2040. What do you recommend she do this year to be ready for these expenses next January?

Practice set 2

●●○○

Section A Multiple-choice questions

For each question select the correct answer **A**, **B**, **C** or **D**.

1 During exercise, Roberta had an average pulse rate of 140 beats/minute.
How many times did her heart beat during her 40-minute exercise session?

    A 3.5   **B** 210   **C** 5600   **D** 8400

2 How many cubic centimetres are equivalent to 650 mm^3?

    A 0.65 cm^3 **B** 6.5 cm^3

    C 65 cm^3 **D** 650 000 cm^3

3 Walid earns $3672 per month. What is his weekly pay?

    A $847.38   **B** $918   **C** $1694.77   **D** $1836

4 Calculate the value of $2x - y$ when $x = 5$ and $y = 6$.

    A −2   **B** 4   **C** 16   **D** 19

5 What type of graph is the best choice to show information on the changing weight of a baby over 6 months?

    A picture   **B** column   **C** sector   **D** line

6

Activity	Time required to use 1000 kJ
Sleeping	4 hours
Eating	3 hours
Working in class Studying Watching TV	2 hours 30 minutes
Walking	1 hour
Bike riding	50 minutes
Swimming	30 minutes

According to this table, which activity will use 3500 kJ?

    A   Sleeping for 12 hours and 30 minutes

    B   Studying for 7 hours and 30 minutes

    C   Bike riding for 2 hours and 55 minutes

    D   Swimming for 1 hour and 35 minutes

7 Lina's television uses 438 kWh of electricity annually. What would it cost to run the TV for a year if electricity costs 28.237c/kWh?

    A $12.37   **B** $123.68   **C** $1236.78   **D** $12 367.81

8 The internal dimensions of a refrigerator are 150 cm (height), 60 cm (width) and 40 cm (depth). What is the capacity of the refrigerator in litres?

    A 250 L   **B** 300 L   **C** 360 L   **D** 430 L

9 A tub of margarine weighs 500 g. This is a mass greater than

    A 60 000 mg   **B** 0.8 kg   **C** 0.01 tonnes   **D** 2.5 kg

10 For the formula $A = \dfrac{h(a+b)}{2}$, evaluate A when $h = 4.5$, $a = 6$ and $b = 8$.

    A 9.25   **B** 18.5   **C** 31   **D** 31.5

Section B   Short-answer questions

1 Given that $d = 10$, $e = -3$ and $f = 5$, evaluate each expression:

    a $d + e$ **b** $de + f^2$ **c** $\dfrac{d}{2} + 3f$ **d** $3e - 2d - f$

2 A Christmas box for shortbread is in the shape of a rectangular prism. It measures 18 cm long, 11 cm deep and 7 cm high. Calculate the volume of the box.

3 This clustered column graph from Chapter 5 shows the number of motor vehicle thefts per year for 3 different areas.

Vehicle thefts

    a In which year is the highest number of thefts in the Outer suburbs?

    b In which area have motor vehicle thefts declined most?

    c In which year is the difference between the number of thefts in the Inner city and the Country town the highest?

    d Estimate this difference.
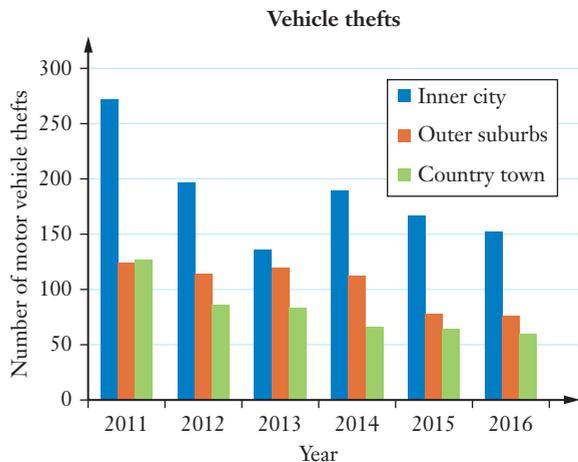
4 Malek is exercising and he takes his pulse. He counts 39 beats in 15 seconds. Calculate his pulse in beats per minute.

5 Patrick buys a carton of eggs. The label says '12 large eggs 600 g'.

   a   What is the approximate mass of one egg?

   b   The eggs are delivered to the supermarket in a box containing 20 cartons. What is the mass of the box in grams?

   c   What is the mass of the box in kilograms?

6 A group of people were surveyed about whether they exercised regularly.

Age group	Exercise regularly	Do not exercise regularly	Totals
Under 40	60		110
40 and over		25	
Totals	125	75	

   a   Copy and complete the table.

   b   What percentage of the people surveyed do not exercise regularly?

   c   Of those who exercised regularly, what percentage were 40 and over?

7 Copy and complete each table of values.

   a $y = 2x + 1$

x	0	2	3	5
y				

   b $y = 6 - 2x$

x	−1	0	2	3
y				

8 Use this graph to answer the questions.

Sunny days per month: Broome
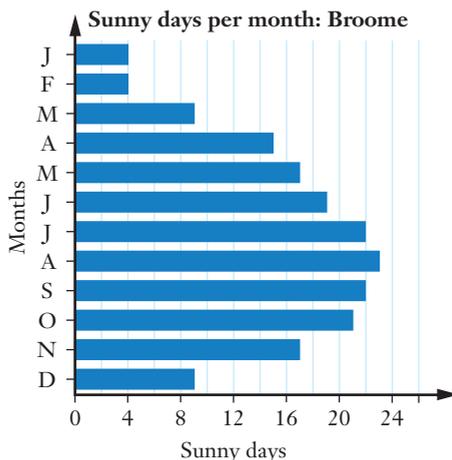
a How many sunny days were there in April?

b How many months of the year had fewer than 16 sunny days?

c How many sunny days were there in total for Broome in this particular year?

9 A box of teabags is a rectangular prism 17 cm long, 12.5 cm wide and 17.5 cm high.

a Find the volume of the box.

b How many such boxes would fit in a crate 1.4 m long, 1.02 m wide and 1 m high?

10 Find a formula relating x and y in each table of values.

a

x	1	2	3	4	5
y	7	6	5	4	3

b

x	1	2	3	4	5
y	9	18	27	36	45

11 Jane has lunch consisting of 2 slices of ham, 1 slice of cheese and 1 slice of buttered bread, followed by a banana.

a Use the table in Chapter 6, page 152 to calculate how many kilojoules are in Jane's meal.

b In the afternoon, Jane goes swimming. Use the table from Question **6** in Section A on page 231 to determine how long Jane must swim to use the kilojoules from her lunch.

12 A catering company calculates its charges using the formula

$C = 350 + 49n$, where n is the number of people attending the party.
Calculate the cost of catering for a party of 200 people.

13 Draw a line graph for this data about the temperature over 1 day in winter.

Time	9 a.m.	10 a.m.	11 a.m.	12 noon	1 p.m.	2 p.m.	3 p.m.	4 p.m.
Temperature	8°C	11°C	13°C	16°C	18°C	17°C	16°C	13°C

14 James has a clothes dryer that he uses 3 times per week for 2 hours each time.
The clothes dryer has a power rating of 2400 W.

a How many kWh of electricity does James use with the clothes dryer each week?

b How many kWh does the clothes dryer use in one year?

c Calculate the annual cost of using the clothes dryer if electricity costs 34c/kWh.

15 The Anderson family are installing an underground water tank on their property.
They want the tank to hold 75 000 litres. They are currently planning to build a
tank in the shape of a rectangular prism 4 m by 10 m by 2 m. Will this tank hold
75 000 litres? Justify your answer with calculations.

16 a Janine is paid a $109 000 annual salary. How much is this each fortnight?

b Michael is paid $33.50 per hour. How much is he paid for a 35-hour week?

17 Simon is paid $276 for working 6 hours on a Sunday at double time. What is his
usual hourly rate of pay?

18 Anilha earns $970 per week. Each year she is paid 17.5% annual leave loading on
4 weeks pay. Calculate:

a her pay for 4 weeks

b the annual leave loading she will be paid

c her total gross pay

9.

SHOW ME THE DATA

Chapter problem

The Nelsonville College principal thought that too many cars were speeding through the school zone after school when the speed limit is 40 km/h. One day, the police recorded the speeds of all cars for 1 hour after school.

What type of data is this? What would be the best way to organise and present this data?

WHAT WILL WE DO IN THIS CHAPTER?

- Distinguish between categorical data and numerical data
- Graph categorical data and numerical data
- Graph and interpret histograms, dot plots, stem-and-leaf plots and choose the best display for a particular set of data
- Identify outliers in a set of data

HOW ARE WE EVER GOING TO USE THIS?

- When we need to organise information we have collected
- When preparing a presentation of information for a group of people
- When evaluating data presented in the media

9.01 Categorical and numerical data

A collection of facts or information is called **data**. There are two main types of data.

> **Categorical data** is information that is grouped into categories, such as the colour of cars or ice cream flavour.
>
> **Numerical data** is information that is counted or measured as numbers, such as the number of goals scored or a person's height.

EXAMPLE 1

Classify each type of data as categorical or numerical.

a makes of cars

b people's salaries

c weights of athletes

d favourite radio stations

Solution

a Makes of cars are words.   Categorical

b Salaries involve numbers.   Numerical

c Weights of athletes involve measurement on a numerical scale.   Numerical

d Radio stations involve words.   Categorical

Exercise 9.01 Categorical and numerical data

Example 1

1 Classify each type of data as categorical (C) or numerical (N).

a masses of Year 11 students

b brands of computers

c prices of large pizzas

d number of TVs owned by families

e monthly rainfall in Mount Isa

f causes of tooth decay

g sets won in a tennis match

h speed of trucks

2 Classify each type of data as categorical (C) or numerical (N).

a people's hair colours

b customer ratings of a restaurant's level of service (from poor to excellent)

c number of homes with smart TVs

d times taken for athletes to run 100 m

e countries where cars are manufactured

f school populations

g heights of bridges

h classification ratings of films (for example, PG)

3 You are asked to do a survey on people's preferences about anything to do with cars. Write a questionnaire with 6 questions: 3 questions whose answers are categorical and 3 questions whose answers are numerical.

9.02 Displaying categorical data

When we collect categorical data, we can organise it into a **frequency table**. This makes it easier to see what the information is telling us.

EXAMPLE 2

Heidi asked a group of her fellow students which night of the week they would prefer to have the school ball. She recorded the responses as T (Thursday), F (Friday), Sa (Saturday) and Su (Sunday). This is her data.

| F | F | T | Sa | F | Sa | F | Sa | Sa | F | Sa | T | Sa | F |
| F | T | T | Su | F | Sa | T | Sa | F | F | F | F | T | T |

Arrange this data in a frequency table.

Solution

A frequency table has three columns. Complete the tally column by putting one tally mark for each response.

Day of the week	Tally	Frequency
Thursday	℧ ‖	
Friday	℧ ℧ ‖	
Saturday	℧ ‖‖	
Sunday	│	

Count the tally marks to complete the frequency column.

Day of the week	Tally	Frequency
Thursday	℧ ‖	7
Friday	℧ ℧ ‖	12
Saturday	℧ ‖‖	8
Sunday	│	1
Total		**28**

We can display categorical data in a column graph.

EXAMPLE 3

Display the data from Example 2 in a column graph.

Day of the week	Frequency
Thursday	7
Friday	12
Saturday	8
Sunday	1

Solution

The horizontal axis will be the days of the week.

The vertical axis will be the frequency.

Columns will have spaces between them.

Preferred day for school ball
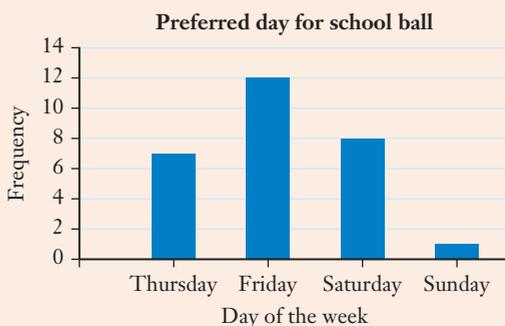
Exercise 9.02 Displaying categorical data

Example 2

1 Piyush recorded the methods students in his year use to travel to school. He recorded the data as W = walk, R = ride a bike, B = bus, C = car and T = train. This is his data.

B B C T W	R W W T C	T T C B R	W W R R R
W W C R B	B W T W R	W W B R B	R W W T C
R R W W T	C W R W W	C B W W R	R R W B R
W R R W C	T R W W B	R R C B T	W R R B C

a Arrange this data in a frequency table.

b What is the most common way for students to travel to school?

c What is the least common travel method?

2 Tiana surveyed a selection of homes in Nelson Waters to find out the ages of each child. She recorded the data as B = babies up to 2 years, P = pre-schooler, I = early primary and O for children older than 8 years. This is Tina's data.

B B O I O   O B P P P   O B I I O   O I I I P   O B B O I

P O O P I   P P O B I   I O P O O   B I P B I

    a Arrange Tiana's data in a frequency table.
    b Which category of children contains the largest number of children?
    c What percentage of children in the survey are babies?

3 Jasmine asked 30 students in Year 11 'What is your preferred brand of car?'

Her results are shown below and coded as follows: Holden = H, Ford = F, Toyota = T, Mitsubishi = M, Subaru = S, Other = O

H H T F F   F M T O S   T H H H F   S M T T H   F F H H O   S T M H F

    a Arrange Jasmine's data in a frequency table.
    b What is the most popular brand of car amongst these students?
    c What percentage of students preferred Mitsubishi?

4 Tristian surveys a class of 30 students about the day of the week that each student's birthday falls on this year. The results are shown in the table below. Display this data in a column graph.

Alamy Stock Photo/Hoxton

Example **3**

Day	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Number of students	6	3	4	6	3	5	3

5 Allison counted the colours of the jelly beans in a large jar.

Colour	Red	Black	Purple	Pink	Orange	White
Frequency	110	50	20	40	60	80

Display this data as a column graph. ← You can use a spreadsheet to construct the graph if you want to!

9.03 Displaying numerical data

We can also summarise numerical data into a frequency table and present it in a graph.

EXAMPLE 4

Kyle asked 25 students in his class: 'How many children are there in your family?' The answers are recorded below:

1, 6, 7, 4, 3, 3, 2, 2, 5, 3, 3, 3, 3, 1, 7, 3, 2, 3, 2, 5, 4, 4, 1, 1, 2

Arrange Kyle's information in a frequency table.

Solution

Number of children	Tally	Frequency
1	||||	4
2	Ⅶ	5
3	Ⅶ |||	8
4	|||	3
5	||	2
6	|	1
7	||	2

We often graph numerical data using a **histogram**. A histogram is like a column graph but there are no spaces between the columns. We show **frequency** on the vertical axis and we show the scores on the horizontal axis.

Shutterstock.com/goodluz

EXAMPLE 5

Draw a histogram for the data in Example 4.

Solution

Place 'Number of children' on the horizontal axis.

Place 'Frequency' on the vertical axis.

Make sure that the columns are centred so that the values on the horizontal axis are directly below them.

Add a title to the graph.

Number of children in a family
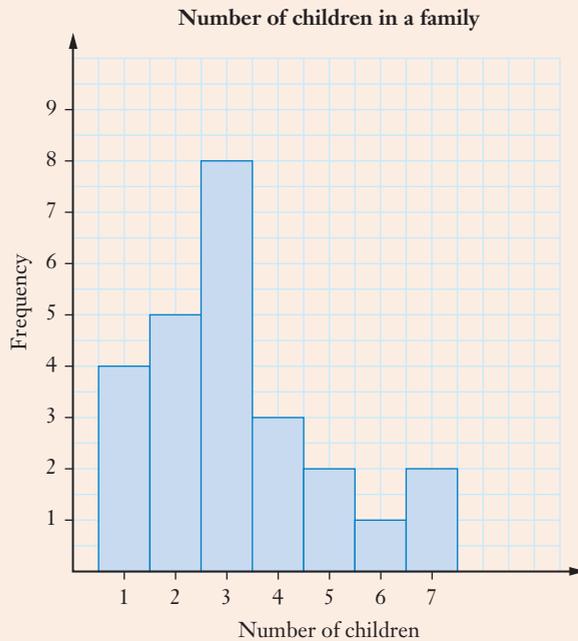
Exercise 9.03 Displaying numerical data

1 The number of hamburgers sold each day in a food court between 12 noon and 2 p.m. in August is listed below.

17   27   28   18   18   17   19   19   25   27   17   19   20   19   21   26

28   18   19   20   17   19   23   24   20   18   17   20   19   27   28

Example
4

a Arrange this information in a frequency table.

b On how many days did the shop sell fewer than 20 hamburgers?

c On what percentage of days did it sell more than 25 hamburgers? Round your answer to the nearest whole number.

Shutterstock.com/Sorbis

2 Sajjid asked a group of Year 11 students how many siblings (brothers and sisters) they had. The results were as follows:

4 0 2 3 2 4 3 4 3 0 0 1 2 3 2 2 1 4 3

1 1 1 2 0 1 2 1 0 1 3 2 3 4 1 1 3 3

    a   Complete a frequency table for Sajjid's data.

    b   How many students were asked this question?

    c   How many students had no siblings?

    d   How many students had fewer than 3 siblings?

    e   What percentage of students had 1 sibling? Round your answer to the nearest whole number.

3 A life insurance company recorded the ages of 40 clients.

84 76 39 45 38 74 66 81 49 57

59 42 31 43 71 80 40 37 73 87

77 49 53 62 62 74 84 90 31 47

52 62 79 33 31 52 46 43 55 38

    a   Copy and complete the grouped frequency table below for this data.

Age	Tally	Frequency
31–40		
41–50		
51–60		
61–70		
71–80		
81–90		
Total		

    b   Which age group has the most clients in it?

    c   How many clients were 50 years old or younger?

    d   What percentage of clients were over 70 years old?

Example 5

4 Amber surveyed 20 households in her street about how many phones they owned.
The results are shown in this frequency table.

Draw a histogram to display Amber's data.

Number of phones	Frequency
0	2
1	7
2	8
3	2
4	1

5 This frequency table shows the number of letters received by an office each day.

   a Draw a histogram for this data.

   b On how many days did the office receive fewer than 5 letters?

   c Which number of letters had the highest frequency?

Number of letters	Frequency
3	4
4	7
5	8
6	14
7	12
More than 7	10

6 Atiq counted the number of phone calls he made each day for 30 days.

5 3 6 2 4 3 3 5 4 7 5 1 6 3 2

3 5 6 1 6 2 4 3 1 5 4 2 7 3 2

   a Complete a frequency table for this data.

   b Draw a histogram for this data.

   c On how many days did Atiq make 5 calls?

   d What was the most common number of phone calls made each day?

7 The P.E. department recorded the heights of Year 11 students in centimetres.

151 167 181 172 179 155 159 162 169 174 178 180 158

166 171 168 157 160 175 172 150 169 163 170 176

   a Copy and complete this grouped frequency table.

Class	Tally	Frequency
150–154		
155–159		
160–164		
165–169		
170–174		
175–179		
180–184		
Total		

   b How many students had their height recorded?

   c Draw a histogram for this data.

   d How many students were 170 cm or taller?

   e Which **class interval** has the most students in it?

9.04 Dot plots and stem-and-leaf plots

Dot plots are used for small sets of numerical data that are close together.

Stem-and-leaf plots are used for larger sets of numerical data and list the actual data values.

EXAMPLE 6

The daily maximum temperature (in °C) in Port Hedland in May was recorded for 15 days.

32   30   31   32   31   30   31   31   31   31   29   25   28   27   29

Construct a dot plot for this data.

Getty Images / ullstein bild

Solution

The temperatures go from 25° to 32°, so the line for the dot plot should go from 24 to 33.

Add a dot above the line for each data value.
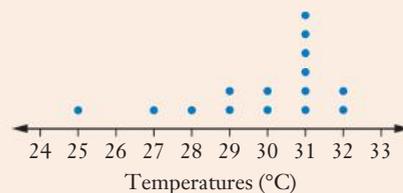
EXAMPLE 7

Sarah works for law enforcement and recorded the number of malicious property damage reports in the inner city each month over 3 years.

54 41 55 49 37 38 37 48 51 44 52 44 58 70 60 46 63 54

45 43 46 55 55 67 49 66 90 45 66 62 51 51 53 53 38 52

Draw an ordered stem-and-leaf plot for this data.

Solution

The stem will be the tens digits. The smallest number is 37 and the largest number is 90, so the stem will go from 3 to 9.

Stem	Leaf
3	
4	
5	
6	
7	
8	
9	

The leaf will be the units digit for each number in the data. This is called an unordered stem-and-leaf plot because the 'leaves' are not in order.

Stem	Leaf
3	7 8 7 8
4	1 9 8 4 4 6 5 3 6 9 5
5	4 5 1 2 8 4 5 5 1 1 3 3 2
6	0 3 7 6 6 2
7	0
8	
9	0

key: 3 | 7 = 37

Then we write the 'leaves' in order. This is called an ordered stem-and-leaf plot.

Fairfax Media/Jeffrey Chan

Stem	Leaf
3	7 7 8 8
4	1 3 4 4 5 5 6 6 8 9 9
5	1 1 1 2 2 3 3 4 4 5 5 5 8
6	0 2 3 6 6 7
7	0
8	
9	0

key: 3 | 7 = 37

Exercise 9.04 Dot plots and stem-and-leaf plots

1 Ahmed surveyed his maths class to find the number of hours each student spent on the Internet each week. These are the results.

14   15   17   18   13   16   19   19   18   14

17   15   13   13   14   19   13   14   17   18

a Draw a dot plot for Ahmed's data.
b How many students were in the class?
c How many students used the Internet for 14 hours per week?
d How many students used the Internet for more than 16 hours per week?

2 The number of motor vehicle thefts in an inner-city suburb was recorded each month for one year.

15   9   11   16   13   11   13   12   10   15   13   9

a Draw a dot plot for this data.
b In how many months were 13 motor vehicles stolen?
c What percentage of months had 13 motor vehicles stolen?
d In how many months were fewer than 12 motor vehicles stolen?

3 Lisa surveyed her group of friends about the amount of money they spent on fuel last week. The answers were rounded to the nearest dollar. This is the data she recorded.

$20 $28 $25 $26 $22 $26 $28 $28 $24 $22 $29 $28

a Draw a dot plot for this data.
b How many friends did Lisa survey?
c What was the most common amount of money spent on fuel?
d How many of Lisa's friends spent less than $26 on fuel?

4 Mrs White, the school canteen manager, records the daily number of students visiting the canteen over 3 weeks.

105   76   97   88   114   86   124   101   112   98   95   105   117   81   112

a Show this information in a stem-and-leaf plot.
b On what percentage of days were more than 100 students served? Answer correct to the nearest whole percentage.

5 A security firm recorded the monthly number of shoplifting incidents over 3 years.

20 20 23 11 12 33 22 30 16 17 35 48

25 27 25 34 20 23 25 17 12 14 13 13

48 42 55 33 24 39 26 41 33 31 19 55

    a   Show this data on a stem-and-leaf plot.

    b   How many months had the number of incidents in the 30s?

    c   What percentage of the total months was this? Answer correct to the nearest whole percentage.

6 A class of Year 11 students were surveyed on the number of hours of part-time work they did last month.

42   16   35   27   9   0   33   21   14   11

26   29   31   22   8   24   5   0   15   25   17

    a   Complete a stem-and-leaf plot to show this information.

    b   What was the most number of hours worked by anyone in this sample?

    c   How many students worked between 10 and 20 hours in the month?

    d   How many students worked more than 20 hours in the month?

    e   How many students were in this class?

    f   What percentage of students worked more than 20 hours in the month? Answer correct to the nearest whole percentage.

7 Decide which graph – a histogram (H), a dot plot (D) or a stem-and-leaf plot (SL) – would be best to use for the given data. Justify your answer.

    a   Number of apples per tree

    b   Minimum temperature each day for a fortnight in February in Fremantle

    c   Salaries of the 40 employees of a small business

    d   Time taken to travel to school in minutes by students in Year 12

    e   Rainfall each day for the month of August in Esperance

    f   Number of mobile phones per family in Nelson St

    g   Ages of patients in a doctor's practice

    h   Sales of shirts at all branches of a fashion store in one week

    i   Number of students in each class at St Judy's Primary School

    j   Heights of all Year 11 students at Thomson Grammar School

Chapter problem

You've covered the skills required to solve the chapter problem. Can you solve it now?

9.05 Outliers

Sometimes with numerical data we have a number that is an **outlier**, a value that is very different from the rest of the data. It can be either much bigger or much smaller than the other scores. An outlier can make it difficult to graph the data. When we see a score that looks like an outlier, we should check that the score is reasonable because it could be a mistake.

EXAMPLE 8

Lochie asked eight friends about the amount of pocket money they received each week. The results were:

$20 $32 $32 $40 $18 $32 $18 $75

a Identify the outlier in this data.

b Is this outlier reasonable or likely to be a mistake?

Solution

a Write the data in order.

18, 18, 20, 32, 32, 32, 40, 75

Choose the score that is either much bigger than the other scores or much smaller than the other scores.

The outlier here is $75 because it is much bigger than the other scores.

b

It is reasonable, as it is quite possible for one student to receive much more pocket money than other students.

Example
8

Exercise 9.05 Outliers

1 For each set of data, identify the outlier.

a 12   15   28   19   15   14   16

b 7   5   6   8   7   1   8   6   9

c 32   35   12   40   36   29   38   30

d 94   49   35   38   31   44

2 Data can have more than one outlier. What are the outliers in this data set?

6   8   0   6   8   16   8   7   2   8   9   9   8

3 The results of a mathematics test (out of 100) for a Year 10 class are shown.

55   52   50   45   55   45   60   50   60   58
75   45   49   59   58   59   56   49   31   52

a Sort these results in order from highest to lowest.

b What are the outliers in this data?

4 The nurse recorded the masses (in kg) of patients in the hospital emergency room.

| 68 | 59 | 63 | 80 | 68 | 54 | 48 |

| 49 | 64 | 47 | 48 | 59 | 68 | 30 |

  a Place these results in order from highest to lowest.

  b What are the outliers in this data set?

5 Katrina measured the heights of 25 Year 11 male students in centimetres.

175 176 185 176 25 184 197 161 186 169 171 170 182

165 179 180 167 169 198 167 170 180 182 173 230

  a Draw a stem-and-leaf plot of this data.

  b What are the outliers for this data?

  c For each outlier, decide if it is reasonable or likely to be a wrongly-recorded height. Explain your answer.

6 The prices of 8 houses sold in Nelson Waters Rd over the last 2 years are:

| $620 000 | $700 500 | $738 000 | $625 000 |

| $598 000 | $696 500 | $720 000 | $1 800 000 |

  a What is the outlier for this data?

  b Is this outlier reasonable or is it likely to be a mistake? Explain your answer.

7 Ten people work in a small business which sells stationery. Their annual salaries are:

| $61 000 | $57 000 | $66 000 | $51 000 | $53 000 |

| $62 000 | $56 000 | $63 000 | $60 000 | $245 000 |

  a What is the outlier for this data?

  b Is this outlier reasonable or is it likely to be a mistake? Explain your answer.

8 For the same sample of Year 11 males used in question **5**, Katrina recorded the length of the right foot in centimetres. This is her data.

35 27 28 28 25 28 30 27 27 25 28 26 29

10 26 30 15 27 33 25 25 20 33 11 40

  a How many of these scores are in the 20s?

  b What are the outliers in this data?

  c For each outlier, decide if it is reasonable or likely to be a wrongly recorded foot length. Explain your answer.

9 Francine is a florist. In the first 8 years of her business, her annual profits were $35 000, $66 000, $69 000, $72 000, $75 000, $71 000, $68 000 and $76 000.

  a What is the outlier for this data?

  b Is this outlier reasonable or is it likely to be a mistake? Explain your answer.

DATA IN EVERYDAY LIFE

In this investigation you will find real-life examples of data presented in different ways. Here are some of the key words from this chapter:

categorical data	numerical data	histogram
dot plot	stem-and-leaf plot	outlier

What you have to do

- Search the Internet for each keyword/phrase, including images. You may like to search for Australian examples.

- Find an example for each one including a graph. Try to find one from real life, not from a maths site.

- Save it and explain its context and purpose.

- Create a PowerPoint presentation of what you have found.

Data find-a-word

KEYWORD ACTIVITY

categorical data	numerical data	frequency table	histogram
dot plot	stem-and-leaf plot	outlier	

Match each word above with one of the following definitions.

A a table summarising data

B a graph using dots to make columns

C information that is grouped into categories, such as the colour of cars

D a score that is very different from the rest of the data

E looks like a column graph but there are no spaces between the columns

F information that is counted or measured, such as the number of goals scored

G graph used for larger data sets that keeps all the detail of the data

SOLUTION ^{TO}_{THE}
CHAPTER PROBLEM

Problem

The Nelsonville College principal thought that too many cars were speeding through the school zone after school when the speed limit is 40 km/h. One day, the police recorded the speeds of all cars for 1 hour after school.

What type of data is this? What would be the best way to organise and present this data?

Solution

The data is speed, which are numbers, so the data is numerical.

Numerical data is best organised into a frequency table. If the speeds are spread over a wide range, it may be necessary to use a grouped frequency table.

Data is usually presented in a graph. For a few cars, we could use a dot plot, but as there will probably be a lot of cars, we should use a histogram or a stem-and-leaf plot.

As the principal is interested in the number of cars travelling at more than 40 km/h, it would be useful to calculate this number.

Qz

Practice quiz

Exercise 9.01

Show me the data

1 Classify each type of data as categorical (C) or numerical (N):

a brands of toothpaste

b hours of TV watched per week

c number of employees in small businesses

d country of birth of students at a school

e heights of school students

f ratings given by customers for a restaurant

Exercise 9.02

2 Marisa surveyed Year 11 students about their favourite colour from the following list:

Blue (B)   Green (G)   Red (R)   Purple (P)   Yellow (Y)   Magenta (M)

These are their results:

BBPRB   GYYMG   BGRPY   MMYPP   RRGBG   PYRGM

YPGRP   BBBBM   GGRPY   GGBBB   YYPPR   MMBBG

a Arrange this data in a frequency table.

b What is the most popular colour?

c What percentage of students chose green?

d Display this data in a column graph.

Exercise 9.03

3 The temperature at 11 a.m. each day is recorded:

15°C	22°C	17°C	21°C	18°C	20°C	19°C	21°C
20°C	19°C	22°C	21°C	21°C	19°C	15°C	21°C
22°C	18°C	21°C	20°C	22°C			

a Complete a frequency table for this data.

b For how many days was the temperature recorded?

c How many days had temperatures below 20°C?

d Draw a histogram for this data.

4 These are the results for Andre's Year 11 class for a quick maths quiz out of 20.

| 10 | 14 | 13 | 17 | 16 | 11 | 14 | 14 | 12 | 14 | 13 | 16 |

| 15 | 12 | 16 | 13 | 12 | 15 | 10 | 14 | 13 | 16 | 14 |

a Draw a dot plot for Andre's data.

b How many students in the class?

c How many students scored more than 14 out of 20 for the quiz?

5 *Tech-to-go Gamestore* records the age of each customer who comes into the store one morning.

| 25 | 55 | 36 | 29 | 28 | 50 | 47 | 39 | 52 | 41 | 33 |

| 50 | 29 | 28 | 56 | 33 | 26 | 35 | 35 | 48 | 32 |

a Show this information on a stem-and-leaf plot.

b How many customers came into the store that morning?

c What age was the oldest customer that morning?

d What percentage of customers were under the age of 35? Answer correct to 1 decimal place.

6 For each set of data, identify the outlier.

a 27 28 19 26 27 25 28 27

b 0 3 2 3 1 7 1 0 0 2 3

c 43.1 43.3 43.1 43.2 43.9 43.0 43.1 43.0

d 95 101 98 76 97 105 103 99

7 NelsonNet Airlines flies from Perth to Adelaide. The number of passengers on the 7 a.m. flight for 10 days was recorded.

| 56 | 100 | 98 | 104 | 125 | 101 | 89 | 93 | 100 | 99 |

a Write these scores in order from lowest to highest.

b What are the outliers in this data?

c For each outlier, decide if it is reasonable or likely to be a mistake. Explain your answer.

10.

IT'S ABOUT TIME

Chapter problem

Daniel needs to be at work by 8:30 a.m. and catches a bus to the station and then a train. The bus stop is 10 minutes from home and the bus trip takes 15 minutes. Buses leave every 15 minutes from 6:00 a.m. The train trip takes 10 minutes and trains leave every 20 minutes from 6:05 a.m. Daniel's workplace is a 5-minute walk from the station. What time does Daniel need to leave home to get to work on time?

WHAT WILL WE DO IN THIS CHAPTER?

- Convert between units of time: second, minute, hour, day, week, fortnight, month, year
- Write the time of day in 12- and 24-hour time and convert between the two formats
- Calculate time differences
- Solve problems involving Australian time zones
- Solve problems involving transport timetables and schedules, including planning trips

HOW ARE WE EVER GOING TO USE THIS?

- When looking up timetables and making plans for travel
- When checking TV programs or performance times
- Any time you need to calculate anything to do with time!

10.01 Units of time

Unit	Relationships
second (s)	
minute (min)	1 min = 60 s
hour (h)	1 h = 60 min = 3600 s
day	1 day = 24 h
week	1 week = 7 days
fortnight	1 fortnight = 2 weeks = 14 days
month	1 month = 30 or 31 days February has 28 days (or 29 days on leap years)
year	1 year = 12 months 1 year = 52 weeks 1 year = 365 days 1 leap year = 366 days

Dreamstime.com/Vevesoran

EXAMPLE 1

Convert:

a 23 minutes into seconds

b 91 days into weeks

Solution

a 1 min = 60 s, so multiply by 60.

$$23 \text{ min} = 23 \times 60 \text{ s}$$
$$= 1380 \text{ s}$$

b 1 week = 7 days, so divide by 7.

$$91 \text{ days} = 91 \div 7$$
$$= 13 \text{ weeks}$$

Scientific calculators have a degrees-minutes-seconds key ◯' '' or DMS.

As we saw in Chapter 1, *What's the score?*, this key is useful for calculations involving hours, minutes and seconds.

Convert 275 minutes into hours and minutes.

Solution

1 hour = 60 min so divide by 60.

$275 \text{ min} = 275 \div 60$

$= 4.583333\ldots \text{ min}$

$= 4 \text{ h } 35 \text{ min}$

Press the ⊙ʼ" or 2ndF DMS to change from decimal form to hours and minutes.

[4°35'0" on the calculator display]

Exercise 10.01 Units of time

1 Copy and complete each conversion.

a 6 hours = _____ minutes

b $2\frac{1}{2}$ years = _____ weeks

c 480 seconds = _____ minutes

d 120 months = _____ years

e 96 hours = _____ days

f 3 fortnights = _____ days

g 5 years = _____ months

h 24 weeks = _____ fortnights

i 18 weeks = _____ days

j 78 months = _____ years

2 Saranya runs a marathon in $3\frac{1}{4}$ hours. What is this time in minutes?

3 Eddie is sentenced to spend 105 days in gaol. How many weeks is this?

4 Letitia is paid $3040 per fortnight. How much is this per week?

5 Yusuf takes out a loan to be paid back in monthly instalments over 15 years. How many monthly repayments is this?

6 Evan is paid $5585 per month.
   a How much is Evan paid per year?
   b How much is Evan paid per week?

7 Use the degrees-minutes-seconds key on your calculator to copy and complete each conversion.

a 212 minutes = _____ hours _____ minutes

b 561 seconds = _____ minutes _____ seconds

c 330 seconds = _____ minutes _____ seconds

d 135 minutes = _____ hours _____ minutes

e 409 minutes = _____ hours _____ minutes

f 767 seconds = _____ minutes _____ seconds

8 In a training session, Zak takes 35 seconds to swim each 50 m lap.

    a How many seconds does Zak take to complete 40 laps?

    b Express your answer to part **a** in minutes and seconds.

    c Zak started swimming laps at 5 a.m. At what time will he finish the 40 laps?

9 Pooja is training for a marathon. She runs every day. On weekdays, she runs for $1\frac{1}{2}$ hours in the morning and $2\frac{1}{4}$ hours in the evening. On weekends, she runs 4 hours each day. For how long does Pooja run each week? Give your answer in hours and minutes.

10 Nelson Anglican College has a 20-minute break in the morning and a 45-minute lunch break. What is the total time for breaks in a fortnight? Give your answer in hours and minutes.

    → *How many school days in a fortnight?*

11 In a charity marathon run, 7 people ran an equal amount of time in a 24-hour relay. Joanne was one of the runners. To work out how long she ran for, she did the following calculation:

$$24 \div 7$$

The calculator answer shows as 3.4285 …

    a Explain why the answer is NOT 3 hours 42 minutes.

    b Calculate the correct answer.

TECHNOLOGY

Calculating wages

On a spreadsheet, it is easier to enter times as decimals so they can be used in calculations.

1 Enter the following data into a spreadsheet.

2 Convert the times in column B to decimal hours and write the answers in column C. For Grainger, this should be 37.50 hours.

	A	B	C	D	E
1	**Calculating wages**				
2					
3	Name	Time worked	Hours worked	Hourly rate	Wages
4	Grainger	37h 30 min	37.50	$27.40	$1,027.50
5	Sharwood	40h 12 min		$19.60	
6	Bush	39h 15 min		$25.90	
7	Nabaglo	29h 45 min		$32.20	
8	James	32h 30 min		$28.70	
9	Kerry	44h 36 min		$18.50	
10					
11			Total weekly wages =		
12					

3 Enter the formula **= C5*D5** into cell E5.

4 Use **Fill Down** to complete column E.

5 Calculate the total weekly wages by entering **= SUM(E4:E9)** in cell E11.

10.02 0600 hours

There are two ways to show the time of day:

- **12-hour time:** the conventional way using a.m. and p.m. and the hours 1 to 12

- **24-hour time:** a more formal way that uses 4 digits, the hours 00 to 23 and no a.m./p.m.

There are two main types of clocks we use to tell the time:

- Analog clock with a clock face and the numbers 1 to 12 on it

- Digital clocks that can show either 12-hour or 24-hour time.

This table shows the relationship between 12-hour and 24-hour time.

Analog clock

Digital clock

WS
12-hour and
24-hour time

WS
24-hour time
on an
analogue
clock

24-hour time	12-hour time	24-hour time	12-hour time
0000	12 a.m. (midnight)	1200	12 p.m. (midday)
0100	1 a.m.	1300	1 p.m.
0200	2 a.m.	1400	2 p.m.
0300	3 a.m.	1500	3 p.m.
0400	4 a.m.	1600	4 p.m.
0500	5 a.m.	1700	5 p.m.
0600	6 a.m.	1800	6 p.m.
0700	7 a.m.	1900	7 p.m.
0800	8 a.m.	2000	8 p.m.
0900	9 a.m.	2100	9 p.m.
1000	10 a.m.	2200	10 p.m.
1100	11 a.m.	2300	11 p.m.

EXAMPLE 3

Write 8:25 a.m. in 24-hour time.

Solution

8:25 a.m. is in the morning. Leave out the ':'
and put a zero at the front

8:25 a.m. = 0825

EXAMPLE 4

Write 1615 as 12-hour time.

Solution

1615 is bigger than 1200 so it's in the afternoon (p.m.). For the hour, take 12 away from 16. 16 – 12 = 4.

$1615 = 4\!:\!15$ p.m.

Exercise 10.02 0600 hours

Example **3**

1 Write as 24-hour time:

   a   11:44 a.m.   **b**   6:35 p.m.   **c**   2:51 a.m.   **d**   9:54 p.m.

Example **4**

2 Write as 12-hour time:

   a   0845   **b**   1320   **c**   2331   **d**   1045

3 Write the time shown on each clock in 12-hour time:

   a   11:23   **b**   17:54   **c**   13:16

4 Write the time shown on each clock in 12-hour time. All times are in the morning.

   a   **b**   **c**

5 Write the time shown on each clock in 12-hour time. All times are in the afternoon or evening.

   a   **b**   **c**
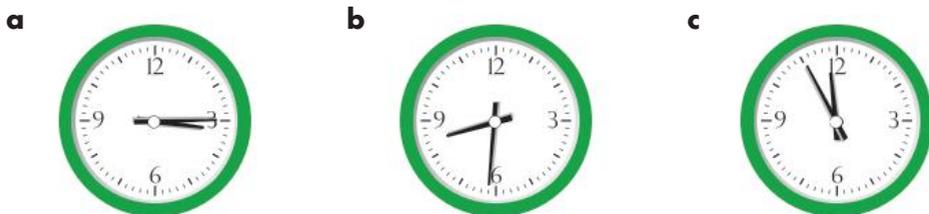
6 Show each time on an analog clock face.

   a   8:15 a.m.   **b**   10:40 p.m.   **c**   3:35 p.m.

7 Copy and complete this table.

12-hour time	5 a.m.	a	2:10 p.m.	5:18 p.m.	b	c	d
24-hour time	e	0715	f	g	1730	2150	1120

8 Sue wants to program her DVR to record a television program when she's out. The program starts at 8:30 p.m. and lasts for an hour and a half. Her DVR works in 24-hour time.

  a At what time will Sue need to set her DVR to start recording the program?

  b What time should she set for her finish time? Allow an extra 5 minutes for the recording.

9 24-hour time is used in the army, navy and air force, so it is sometimes called 'military time'. Sean rings his wife from the army camp at 1730. What is this in 12-hour time?

10 Andrew was on police duty one Saturday night from 2200 to 0600 on Sunday morning. He receives a report of a fight at 2245 and again at 0220.

  a How long was Andrew on duty?

  b How long was it between the 2 incident reports?

  c A patient is taken from the second fight to hospital and arrives 45 minutes after the incident was reported. What time does the patient arrive at hospital?

10.03 How long will it take?

How long do I have before my favourite TV program starts? How long is my stopover in Hong Kong? How long have I worked here? We can answer all these questions by doing a time calculation.

EXAMPLE 5

What is the difference in time between 8:35 a.m. and 3:10 p.m.?

Solution

Use a timeline and count to the next full hour.
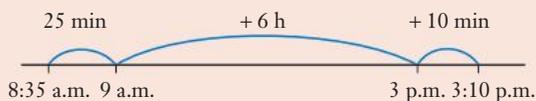
From 8:35 a.m. to 9:00 a.m.   25 minutes

From 9:00 a.m. to 3:00 p.m.   6 hours

From 3:00 p.m. to 3:10 p.m.   10 minutes

Add together.   Total time difference = 6 h + 25 min + 10 min

                                                           = 6 h 35 min

---

EXAMPLE 6

What is the time 7 hours and 40 minutes after 11:52 p.m.?

Solution

Use a timeline and add the hours first:
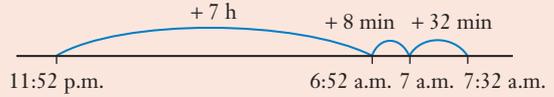
11:52 p.m. + 7 hours	6:52 a.m.
Count to the next full hour and add the number of minutes.	8 minutes to 7 a.m.
To make up 40 minutes, add another 32 minutes: 7 a.m. + 32 min.	7:32 a.m.

EXAMPLE 7

In March 2020, Kane's car was 5 years and 9 months old. When was Kane's car made?

Solution

Subtract 5 years from March 2020	2020 − 5 = 2015
	March 2015
Count back to the start of 2015 and subtract 3 months.	3 months to start of 2015
To make up 9 months, subtract another 6 months: Start of 2015 − 6 months	June 2014

Exercise 10.03 Time calculations

1 Calculate the time difference between each pair of times.

    a   7:27 a.m. and 1:12 p.m.   **b**   4:09 a.m. and 9:53 a.m.

    c   3:42 p.m. and 6:02 p.m.   **d**   11:15 p.m. and 3:08 a.m.

2 What is the time difference between each pair of 24-hour times?

    a   0800 and 1100   **b**   0500 and 1500

    c   0940 and 1455   **d**   1340 and 2150

3 Vamsee's flight lands in Hong Kong at 0950. His next flight leaves Hong Kong at 1920. How long does Vamsee have in Hong Kong airport?

4 At Thomson District High School, the school day begins at 8:45 a.m. and ends at 3:10 p.m. How long is the school day?

5 What time will it be:

    a   5 hours after 3:00 p.m.?   **b**   28 minutes after 7:15 p.m.?

    c   3 hours 32 minutes after 9:45 a.m.?   **d**   9 hours 10 minutes after 5:14 p.m.?

6 What time was it:

    a   4 hours before 6:15 p.m.?   **b**   45 minutes before 3:20 a.m.?

    c   2 hours 10 minutes before 1:35 p.m.?   **d**   3 hours 35 minutes before 11:25 a.m.?

7 Ewan has to take his tablets $1\frac{1}{2}$ hours after he finishes lunch. He finished his lunch at 1.45 p.m. What time should Ewan take his medicine?

8 Ramona wants to go for a jog for 50 minutes, but be back in time to watch *Zombie Vampire Athletes* on TV starting at 8:35 p.m. What is the latest time that she can leave for her jog?

9 Jamie bought a computer in December 2015. How old is it:

    a   in August 2019?   **b**   in January 2020?   **c**   today?

10 A box of chocolates bought in November 2020 has a 'Use by' date of March 2022. How long, in months, will the chocolates last?

11 In February 2018, Stephanie was $3\frac{1}{2}$ years old. When was Stephanie born?

12 Ask your teacher when they started teaching at your school. Work out how long they have been at your school in years, months and days.

13 How old are you today in years, months and days?

Chapter problem

You've covered the skills required to solve the chapter problem. Can you solve it now?

10.04 Times across Australia

Australia has 3 **time zones**:

- **Australian Western Standard Time (AWST)**, covering Western Australia
- **Australian Central Standard Time (ACST)**, covering South Australia and the Northern Territory and $1\frac{1}{2}$ hours ahead of AWST
- **Australian Eastern Standard Time (AEST)**, covering Queensland, New South Wales, the ACT, Victoria and Tasmania, and 2 hours ahead of AWST

Australian Western Standard Time (AWST)	Australian Central Standard Time (ACST)	Australian Eastern Standard Time (AEST)
0 hours	$+1\frac{1}{2}$ hours	+2 hours
10 a.m.	11:30 a.m.	12 noon
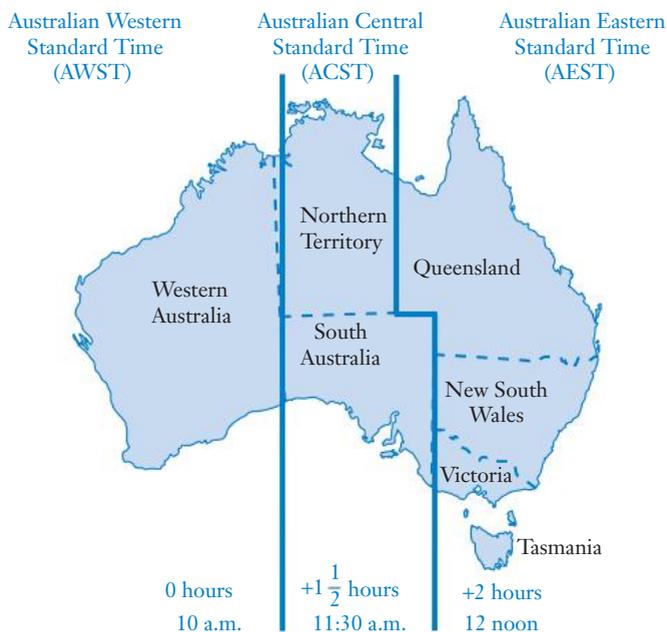
EXAMPLE 8

Show the Australian time zones on a timeline with Queensland as 0 hours.

Solution

If Queensland (AEST) is 0, then Western Australia is − 2 hours and Central Australia is $-\frac{1}{2}$ hours.

AWST	ACST	AEST
−2	$-\frac{1}{2}$	0
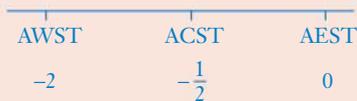
Time zones

When moving east, add on the time difference.

When moving west, subtract the time difference.

EXAMPLE 9

a It is 9 a.m. in Perth. What time is it in Adelaide?

b It is 2 p.m. in Brisbane. What time is it in Adelaide?

Solution

a Moving east from Perth to Adelaide: add the time difference.

$9 \text{ a.m.} + 1\frac{1}{2} \text{ hours} = 10:30 \text{ a.m.}$

b Moving west from Brisbane to Adelaide: subtract the time difference.

$2 \text{ p.m.} - \frac{1}{2} \text{ hour} = 1:30 \text{ p.m.}$

Exercise 10.04 Times across Australia

1 Show the time zones on a timeline with the Northern Territory as 0 hours.

2 State whether each location is ahead of, behind or has the same time as Adelaide.

    a Brisbane   **b** Melbourne   **c** Darwin   **d** Canberra

    e Geraldton (WA)   **f** Mt Isa (Qld)   **g** Ballarat (Vic)   **h** Ceduna (SA)

    i Hobart   **j** Broome (WA)

3 It is 10:30 a.m. in Adelaide. What time is it in:

    a Cairns (Qld)?   **b** Freemantle (WA)?   **c** Alice Springs (NT)?

    d Launceston (Tas)?   **e** Bendigo (Vic)?   **f** Broome (WA)?

4 What is the time in each city when it is 11 p.m. in Brisbane?

    a Melbourne   **b** Adelaide   **c** Perth

    d Darwin   **e** Hobart   **f** Canberra

5 The AFL Grand Final started in Melbourne at 2:15 p.m. and was shown live in Adelaide. What time did the game start on Adelaide TV?

6 a Mick's flight from Brisbane to Perth will take $5\frac{1}{2}$ hours. He leaves Brisbane at 2 p.m. What time does he land in Perth? Give your answer as Perth local time.

    b When Mick flies home, he leaves Perth at 11:30 a.m. What time does he land in Brisbane? Give your answer as Brisbane local time.

7 When Joanna was holidaying at Margaret River in WA, she phoned her parents in Cairns. She rang at 6:30 p.m. Western Standard Time. What time was it in Cairns?

8 Simone, in Toowoomba, uses the Internet to talk with her cousins in Fremantle, WA. At what time should Simone log on to catch her cousins at 8:00 p.m. Fremantle time?

9 a Use the Internet to find out when daylight saving begins and ends in NSW and Victoria.

b Why do some states have daylight saving?

c How does daylight saving affect the different time zones?

d When it is 12:30 p.m. in Western Australia (not on daylight saving),what time is it in NSW on Eastern Daylight Saving Time?

10 Broken Hill in NSW operates on Central Standard Time rather than Eastern Standard Time like the rest of NSW. Suggest a reason why Broken Hill might have chosen to do this. (Hint: look at a map.)

11 Karl is watching the cricket at the Melbourne Cricket Ground live on TV at 2.30 p.m., but the clock at the cricket ground says 5.30 p.m. (Eastern Daylight Saving Time). Where is Karl watching from?

12 Isabella and Lara like to talk on Facetime. On New Year's Eve, Lara called at 10 p.m. local time and it was 7.30 p.m. in Isabella's location. Where could the girls be located?

10.05 Timetables

Thousands of Australians rely on rail, bus and ferry **timetables** every day.

EXAMPLE 10

A section of a train timetable is shown here.

Armadale/Thornlie to Perth

Source: Transperth

Armadale	7:16 AM		7:46 AM		8:16 AM		8:31 AM	
Sherwood	7:18 AM		7:48 AM		8:18 AM		8:33 AM	
Challis S	7:20 AM		7:50 AM		8:20 AM		8:35 AM	
Kelmscott	7:22 AM		7:52 AM		8:22 AM		8:37 AM	
Seaforth	7:25 AM		7:55 AM		8:25 AM		8:40 AM	
Gosnells	7:27 AM		7:57 AM		8:27 AM		8:42 AM	
Maddington	7:30 AM		8:00 AM		8:30 AM		8:45 AM	
Kenwick	7:32 AM		8:02 AM		8:32 AM		8:47 AM	
Beckenham	7:34 AM		8:04 AM		8:34 AM		8:49 AM	
Thornlie		7:35 AM		8:05 AM		8:35 AM		8:50 AM
Cannington	7:36 AM	7:39 AM	8:06 AM	8:09 AM	8:36 AM	8:39 AM	8:51 AM	8:54 AM
Queens Park		7:40 AM		8:10 AM		8:40 AM		8:55 AM
Welshpool		7:42 AM		8:12 AM		8:42 AM		8:57 AM
Oats Street	7:39 AM	7:44 AM	8:09 AM	8:14 AM	8:39 AM	8:44 AM	8:54 AM	8:59 AM

Carlisle		7:45 AM		8:15 AM		8:45 AM		9:00 AM
Victoria Park		7:48 AM		8:18 AM		8:48 AM		9:03 AM
Burswood		7:50 AM		8:20 AM		8:50 AM		9:05 AM
Belmont Park				8:22 AM		8:52 AM		9:07 AM
Claisebrook	7:47 AM	7:54 AM	8:17 AM	8:24 AM	8:47 AM	8:54 AM	9:02 AM	9:09 AM
Mciver	7:49 AM	7:56 AM	8:19 AM	8:26 AM	8:49 AM	8:56 AM	9:04 AM	9:11 AM
Perth	7:50 AM	7:58 AM	8:20 AM	8:28 AM	8:50 AM	8:58 AM	9:05 AM	9:13 AM

Perth to Armadale/Thornlie

Perth	4:37 PM	4:45 PM	4:52 PM	5:00 PM	5:07 PM	5:15 PM	5:22 PM	5:30 PM
Mciver	4:38 PM	4:46 PM	4:53 PM	5:01 PM	5:08 PM	5:16 PM	5:23 PM	5:31 PM
Claisebrook	4:40 PM	4:48 PM	4:55 PM	5:03 PM	5:10 PM	5:18 PM	5:25 PM	5:33 PM
Belmont Park	4:42 PM		4:57 PM		5:12 PM		5:27 PM	
Burswood	4:44 PM		4:59 PM		5:14 PM		5:29 PM	
Victoria Park	4:46 PM		5:01 PM		5:16 PM		5:31 PM	
Carlisle	4:48 PM		5:03 PM		5:18 PM		5:33 PM	
Oats Street	4:49 PM	4:54 PM	5:04 PM	5:09 PM	5:19 PM	5:24 PM	5:34 PM	5:39 PM
Welshpool	4:51 PM		5:06 PM		5:21 PM		5:36 PM	
Queens Park	4:53 PM		5:08 PM		5:23 PM		5:38 PM	
Cannington	4:55 PM	4:58 PM	5:10 PM	5:13 PM	5:25 PM	5:28 PM	5:40 PM	5:43 PM
Beckenham		4:59 PM		5:14 PM		5:29 PM		5:44 PM
Kenwick		5:01 PM		5:16 PM		5:31 PM		5:46 PM
Maddington		5:03 PM		5:18 PM		5:33 PM		5:48 PM
Gosnells		5:07 PM		5:22 PM		5:37 PM		5:52 PM
Seaforth		5:09 PM		5:24 PM		5:39 PM		5:54 PM
Kelmscott		5:12 PM		5:27 PM		5:42 PM		5:57 PM
Challis		5:14 PM		5:29 PM		5:44 PM		5:59 PM
Sherwood		5:16 PM		5:31 PM		5:46 PM		6:01 PM
Armadale		5:19 PM		5:34 PM		5:49 PM		6:04 PM
Thornlie	5:00 PM		5:15 PM		5:30 PM		5:45 PM	

Louise catches the 7:52 a.m. train from Kelmscott to get to work at Burswood. What time does she arrive at Burswood station?

Solution

The 7:52 a.m. train from Kelmscott does not stop at Burswood. She will need to change trains at Oats Street. She can then catch a train to Burswood.

The train to Burswood arrives at the station at 8:20 a.m.

Exercise 10.05 Timetables

Use the timetable on the previous pages to answer each question.

1 What time does the 7:16 a.m. train from Armadale arrive at Perth?

2 What time does the 5:03 p.m. train from Carlisle arrive at Thornlie?

3 Ravi lives at Queens Park and works in Perth. He starts work at 8:45 a.m. What is the latest train he can catch at Queens Park to get to work on time?

4 Ravi finishes work at 4:30 p.m. It takes him 10 minutes to walk to the station.
   a What time can he catch the train home?
   b What time does he get to Queens Park?
   c Three days a week Ravi catches up with friends after work for half an hour. On these days, what time does he catch the train home?

5 Frances catches the 5 p.m. train from Perth. What time will she arrive at Gosnells?

6 Katarina is going to catch the train at Maddington to meet her friend Vimala at Belmont Park. They have agreed to meet for shopping and coffee at 9:15 a.m. What time does Katarina need to catch the train?

7 It takes 1 hour and 10 minutes to travel by bus from Thornlie to Perth.
   a How much longer does it take by bus than by train?
   b Suggest reasons why the bus might take longer.

8 Use the Internet to find a local or Perth train timetable. Save it or print a copy.
   a Write 5 questions, similar to those in questions **1** to **7**, for the timetable you have found.
   b Swap questions with a friend and answer their questions.

Shutterstock.com/Adwo

This is the bus timetable for Adelaide to Alice Springs and return. Use it to answer questions **9** to **13**.

ALICE SPRINGS - ADELAIDE

TOWN	CODE		GX850 DAILY EST	PICK-UP AND SET-DOWN POINT
ALICE SPRINGS	ASP	Dep	10.30A	Greyhound Terminal, Shop 2/76 Todd St
Erldunda	ERL		12.35P	Desert Oaks Resort, Cnr Stuart & Lassester Hwy
Kulgera	KUL	Arr	1.25P	Kulgera Roadhouse Hotel, Stuart Hwy
		Dep	2.00P	
SOUTH AUSTRALIA				
Indulkna Turnoff	IDK		3:20P	Roadside mailbox at turn off
Marla	MBR		4:00P	Traveller's Rest, Stuart Hwy
Cadney Park	CDY		4:55P	Mobil Roadhouse
Coober Pedy	CPD	Arr	6:30P	Terminal, 52-56 Hutchison St
		Dep	7:25P	
Bilgunnia Turnoff	BGN		8:55P	Turn Off
Glendambo	GBO	Arr	10:10P	Mobil Roadhouse
		Dep	10:30P	
Pimba	PIM	Arr	11:45P	Pimba Roadhouse
		Dep	12:01A	
Port Augusta	PUG		1:50A	Post Office, 50 Commerical Road
Port Augusta Meal Break	PUB	Arr	2:00A	Gull Service Station, Lot 8 Highway
		Dep	2:45A	
Port Pirie	PIR	Arr	3:40A	BP Service Station
Port Wakefield	PWF	Dep	5:00A	BP Service Station, 26 Snowtown Rd.
Bolivar	BLV		5:45A	BP Service Station
Cavan	CAV		6:00A	Bus Stop 26, Port Wakefield Road
ADELAIDE	ADL	Arr	6:25A	Greyhound Terminal, 85 Franklin St

ADELAIDE - ALICE SPRINGS

TOWN	CODE		GX580 DAILY EST	PICK-UP AND SET-DOWN POINT
ADELAIDE	ADL	Dep	6.00P	Greyhound Terminal, 85 Franklin St
Cavan	CAV		6.20P	Bus Stop 26, Port Wakefield Road
Bolivar	BLV		6.30P	Caltex Service Station
Port Wakefield	PWF		7.25P	BP Service Station, 26 Snowtown Rd.
Port Pirie	PIR		8.40P	BP Service Station

Port Augusta Meal Break	PUB	Arr	9.45P	Gull Service Station, Lot 8 Highway
		Dep	10.30P	
Port Augusta	PUG		10.50P	Post Office, 50 Commerical Rd
Pimba	PIM	Arr	12.45A	Shell Roadhouse
		Dep	1.00A	
Glendambo	GBO	Arr	2.15A	Shell Roadhouse
		Dep	2.30A	
Bulgunnia Turnoff		BGN	3.35A	Turn Off
Coober Pedy	CPD	Arr	5.15A	Terminal, 52-56 Hutchison St
		Dep	5.50A	
Cadney Park	CDY	Arr	7.30A	Mobil Roadhouse
Marla	MBR		8.20A	Traveller's Rest, Stuart Hwy
			9.05A	
Indulkna Turn Off	IDK		9.35A	Roadside mailbox at turn off
NORTHERN TERRITORY				
Kulgera	KUL		11.00A	Kulgera Roadhouse Hotel, Stuart Hwy
Erldunda	ERL	Arr	11.45A	Desert Oaks Resort, Cnr Stuart & Lassester Hwy
		Dep	12.20P	
ALICE SPRINGS	ASP	Arr	2.30P	Greyhound Terminal, Shop 2/76Todd St

9 How long does the trip from Adelaide to Alice Springs take?

10 How many times during the trip does the bus stop for more than 20 minutes? Where are these stops?

11 Harry joins the bus at Port Augusta to travel to Coober Pedy.
a How long is his bus trip?
b When Harry returns from Coober Pedy he will travel all the way to Adelaide. How long will it take?

12 Ariana and Axel are friends. Ariana lives in Adelaide and Axel lives in Alice Springs. They are planning to meet 'in the middle' to spend the weekend together.
a Where is the closest stop to 'the middle'?
b Taking into account the time of day and when each person would arrive, where would be the best place to meet along this route? Justify your answer.

13 The train from Adelaide to Alice Springs leaves Adelaide at 12:20 p.m. Sunday and arrives in Alice Springs at 1:45 p.m. Monday.
a How long does it take to travel by train from Adelaide to Alice Springs?
b How does this time compare to the bus trip?
c Would you prefer to travel by bus or train from Adelaide to Alice Springs? Justify your answer.

This timetable is for CityCat ferries operating on the Brisbane River. Use it to answer questions **14** to **16**.

Departs Terminal:	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	a.m.	p.m.
Northshore Hamilton	…..	…..	…..	…..	…..	…..	…..	…..	…..
Apollo Wharf	10.25	10.37	10.50	11.02	11.15	11.27	11.40	11.52	12.05
Bretts Wharf	10.28	10.40	10.53	11.05	11.18	11.30	11.43	11.55	12.08
Bulimba	10.34	10.46	10.59	11.11	11.24	11.36	11.49	12.01	12.14
Teneriffe	10.37	10.49	11.02	11.14	11.27	11.39	11.52	12.04	12.17
Hawthorne	10.41	10.53	11.06	11.18	11.31	11.43	11.56	12.08	12.21
New Farm Park	10.46	10.58	11.11	11.23	11.36	11.48	12.01	12.13	12.26
Mowbray Park	10.50	11.02	11.15	11.27	11.40	11.52	12.05	12.17	12.30
Sydney Street	10.53	11.05	11.18	11.30	11.43	11.55	12.08	12.20	12.33
Riverside	11.01	11.13	11.26	11.38	11.51	12.03	12.16	12.28	12.41
QUT Gardens Point	11.09	11.21	11.34	11.46	11.59	12.11	12.24	12.36	12.49
South Bank 2	11.12	11.24	11.37	11.49	12.02	12.14	12.27	12.39	12.52
North Quay	11.16	11.28	11.41	11.53	12.06	12.18	12.31	12.43	12.56
Regatta	11.24	11.36	11.49	12.01	12.14	12.26	12.39	12.51	1.04
Guyatt Park	11.28	11.40	11.53	12.05	12.18	12.30	12.43	12.55	1.08
West End	11.31	11.43	11.56	12.08	12.21	12.33	12.46	12.58	1.11
University of Queensland	11.35	11.47	12.00	12.12	12.25	12.37	12.50	1.02	1.15

Translink © State of Queensland (https://jp.translink.com.au/plan-your-journey/timetables/ferry/t/citycat)

14 How long does the ferry take to travel from Bretts Wharf to South Bank 2?

15 a Phillip needs to be at work in a restaurant at Riverside by 11:30 a.m. What is the latest time he can catch the ferry at Teneriffe?

b After work he travels out to the University of Queensland to meet up with friends. How long does the ferry trip take?

c At the end of the evening he returns home. How long will this trip take if he chooses to go by ferry? Assume the reverse journey will take the same length of time as the forward journey.

d To travel from the University of Queensland to Teneriffe by bus takes approximately 55 minutes. Why might people choose to travel by bus rather than ferry?

16 Why is one part of the timetable grey and one part unshaded?

17 The City Explorer Bus stops at places of interest in the city and operates in Brisbane, Sydney and Melbourne. This is the timetable for the explorer bus in Brisbane.

GPO terminal	9:00	9:45	10:30	11:15	12:00	12:45	1:30	2:15	3:00	3:45	4:30	5:15
City Hall	9:05	9:50	10:35	11:20	12:05	12:50	1:35	2:20	3:05	3:50	4:35	5:20
Treasury Casino Hotel	9:10	9:55	10:40	11:25	12:10	12:55	1:40	2:25	3:10	3:55	4:40	5:25
Riverside Centre	9:15	10:00	10:45	11:30	12:15	1:00	1:45	2:30	3:15	4:00	4:45	5:30
Old Windmill	9:20	10:05	10:50	11:35	12:20	1:05	1:50	2:35	3:20	4:05	4:50	5:35
Transit Centre	9:28	10:13	10:58	11:43	12:28	1:13	1:58	2:43	3:28	4:13	4:58	5:43
Suncorp Stadium	9:32	10:17	11:02	11:47	12:32	1:17	2:02	2:47	3:32	4:17	5:02	5:47
Regatta Hotel	9:45	10:30	11:15	12:00	12:45	1:30	2:15	3:00	3:45	4:30	5:15	6:00
Park Rd	9:48	10:33	11:18	12:03	12:48	1:33	2:18	3:03	3:48	4:33	5:18	6:03
Cultural Centre	9:54	10:39	11:24	12:09	12:54	1:39	2:24	3:09	3:54	4:39	5:24	6:09
Southbank	10:00	10:45	11:30	12:15	1:00	1:45	2:30	3:15	4:00	4:45	5:30	6:15
Maritime Museum	10:04	10:49	11:34	12:19	1:04	1:49	2:34	3:19	4:04	4:49	5:34	6:19
City lookout	10:10	10:55	11:40	12:25	1:10	1:55	2:40	3:25	4:10	4:55	5:40	6:25
Chinatown	10:20	11:05	11:50	12:35	1:20	2:05	2:50	3:35	4:20	5:05	5:50	6:35
ANZAC Square	10:24	11:09	11:54	12:39	1:24	2:09	2:54	3:39	4:24	5:09	5:54	6:39
GPO terminal	10:30	11:15	12:00	12:45	1:30	2:15	3:00	3:45	4:30	5:15	6:00	6:4

Source: Explorer Bus Tours http://theaustralianexplorer.com.au/

a How many buses are needed to meet the Explorer Bus timetable? Explain how you arrived at your answer.

b Vo, Binh and Vicki arrived at City Hall at 11:42 a.m. They caught the Explorer Bus to Southbank. What is the earliest time they could expect to arrive at Southbank? Explain your answer.

c Manuel and Sofia are dropped off by car at the Riverside Centre at 10:25 am. They arrange to meet their hosts at the City Lookout at 4:30 p.m. They want to spend at least an hour at Suncorp Stadium, ride on the Ferris Wheel at Southbank and do some souvenir shopping at the Maritime Museum. Plan a list of times for them to catch the Explorer Bus to do these things and meet their hosts on time.

d The company is considering introducing an early morning bus starting at the GPO terminal at 8.15 a.m. Write out the timetable for this bus.

PLANNING A TRIP

You are visiting one of the state capitals in Australia. You are going to plan a trip from the airport to the CBD and on to an island off the coast.

1 Choose which capital you are going to visit.

2 You need to travel from the airport to the CBD for your accommodation. Choose a hotel in the capital city to stay at. Find out the best way to travel from the airport to the hotel, how long it will take and what it will cost.

3 You are going to visit one of the islands near the city you have chosen (Stradbroke near Brisbane, Kangaroo near Adelaide or Phillip near Melbourne, for example). Find out how to get there from your hotel (train, bus and/or ferry), how long it will take and what it will cost.

4 Choose another tourist attraction in the capital city and find out how to get there from your hotel.

5 Find out if there any special public transport deals available in the capital city you have chosen that could save you money when you are visiting the city.

10.06 Nature's timetables

Tide charts tell us when high and low tide are along our coastline. There are sunrise and sunset charts, and there are also charts for the phases of the moon.

Alamy Stock Photo/Marc Anderson

EXAMPLE 11

This chart shows information about tides (time and height) and sunrise/sunset times for Cairns over two weeks in October.

Date	High tides				Low tides				Sunrise/sunset	
October	a.m.	m	p.m.	m	a.m.	m	p.m.	m	a.m.	p.m.
Sun 13	4:59	2.02	5:36	2.76	10:50	0.85	11:54	0.77	5:49	6:16
Mon 14	5:53	2.24	6:22	2.85	11:43	0.72			5:49	6:16
Tue 15	6:40	2.45	7:04	2.88	12:30	0.60	12:30	0.63	5:48	6:16
Wed 16	7:24	2.60	7:40	2.84	1:05	0.48	1:12	0.60	5:47	6:17
Thu 17	8:03	2.70	8:11	2.73	1:39	0.41	1:51	0.64	5:46	6:17
Fri 18	8:39	2.74	8:38	2.58	2:13	0.39	2:30	0.74	5:46	6:17
Sat 19	9:13	2.71	9:04	2.40	2:46	0.43	3:08	0.89	5:45	6:17
Sun 20	9:48	2.63	9:31	2.19	3:18	0.53	3:46	1.08	5:45	6:18
Mon 21	10:25	2.50	9:57	1.96	3:50	0.68	4:26	1.29	5:44	6:18
Tue 22	11:05	2.33	10:12	1.75	4:21	0.87	5:10	1.49	5:43	6:18
Wed 23	11:55	2.17			4:49	1.06			5:43	6:19
Thu 24	2:48	2.09			5:19	1.24			5:42	6:19
Fri 25	4:15	1.44	3:57	2.17	1:28	1.35	6:08	1.41	5:42	6:19
Sat 26	4:42	2.26			12:12	1.28	11:56	1.18	5:41	6:20

The following time adjustments may be made for other places near Cairns.

Flinders Island: 22 min after Cairns

Morris Island: 14 min after Cairns

Cruiser Pass: 7 min before Cairns

Euston Reef: 27 min before Cairns

Cape Flattery: 10 min before Cairns

Cape Grenville: 51 min after Cairns

Michaelmas Cay: 11 min before Cairns

Swallows Landing: 2 min after Cairns

Find the time of the second high tide on 17 October in:

a Cairns   **b** Morris Island   **c** Euston Reef

Solution

a Find Oct 17 in the main table, and then the second high tide.

8:11 p.m.

b High tide at Morris Island is 14 min after Cairns.

8:11 p.m. + 14 min = 8:25 p.m.

c High tide at Euston Reef is 27 min before Cairns.

8:11 p.m. – 27 min = 7:44 p.m.

Exercise 10.06 Nature's timetables

1 Use the tide table on page 284 the time of the morning low tide on 21 October in:

    a   Cairns   **b**   Cruiser Pass   **c**   Swallows Landing

2 Find the time of the first high tide on 25 October in:

    a   Cairns   **b**   Flinders Island   **c**   Cape Flattery

3 **a**   On 22 October, calculate how many hours and minutes are between the 2 low tides.

    b   What is the height difference in metres between these low tides?

4 **a**   On 15 October what are the times for sunrise and sunset?

    b   How many hours of daylight are there on this day?

5 Most days have 4 tides. Which days have fewer than 4 tides?

6 **a**   Which day has the earliest sunrise?

    b   What is happening to the time of sunrise over these 14 days?

7 Jacob likes to fish on the 'rising tide', when the tide is changing from low to high.

    a   Approximately when could he go fishing at Cairns on 19 October?

    b   The next day he decides to fish at Cape Grenville. Approximately when could he go?

8 At Michaelmas Cay, boats cannot be launched within one hour of low tide because the water is too shallow. Kylie wants to launch her boat on the afternoon of 16 October. After what time can she launch the boat?

9 **a**   How many hours of daylight are there on 26 October?

    b   What is happening to the hours of sunlight over these 14 days?

10 There also tables for the phases of the moon. Choose a city and find a table of moon phases for this city.

INVESTIGATION

MY NEXT TRIP

You are planning to experience a uniquely Australian attraction for you next holiday:

- see the fairy penguins at Phillip Island at dusk   OR

- see the sun rise over Uluru.

Choose which attraction you will see and plan your trip. Create a PowerPoint or a display book that shows all times, methods of transport and costs.

Share your plans with the rest of the class.

TRAVELLING TO ROTTNEST ISLAND

1 Investigate online the options for travelling to Rottnest Island from where you live. These may be by car, bus, train and/or plane. Google Maps may help.

- Write down all the options and how long each one takes.

- Give a reason why you might choose each of the different options. Consider factors such as time taken, cost, activities you might do on the way, reasons for travelling.

2 Choose 2 places that you could visit, one in Western Australia, one in another part of Australia, and repeat Question 1.

KEYWORD ACTIVITY

Describe each term below in a sentence and match it with one of the photos below:

12-hour time   24-hour time   timeline   time zone   timetable

A

Shutterstock.com/Claudio Divizia

B

Shutterstock.com/Matteo Fes

C

Alamy Stock Photo/BCS

D

Shutterstock.com/Iraidka

E

Thinkstock/Comstock

SOLUTION TO THE CHAPTER PROBLEM

Problem

Daniel needs to be at work by 8:30 a.m. and catches a bus to the station and then a train. The bus stop is 10 minutes from home and the bus trip takes 15 minutes. Buses leave every 15 minutes from 6:00 a.m. The train trip takes 10 minutes and trains leave every 20 minutes from 6:05 a.m. Daniel's workplace is a 5-minute walk from the station. What time does Daniel need to leave home to get to work on time?

Solution

We need to work backwards from 8:30 a.m.

Home 7:35   Bus 7:45   Train 8:05   Station 8:25 Work 8:30
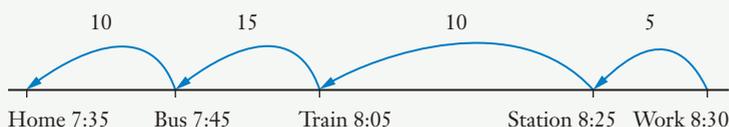
Daniel needs to be at the station at least 5 minutes before 8:30 a.m, that is, at 8:25 a.m. (5 minutes to walk)

Daniel must catch the train by 8:15 a.m. (10-minute train trip)

Trains leave at 6:05 a.m. and then every 20 minutes, so we need to calculate train departure times: 6:05, 6:25, 6:45, 7:05, 7:25, 7:45, 8:05 and 8:25.

Daniel must catch the train at 8:05 a.m.

Daniel must catch the bus by 7:50 a.m. (15-minute bus trip)

Buses leave at 6:00 a.m. and then every 15 minutes, so the bus departure times are 6:00, 6:15, 6:30, 6:45, 7:00, 7:15, 7:30, 7:45 and 8:00.

Daniel must catch the bus at 7:45 a.m.

Daniel must leave home by 7:35 a.m. (10-minute walk to bus stop)

CHECK THE SOLUTION

Daniel leaves home at 7:35, catches the bus at 7:45, arrives at the train station at 8:00, catches the train at 8:05, arrives at 8:15, walks to work and arrives at 8:20, which is before 8:30, so this solution works.

Depending on the reliability of the bus and train, he may choose to leave earlier to be sure to get to work on time.

10. TEST YOURSELF

It's about time

1 Copy and complete each conversion.

    a 720 seconds = _____ minutes

    b 7 weeks = _____ days

    c $4\frac{1}{2}$ years = _____ months

    d 192 hours = _____ days

2 a Arima runs 8 km in 31 minutes and 17 seconds. What time is this in seconds?

    b The *Franken Furniture* Super Sale runs for 96 hours. How many days is this?

3 a Express in 24-hour time:

    i 4:17 a.m.   **ii** 3:25 p.m.   **iii** 10 a.m.

    b Write in 12-hour time:

    i 0615   **ii** 1640   **iii** 2300

4 a A bus leaves Perth at 0945 and arrives at Geraldton at 1555.
How long is the bus trip?

    b Janine works as a paramedic. Her shift starts at 2300 and ends at 0600.
She has 4 callouts during her shift – at 2325, 0048, 0215 and 0450.

      i How long is her shift?

      ii How long was it between the last 2 callouts?

      iii The callout at 0048 required transport to hospital which took 25 minutes.
What time did Janine arrive at the hospital?

5 a Calculate the time difference between 11:15 a.m. and 3:40 p.m.

    b What time was it 3 hours and 5 minutes before 2:30 p.m.?

6 a Lalaja has a stopover at New Delhi airport from 1015 to 1505. How long will
she be at the airport?

    b Keith wants to record a film screening on TV for 2 hours 40 minutes.
He sets the recorder to start at 8 p.m. What time should he set it to finish?

    c In January 2017, Maya had been paying off her car monthly for 22 months.
In what month and year did she start paying off the car?

7 Use the map of Australian time zones on page 266 to answer these questions.

    a Name one city in Australia that is ahead of the time where you live.

    b If it is 11.30 a.m. in Perth, what time is it Brisbane?

    c If it is 3.15 p.m. in Innisfail, Qld, what time is it in Adelaide, SA?

8 Use the train timetable from Example 10 on page 268.

a Anthony catches the 8.25 a.m. train from Seaforth to Perth. What time does he arrive in the city?

b The Kane family are travelling from Gosnells to Victoria Park to catch up with friends. They have planned to meet at 9 a.m. What train should they catch from Gosnells?

c The Kane family want to be home by 5.30 p.m. What train should they catch from Victoria Park?

9 Use the bus timetable from Exercise 10.05 on page 271.

a Carmel is travelling from Alice Springs to Coober Pedy. How long will her trip take?

b Mick joins the bus at Port Augusta to travel to Marla. What time will he arrive in Marla?

c On the trip from Alice Springs to Adelaide the bus has long stops in Kulgera, Coober Pedy and Port Augusta. Give a possible reason for these longer breaks.

10 Use the ferry timetable from Exercise 10.05 on page 273.

a How long does the ferry take to travel from New Farm Park to the University of Queensland?

b Nate lives near Apollo Wharf and starts work near Riverside at 12 noon. What is the latest time he can catch the ferry and not be late?

11 Use the tide chart from Example 11 on page 276.

a At what time is the morning low tide at Michaelmas Cay on 19 October?

b How many hours of daylight are there on 24 October?

c On October 16, what is the difference in hours and minutes between the 2 high tides?

d What is the height difference in metres between these high tides?

PERCENTAGES

11.

APPLYING PERCENTAGES

Chapter problem

Aron buys some bedroom furniture on a store finance arrangement. The bedroom furniture costs $3200. The store finance will charge him 17% p.a. interest and expects him to pay it off monthly over 3 years. How much will Aron have to pay each month?
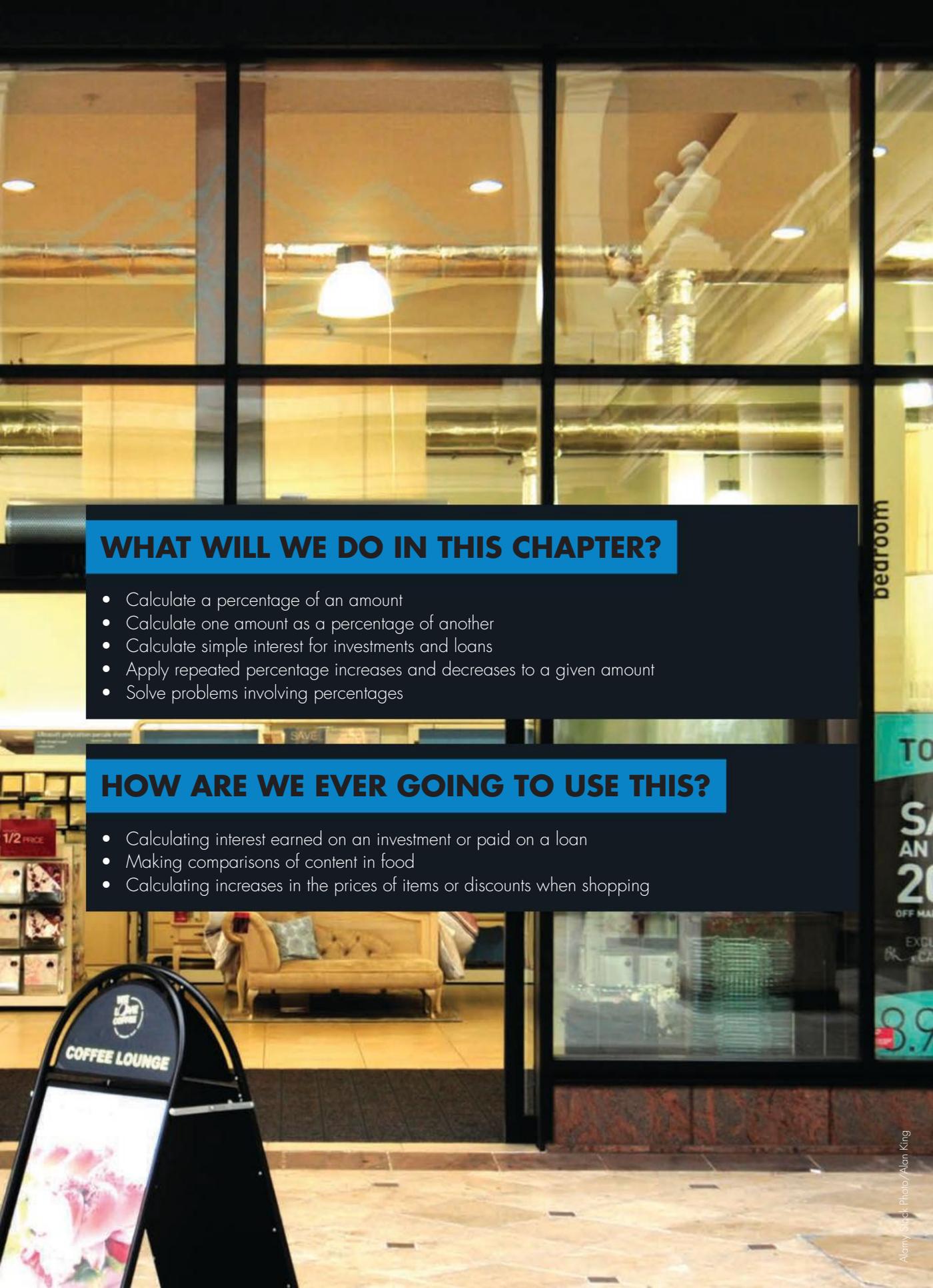
WHAT WILL WE DO IN THIS CHAPTER?

- Calculate a percentage of an amount
- Calculate one amount as a percentage of another
- Calculate simple interest for investments and loans
- Apply repeated percentage increases and decreases to a given amount
- Solve problems involving percentages

HOW ARE WE EVER GOING TO USE THIS?

- Calculating interest earned on an investment or paid on a loan
- Making comparisons of content in food
- Calculating increases in the prices of items or discounts when shopping

11.01 Finding a percentage of a quantity

Remember from Chapter 2, *Giving 110%*:

$$\text{Percentage of a quantity} = \frac{\text{Percentage}}{100} \times \text{quantity} \qquad \text{OR}$$

$$= \text{Percentage} \div 100 \times \text{quantity}$$

EXAMPLE 1

Find:

a   74% of $63

b   40% of 2 km ◄──── 'of' means multiply.

Solution

a   Write the percentage as a decimal (or fraction) and then multiply by the quantity.

$74\% \text{ of } \$63 = 0.74 \times \$63$
$= \$46.62$

b   First convert 2 km to metres.

$2 \text{ km} = 2 \times 1000 = 2000 \text{ m}$

Calculate the percentage.

$40\% \text{ of } 2 \text{ km} = 0.4 \times 2000 \text{ m}$
$= 800 \text{ m}$

Exercise 11.01 Finding a percentage of a quantity

1 Find:

a   12% of $125

b   50% of 88 000 people

c   7.5% of 14 kg

d   27% of 3000 letters

e   62.5% of 1200 m^2

f   150% of 32 L

g   71% of 84 600

h   5% of 120 mins

i   0.4% of $5270

j $6\frac{1}{4}$% of 960 people

2 Kelly went to Hong Kong for 28 days for a holiday. It rained on 25% of the days.

a   On how many days did it rain during Kelly's holiday?

b   How many days were fine?

3 In July, 93 700 new cars were sold in Australia. 27% of these were sold in Victoria. How many new cars were sold in Victoria in July?

4 Josephine earns $97.50 per week from her part-time job. She decides to save 30% of her income so she can go on holiday at the end of Year 12.

a   How much does she save each week? Round your answer to the nearest dollar.

b   Josephine is given a 2.5% wage increase. How much extra does she earn each week? Round your answer to the nearest cent.

5 Brandon pays $225 per week in rent for his share of a house. The landlord decides to increase the rent by 4%.

   a How much extra rent will Brandon have to pay?

   b What is the total amount of rent he will have to pay?

6 At Vanna's school, 85% of Year 11 students have a smartphone. There are 133 students in Year 11. How many have smartphones? Give your answer correct to the nearest whole number.

7 Will buys stationery for his business at *Office Perks*. He has to pay 10% GST on all items. Find the amount of GST he pays on items with a pre-tax value of $391.

8 New vehicle registration duty is a tax paid to the state government when you purchase a new car. It is 3.5% of the purchase price of the car. Simone buys a new car for $30 990. How much new vehicle registration duty will she pay?

9 An aircraft can seat 350 passengers. The plane flies from Brisbane to Perth with 82% of seats occupied. How many passengers were on the plane?

Shutterstock.com/Matej Kastelic

10 Australia has approximately 800 000 km of roads. Approximately 40.5% of Australian roads are sealed with bitumen or concrete. All other roads are gravel, sand or dirt.

   a How many kilometres of Australian roads are sealed?

   b Of the roads that are *not* sealed, approximately 66% are improved surfaces. How many kilometres of improved surface roads are there?

11 a Approximately 30% of Australians suffer from arachnophobia, the fear of spiders. In a school of 1200 students, how many students would you expect to suffer from arachnophobia?

   b Necrophobia is the fear of death. When Kara interviewed 700 people, she found 28% of them had a fear of death. How many of the people Kara interviewed suffer from necrophobia?

12 This pie graph shows the percentages of each blood type in the Australian population of 24 835 000. Calculate the number of people with each blood type.

Blood types in Australia
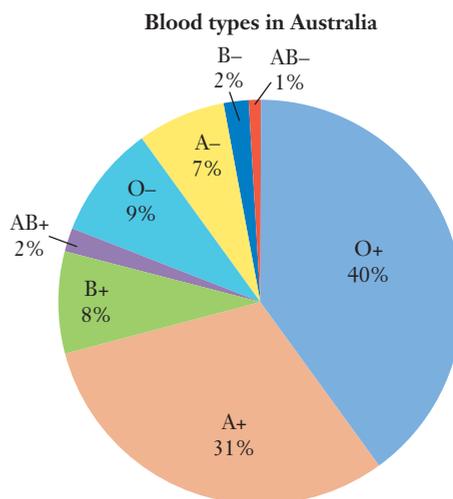
INVESTIGATION

BLOOD TYPES AROUND THE WORLD

Is the percentage of people with the different blood types the same in all countries and continents?

What you have to do

Choose a country from each region below and research the percentages of people in the country that have each blood type.

– Europe	– South America
– Asia	– Africa
– North America	– Middle East

Copy and complete the table below to summarise your results. For each country, write in the percentages of each blood type. Add some extra countries of your choice if you like.

Country	A+	B+	AB+	O+	A–	B–	AB–	O–

Write a paragraph describing the similarities and differences in the percentages of blood types between different countries. How do other countries compare with Australia?

11.02 Comparing quantities using percentages

$$\text{Percentage} = \frac{\text{amount}}{\text{whole amount}} \times 100\% \qquad \text{OR}$$
$$= \text{amount} \div \text{whole amount} \times 100\%$$

EXAMPLE 2

Express a test mark of 27 out of 45 as a percentage.

Solution

Write the result as a fraction and multiply by 100%. $\frac{27}{45} \times 100\% = 60\%$

Sometimes we have to change the units so they are the same before we can find the percentage.

EXAMPLE 3

What percentage of 2 days is 12 hours? ← If you are having trouble knowing which amount to write on the bottom of the fraction, look for the number following the 'of'.

Solution

Change 2 days into hours.

$2 \text{ days} = 2 \times 24 \text{ hours}$
$= 48 \text{ hours}$

Write as a fraction and multiply by 100%.

$\frac{12}{48} \times 100 = 25\%$

Write your answer.

12 hours is 25% of 2 days.

Exercise 11.02 Comparing quantities using percentages

1 Express each test mark as a percentage.

    a   17 out of 20   **b**   51 out of 60

    c   14 out of 35   **d**   105 out of 140

2 Eliza scored the following test marks for her Year 11 exams.

    English: 43 out of 80   Science: 26 out of 40

    Mathematics: 69 out of 85   Business Studies: 59 out of 70

    Design: 38 out of 65   Health: 34 out of 45

    a   Calculate each test mark as a percentage. Give your answers correct to 2 decimal places.

    b   Rank Eliza's achievement in subjects from highest to lowest.

3 Over the last 3 basketball matches Tiago was successful with 18 shots out of 33 attempts, while Luke was successful with 23 shots out of 37 attempts.

    Who was more successful? Justify your answer.

Alamy Stock Photo/Image Source

4 Which food has the higher percentage of sugar in it?

    •   Muesli bars with 11 g of sugar in a 35 g bar   or

    •   Jam with 9.8 g of sugar in a 20 g serving

5 Colombia has an area of 1 141 748 km^2, of which 100 210 km^2 is water.

    Iran has an area of 1 648 195 km^2, of which 116 600 km^2 is water.

    a   Calculate the percentage of water for each country. Give your answer correct to 2 decimal places.

    b   Which country has a higher percentage of water?

    c   Why might the percentage of water be important?

6 Write the first quantity as a percentage of the second. Remember to express both quantities in the same units first.

    a   3 minutes, 1 hour   **b**   75 mm, 20 cm

    c   400 g, 32 kg   **d**   18 hours, 3 days

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7 Jo exercises at the local gym 3 times a week. The table shows how much time Jo spent swimming and her total exercise time for her 3 visits last week.

	Swimming	Total exercise time
Monday	20 minutes	1 hour 10 minutes
Wednesday	35 minutes	1 hours 40 minutes
Saturday	45 minutes	2 hours 30 minutes

    a Calculate the percentage of exercise time spent swimming on each visit. Give your answers correct to one decimal place.

    b On which day did Joanne spend the highest percentage of her time swimming?

    c Calculate the percentage of exercise time spent swimming for the week.

8 Which of the following cocktails has the higher percentage of alcohol?

    A 750 mL of alcohol in a jug of 3 L   or

    B 320 mL of alcohol in a bottle of 1.2 L

9 Two Australian batsmen score at the following rates:

    • Clarkson hit 82 runs off 68 balls

    • Bailden hit 48 runs off 38 balls

    a Calculate the strike rate for each batsman, ⟵ $\text{Strike rate} = \dfrac{\text{Runs}}{\text{Balls}} \times 100$ correct to 1 decimal place.

    b Who is the better batsman based on these figures?

10 Which state has the higher rate of stamp duty payable on new cars?

    • Victoria, $1968 stamp duty on a car purchase of $41 000

    • Western Australia, $522.50 stamp duty on a car purchase of $19 000

STAMP DUTY WHEN BUYING A HOUSE

When you buy a house, you pay the state government a tax called stamp duty. In this investigation, you will find out the different rates for stamp duty in Australia.

What you have to do

- Search the Internet for an online calculator for stamp duty for house purchases.

- Suppose you are buying a $300 000 home and you are not a first home buyer. Use the online calculator to find the amount of stamp duty paid for each state/territory in Australia. Write this information down.

- Calculate the percentage rate used in each state/territory.

$$\text{Rate} = \frac{\text{stamp duty}}{\text{home price}} \times 100\%$$

- Which state/territory has the lowest stamp duty? Which has the highest?

- What is the difference between the lowest and the highest stamp duty?

- Why do you think the states and territories charge different amounts of stamp duty?

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11.03 Simple interest

Interest is the money we earn when we invest with a bank, credit union or other financial institution. It can also be extra money paid back when we take out a loan.

With **simple interest** (or **flat rate** interest), the interest earned or paid is a percentage of the **principal**, the original amount invested or borrowed.

Simple interest formula

$$I = Prn$$

Sometimes this formula is written $I = \dfrac{Prn}{100}$, where r is a percentage (not a decimal).

where I = interest earned or paid

P = principal (what you invest or borrow)

r = **interest rate** per time period, as a decimal

n = number of time periods

EXAMPLE 4

Maurice invested $2000 at 3.25% p.a. simple interest for 3 years.

p.a. = **per annum** = per year. The interest rate is for a whole year.

a How much interest will he earn?

b How much will he have altogether at the end of 3 years?

Solution

a In the simple interest formula $I = Pin$,

$P = 2000$, $r = 3.25\% = 0.0325$, $n = 3$.

$I = 2000 \times 0.0325 \times 3$

$= 195$

Maurice will earn $195 in simple interest.

b At the end of 3 years, Maurice will have his original investment plus the interest.

Total $= \$2000 + \$195$

$= \$2195$

Maurice will have $2195 altogether.

Sometimes money is not invested or borrowed for a whole number of years.
We need to make sure the interest rate and the time period match!

> ### EXAMPLE 5
>
> Ruby borrowed $5600 at 3.9% p.a. for 18 months. How much interest did she have to pay?
>
> #### Solution
>
> When the interest rate is p.a. (years), the time must also be in years. Change 18 months to years by dividing by 12.
>
> $$I = 5600 \times 0.039 \times \frac{18}{12}$$
> $$= 327.6$$
>
> In the simple interest formula $I = Prn$,
>
> Ruby paid $327.60 interest.
>
> $P = 5600$, $r = 0.039$, $n = \dfrac{18}{12}$ years

We can change the interest rate from a yearly rate (p.a.) to a rate for any other time period.

Divide the annual rate by:

- 52 for a weekly rate
- 26 for a fortnightly rate
- 12 for a monthly rate
- 4 for a **quarterly** rate (3 months)
- 2 for a six-monthly rate

> ### EXAMPLE 6
>
> What percentage interest rate per month is equivalent to 5.16% p.a.?
>
> #### Solution
>
> Divide the annual rate by 12 to change it to a monthly rate.
>
> $5.16\% \div 12 = 0.43\%$
>
> 5.16% p.a. is equivalent to 0.43% per month.

Exercise 11.03 Simple interest

Example 4

1 Calculate the simple interest for each investment.

   a $2400 at 5% p.a. for 6 years   **b** $750 at 4% p.a. for 2 years

   c $700 at 6.2% p.a. for 3 years   **d** $520 at 4.2% p.a. for 5 years

   e $4200 at 7% p.a. for $3\frac{1}{2}$ years   **f** $3400 at 4.85% p.a. for $2\frac{1}{2}$ years

   g $750 at 3.1% p.a. for $1\frac{1}{2}$ years   **h** $14 900 at 2.4% p.a. for 5.75 years

2 Nicole borrowed $2400 from a finance company for 2 years at 18% p.a. interest.

   a How much interest did she have to pay?

   b How much, including interest, did Nicole have to repay the finance company?

3 Carlos invested $1500 in an account paying 4.5% for 3 years.

   a How much interest did he earn?

   b How much, including interest, did Carlos have in his account at the end of 3 years?

4 What is the simple interest on each investment?

   a $1080 at 5% p.a. for 16 months

   b $475 at 2% p.a. for 5 months

   c $940 at 3.25% p.a. for 18 months

   d $4700 at 4.7% p.a. for 17 months

   e $12 560 at 7.05% p.a. for 6 months

   f $1560 at $4\frac{1}{2}$% p.a. for 3 months

> Remember to make the units match! The p.a. in the interest rate means the time must be in years.

> Example **5**

5 Rodney won $500 as part of his prize for being the 'Apprentice of the Year'. He invested it for 1 month at 4.5% p.a. interest. How much does he have after 1 month?

6 What percentage interest rate per month is equivalent to 4.68% p.a.?

> Example **6**

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7 The NSM Bank offers investors 8.4% p.a. simple interest. Express, correct to 4 decimal places (where necessary), this rate of interest as a:

   a monthly rate   **b** weekly rate   **c** 6-monthly rate

   d daily rate   **e** fortnightly rate **f** quarterly rate (3-monthly rate)

8 Yolanda invests $3000 with the NSM Bank using their 8.4% p.a. simple interest offer. Find the interest she earns if she invests her money for:

   a 4 months   **b** 21 weeks   **c** 6 months   **d** 45 days

   e 32 weeks (equal to 16 fortnights)   **f** 9 months (equal to 3 quarters)

9 Jeremy owed $365 on his credit card. The credit card company charged him one month's interest at 22% p.a.

   a How much interest was he charged?

   b Calculate the total amount he had to repay the credit card company.

11.04 Simple interest problems

Simple interest is also called **flat-rate interest** because, unlike compound interest, the same amount of interest is paid or earned each year or time period.

EXAMPLE 7

Melinda borrowed $24 500 for 3 years from NelsonNet Finance to buy a car.
The interest rate is 9.5% p.a. flat.

a How much interest will Melinda pay?

b How much will Melinda pay the finance company to repay the loan?

c Melinda is going to repay the loan over 5 years. How much will she have to pay each month?

Solution

a $P = 24\,500, r = 0.095, n = 3$

$I = 24\,500 \times 0.095 \times 3$
$= 6982.5$

Melinda will pay $6982.50 interest.

b Melinda has to repay the amount she borrowed plus the interest.

$24\,500 + \$6982.50 = \$31\,482.50$

Melinda will pay $31 482.50 to repay the loan.

c First calculate how many months there are in 5 years by multiplying by 12.

$5 \times 12 = 60$ months

The total amount must be repaid over 60 monthly payments.

$31\,482.50 \div 60 = \$524.708\,33...$
$\approx \$524.71$

Melinda has to pay $524.71 each month.

> To ensure that the loan is paid off completely, round *up* to the nearest cent when calculating the size of each payment.

Exercise 11.04 Simple interest problems

1 Vanessa borrowed $30 000 from a finance company to set up a catering business. She agreed to repay the money in monthly instalments over 5 years at 12% p.a. flat rate.

    a How much interest will Vanessa have to pay?

    b Calculate the total amount she must repay.

    c How much must Vanessa repay each month?

2 Samir has just finished his apprenticeship and wants to borrow $1500 to buy tools. The bank offers him the money over 2 years at 8.7% p.a. flat rate interest, provided he makes monthly repayments.

    a How much interest will Samir be charged?

    b How much will Samir owe the bank company altogether?

    c Calculate the value of his monthly repayments.

Shutterstock.com/Andrey Armyagov

3 The Great Aussie Credit Union pays higher interest rates for large investments.

    a Donna invested the $38 000 she inherited from her great-aunt with the credit union for 2 years. How much interest will she earn?

    b Goran won $54 000 on lotto. He invested his win with the credit union for 18 months.

Balance	Flat interest rate
$1–$4999	3.00% p.a.
$5000–$9999	3.50% p.a.
$10 000–$19 999	4.00% p.a.
$20 000–$49 999	4.75% p.a.
$50 000 and over	5.50% p.a.

        i How much interest will he earn?

        ii How much money will be in the account at the end of the 18 months?

        iii He decides to live on this money for the next 2 years. How much per month will he have to live on?

    c Lauren saved $5750 from her part-time job at the supermarket.

        i How much interest will she earn if she invests it with the credit union for 9 months?

        ii Will she able to afford a holiday costing $5900? Justify your answer.

4 Sophie signed the contract to buy a new house before she sold her apartment. Six weeks later she needed to borrow $250 000 urgently to pay for the house as she hadn't sold her apartment. Banks have 'bridging finance' for this purpose. Sophie borrowed the money for 6 months at 15% p.a. Calculate the interest Sophie had to pay.

5 Angelo and Trish need $650 000 bridging finance for 3 months. The bank's interest rate for this is 11.5% p.a.

    a   Calculate the interest they will have to pay.

    b   Find the total amount they will have to repay.

    c   During the three months they sell their current home for $575 000. How much will they still owe the bank?

6 Denise wants to buy a ride-on mower for her lawn-mowing business. The mower costs $9495 and she is offered a $700 trade-in on her old mower. The store offers her terms over 3 years at 7.4% p.a. flat rate interest after a deposit of $2500.

    a   How much will Denise owe after she trades in her old mower?

    b   How much will she owe after she pays the deposit?

    c   How much interest will she be charged?

    d   Calculate the total amount Denise must repay in instalments.

    e   What is the amount of each monthly repayment?

7 When Jonny borrowed $18 000 from a finance company, he was charged 9% p.a. simple interest.

    a   How much interest did he pay in one year?

    b   His total interest bill was $6480. For how long did Jonny borrow the money?

8 When Yusuf borrowed $15 000, he was charged 7.8% p.a. simple interest. Including interest, Yusuf repaid $20 850. For how many years did Yusuf borrow the money?

9 Vanessa borrowed $12 000 from a finance company for 2 years. Including interest, she repaid the company $14 400.

    a   How much interest did Vanessa pay per year?

    b   Calculate the rate of simple interest p.a. the company charged her.

$$\text{Rate} = \frac{\text{Interest for one year}}{\text{Amount borrowed}} \times 100\%$$

10 Calculate the flat rate of interest p.a. being charged on each loan, using the same method as you used in question 9.

	Amount borrowed	Amount repaid (including interest)	Term (Length of the loan)
a	$30 000	$37 650	3 years
b	$14 600	$16 628	2 years
c	$12 300	$15 744	5 years
d	$45 000	$56 340	3.5 years

Chapter problem

You've covered the skills required to solve the chapter problem. Can you solve it now?

INVESTIGATION

SIMPLE INTEREST INVESTMENTS

We can construct a spreadsheet to calculate the simple interest earned on investments.

	A	B	C	D	E	F	G
1	**Simple interest calculations**						
2							
3	Enter the principal in F3					3500	
4	Enter the annual interest as a decimal rate in F4					0.05	
5	Enter the length of the investment in years in F5					3	
6							
7							
8		Interest earned =		525			
9		Total in the account =		4025			
10							
11							

1 Create a spreadsheet as shown above, except for the 2 values in column D.

2 What formulas should you enter in cells D8 and D9?

3 Enter these formulas and calculate the **Interest earned** and **Total in the account** for different values.

4 Change the values in column F to see how it affects the interest earned. Try small amounts and large amounts of money. Try low interest rates and high interest rates. Try a short time and a long time.

11.05 Percentage after percentage

In some situations we may need to calculate one percentage after another, for example, buying something on sale with an additional discount for cash or for paying your bill in a certain time. In this situation, we need to remember to do each percentage calculation separately.

EXAMPLE 8

Joanna purchases a new dress priced at $189 during a '20% off' sale.

a How much discount does she receive on her dress?

b What price does Joanna pay for the dress?

c At the checkout, the shop assistant says there is an additional 5% off the discounted price if she pays cash. How much is this additional discount?

d What is the final price of the dress if Joanna pays cash?

e Is this equal to 25% off the original price? Justify your answer with a calculation.

Solution

a Calculate 20% of $189.

$$\text{Discount} = 0.2 \times \$189$$
$$= \$37.80$$

b Discount price = original price – discount

$$\text{Discount price} = \$189 - \$37.80$$
$$= \$151.20$$

c Calculate 5% of $151.20.

$$\text{Discount} = 0.05 \times \$151.20$$
$$= \$7.56$$

The additional discount is $7.56.

d Final price = discount price – discount

$$\text{Final price} = \$151.20 - \$7.56$$
$$= \$143.64$$

The final price of the dress is $143.64.

e Calculate 25% of $189.

$$0.25 \times \$189 = 47.25$$

Subtract this discount from the original price and compare with $143.64.

$$\$189 - \$47.25 = \$141.75$$

No, $143.64 is not the same as a 25% discount. A 25% discount is larger.

We saw in Example **8** that we can't just add the percentages together and find a single percentage. However, we can find a single percentage that is equivalent to one percentage followed by another.

Dennis' Paints offers a 25% trade discount to builders and a further 5% discount if the account is paid within 10 days. Chris is a builder. He purchased $840 worth of paint and paid the account within 10 days.

a How much did he pay for the paint?

b What single discount is equivalent to a 25% discount followed by a 5% discount?

iStock.com/Squaredpixels

a First, calculate the trade discount.

Trade discount = 25% × $840 = $210

Then calculate the discounted price.

Trade price = $840 − $210 = $630

Then calculate the further discount.

Further discount = 5% × $630

= $31.50

Calculate the final price.

Final price = $630 − $31.50

= $598.50

b Find the total discount.

Total discount = $210 + $31.50

= $241.50

The percentage discount is

$\dfrac{\text{total discount}}{\text{original price}} \times 100\%$

Percentage discount = $\dfrac{\$241.50}{\$840} \times 100$

= 28.75%

Exercise 11.05 Percentage after percentage

1 Brody buys a dinner suit costing $720 for his formal. The suit shop has a special formal price of 15% off and offers a further 5% off if Brody pays in cash.

   a How much discount does Brody receive for the special formal price?

   b What price does he pay for the suit?

   c Brody decides to pay cash for his suit. By how much more would his suit be discounted?

   d What is the final price of the suit?

   e Is this equal to 20% off the original price? Justify your answer with a calculation.

2 The advertised price for a Luxura car is $75 999. When Angelique visits the car dealership, she is offered an end-of-financial-year deal of 30% discount. If she finalises the deal within 2 days, she is offered an additional 5% discount.

   a What is the price of the Luxura car after the 30% discount?

   b What price would Angelique pay if she finalises the deal in two days?

   c Is this equal to 35% off the original price? Justify your answer with a calculation.

3 NelsonNet News surveyed 2000 people about phone usage while driving. 58% of people interviewed admitted to using the phone while driving. Of these people, 30% believed it was safe to do so.

   a How many people admitted to using the phone while driving?

   b How many people thought it was safe to do?

   c What percentage of the survey group thought it was safe to use the phone while driving?

4 Mainline Electrical offers a 20% trade discount to electricians and a further 5% discount for bills paid by the end of the month. Tina is an electrician. She buys $345 worth of electrical parts and pays her bill before the end of the month.

   a How much did she pay for the electrical parts?

   b What single discount is equivalent to a 20% discount followed by a 5% discount?

5 The Complete Discount Store is having an end-of-year sale, offering 25% off normal prices and a further 10% discount for cash.

   a Simon and Maddy plan to pay cash for a bed that normally sells for $2300.

   How much will they pay during the sale?

   b How much is their total saving?

   c What single percentage discount is equivalent to a 25% discount followed by a 10% discount?

6 On Mad Monday, Sam's Cameras offers 20% off everything in the store plus a further 5% discount on all PAINT brand cameras.

   a Find Sam's Mad Monday price for a PAINT camera usually priced at $730.

   b What single percentage would give the same discount to customers?

7 The Golden Camellia restaurant gives a 15% discount on all takeaway meals. They also give customers with a loyalty card a further 3% discount.

   a Kate and Jon are loyalty card customers. They order takeaway food that would cost $42 in the restaurant. How much did they pay for the meal?

   b What single percentage discount did they get? Give your answer correct to 1 decimal place.

8 Vision Discounts offers 20% off the cost price of TVs. However, it must then add 10% GST to the price.

   a What is the price of a 55 cm TV costing $800 after the discount?

   b What is the final price when the GST is added?

9 TV Deals 4 U add the GST to the cost of the TV and then offer a 20% discount.

   a What is the price of the same television as in Question 8 at TV Deals 4 U?

   b Which deal is cheaper for the customer – discount followed by GST or GST followed by discount? Justify your answer.

10 The population of Nelson Waters increased by 7% in 2017 and by 3.5% in 2018. At the beginning of 2017, the population was 2516. What was the population at the end of 2018?

11 Judy and Keith deposit $10 000 in an investment account for 4 months at 5.5% p.a. interest. At the end of the 4 months they reinvest the $10 000 plus the interest they received for a further 4 months at 4.5% p.a. interest. How much interest have they earned from these 2 investments?

> To calculate the interest for 4 months, write it as a fraction of a year:
> 4 months = $\dfrac{4}{12}$ years.

12 When a casting company advertised for extras to be part of a crowd scene for a movie, 12 400 people applied to be involved. The company rejected 42% of the applicants because they were too young and they rejected 65% of the remainder because they were too tall. How many of the applicants were neither too young nor too tall?

11.06 Percentage problems

In this chapter, we have used various techniques for different types of problems involving percentages. Deciding which technique to use is an important skill.

$$\text{Percentage of a quantity} = \frac{\text{Percentage}}{100} \times \text{quantity} \qquad \text{OR}$$

$$= \text{Percentage} \div 100 \times \text{quantity}$$

$$\text{Finding a percentage} = \frac{\text{amount}}{\text{whole amount}} \times 100\% \qquad \text{OR}$$

$$= \text{amount} \div \text{whole amount} \times 100\%$$

$$\text{Simple interest: } I = Prn$$

For each problem in the following exercise, decide which strategy you will use before you start the question.

Exercise 11.06 Percentage problems

1 Cindy booked an overseas holiday costing $3650. The travel agent offered her a 17% discount if she paid 90 days in advance.

   a How much will Cindy save if she takes advantage of this offer?

   b Cindy decides to pay 90 days in advance. How much will the trip cost her?

2 Damien borrowed $16 000 from a finance company to buy a new car. He was charged 13% p.a. flat rate interest and agreed to pay the loan back over 5 years.

   a How much interest was Damien charged by the company?

   b How much did he repay in total?

   c Damien repaid the loan by making monthly payments. How much did he have to pay each month?

3 Gabrielle owns a fashion shop. When items come into the store, Gabrielle increases the wholesale price by 95%, and then adds another 10% for GST to determine the final selling price.

   a Gabrielle receives a dress costing $140. Calculate the price of the dress without GST.

   b Determine the price of the dress including GST.

   c What price do you think Gabrielle will put on the price tag? Give reasons for your answer.

   d The wholesale price of a suit is $125. What amount, including GST, will Gabrielle write on the price tag?

4 Thomson Valley Council will not approve house plans if the floor area is greater than 40% of the area of the land on which it is to be built. Jackie's block of land is 480 m². What is the floor area of the largest house the council will allow her to build on her block of land?

5 During the summer sales Felicity bought a towel that is normally priced at $48 for $35. What percentage discount did she receive? Answer to the nearest whole percentage.

6 Holly's new lounge cost $3000 and it is depreciating (decreasing) at a rate of 10% per year.

    a How much will the lounge be worth at the end of 1 year?

    b Find the value of Holly's lounge when it is 2 years old.

    c Is this the same as depreciating by 20% of the original price? Justify your answer with a calculation.

7 Xander owns 700 shares in the company Telco. Each share has a market value of $9.50.

    a How much are Xander's shares worth?

    b Telco pays a dividend of 5% of the value of the shares. How much does Xander receive as his dividend?

8 Ken is charged $65 for a visit to the doctor. The Medicare rebate given to Ken is $35.60. What percentage of the doctor's charge is the Medicare rebate? Answer correct to 1 decimal place.

9 Forster Auto Superstore gives customers who pay cash a 5% discount, but it charges customers who pay with a credit card an additional 1.5%. The shop advertised a set of car mats for $60.

    a What is the 'cash price' of the mats?

    b How much will Joe, who pays with a credit card, be charged for the mats?

     11. Applying percentages

10 TVs R Us advertised a TV for $3999. It can be bought with 10% deposit and weekly repayments of $38.75 over two years.

    a   Marco bought the TV this way. How much deposit does he pay?

    b   How much does Marco owe after paying the deposit?

    c   Calculate the amount Marco pays in the weekly repayments.

    d   How much does Marco pay altogether?

    e   How much more than the sale price did Marco pay?

    f   The extra calculated in part **e** is the interest Marco is charged. How much interest was Marco charged for ONE year?

    g   What rate of interest was Marco charged?

$$\text{Interest rate} = \frac{\text{interest charged for 1 year}}{\text{amount owing after deposit is paid}} \times 100\%$$

11 Yvonne owns Bucknall Mining shares valued at $15.20 each. The company pays a dividend of 53 cents per share. What percentage was this dividend of the value of the share? Give your answer correct to 2 decimal places.

> Remember: units in each quantity must be the same!

KEYWORD ACTIVITY

Percentages find-a-word

DEFINITIONS

deposit	depreciate	discount	dividend
flat-rate interest	GST	interest	per annum
principal	repayment	simple interest	stamp duty

    1   For each word in the list, write a definition or explanation of the word and then use it in a sentence showing its meaning.

    2   Read over the exercises in the chapter and write down any words that you are not familiar with. Write a sentence explaining the meaning.

SOLUTION ^{TO}_{THE}
CHAPTER PROBLEM

Problem

Aron buys some bedroom furniture on a store finance arrangement. The bedroom furniture costs $3200. The store finance will charge him 17% p.a. interest and expects him to pay it off monthly over 3 years. How much will Aron have to pay each month?

Solution

We break this problem down into smaller steps:

Calculate the simple interest: Interest = Prn

$$= \$3200 \times 0.17 \times 3$$

$$= \$1632$$

Calculate the total owed: Total repaid = $3200 + $1632

$$= \$4832$$

Calculate the cost per month: In 3 years there are $3 \times 12 = 36$ months.

Payment each month = $4832 ÷ 36

$$\approx \$134.23 \text{ (rounding up)}$$

Check: $134.23 \times 36 = $4832.28 (which is over $4832).

11. TEST YOURSELF

Applying percentages

1 a Mark's pay is $2764.80 per fortnight. He is saving 15% of his pay to buy a new car. How much does he save each fortnight?

b There are 135 students in Year 12 at Nelson Waters High. Approximately 78% of Year 12 have paid for their formal tickets. How many students have paid for their tickets?

2 a When the Jets netball team played on the weekend, Megan shot 23 goals out of 31 attempts and Jasmine shot 33 goals out of 48 attempts.

    i Calculate the success rate for each shooter as a percentage. Give your answer correct to 2 decimal places.

    ii Who was the better shooter on the weekend?

b The Melbourne Storm played the Canberra Raiders in an NRL match. The Storm completed 17 out of 22 tackle sets. The Raiders completed 19 out of 24 tackle sets.

    i Write each completion rate as a percentage. Give your answer correct to the nearest whole number.

    ii Who achieved the better completion rate?

3 a Calculate the simple interest earned on $5100 invested at 3.5% p.a. for 4 years.

b Priya borrowed $13 000 at 7.95% p.a. for 3 years.

    i Calculate the interest Priya will be charged.

    ii What is the total amount she will have to repay?

4 a What is the simple interest payable on $2000 borrowed at 4.25% p.a. for 18 months?

b Janine sells her car for $17 500 and wants to invest the money for 5 months to finance her future travel. The Advantage Bank offers 3.15% p.a. in an investment account. How much interest will Janine earn?

NSM Finance charges 12.5% p.a. simple interest on short term loans. Use this information to answer questions **5** and **6**.

5 Express (correct to 4 decimal places where necessary) this rate of interest as a:

  a monthly rate   **b** weekly rate   **c** 6-monthly rate

6 Neil borrows $7000 from NSM Finance. Find the interest he pays if he borrows the money for:

  a 5 months   **b** 17 weeks   **c** 6 months

7 Madeline borrows $6300 to set up a small business. She is charged 5.2% p.a. simple interest and she takes out the loan for 3 years, repaying what she owes by making equal monthly repayments.

   a How much interest will Madeline have to pay?

   b Calculate the total amount she must repay.

   c How much will Madeline have to pay each month?

8 Vamsee buys a new Volkswagen. The price is $39 900 with a 'model runout' sale discount of 22%. If he buys a display car already in the saleyard he receives a further 5% discount.

   a What is the price of the car after the sale discount?

   b What price does Vamsee pay if he buys a display car?

9 Franken Furniture is having a mid-year sale. All items in the store are 20% off normal prices. Customers who pay in cash are offered a further 10% discount.

   a Joshua and James pay cash for a lounge suite that normally sells for $2599. How much will they pay?

   b How much is their total saving?

   c What single percentage discount is equivalent to a 20% discount followed by a 10% discount?

10 Manuel is charged $304.60 for X-rays of his foot. The Medicare rebate for Manuel is $164.60. What percentage of the charge is the Medicare rebate? Answer correct to 1 decimal place.

11 For tax purposes, equipment bought for a business is depreciated at 20% per year. Stefan buys a photocopier for $3070.

   a Calculate the amount of the depreciation in the first year.

   b What is the photocopier valued at after 1 year?

   c Find the value of the photocopier at the end of the second year.

12.

APPLYING RATES

Chapter problem

Suzie needs to buy some concrete sealer to seal the bricks in her new garden wall. She needs 24 litres and the sealer is available in 4 L and 6 L containers.

$55

concrete sealer

4 L

concrete sealer

$87

6 L
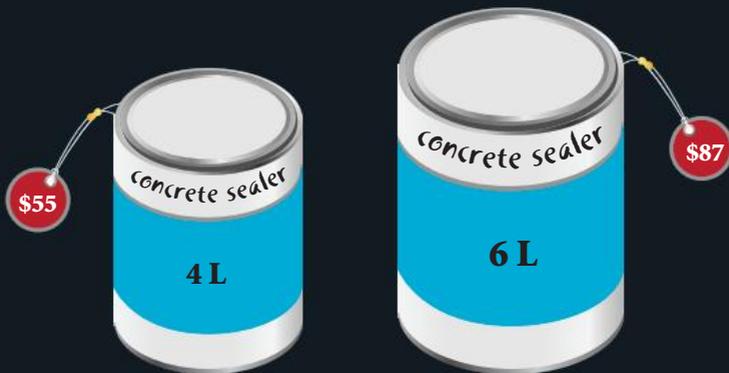
What is the cheapest way for Suzie to buy the sealer?

WHAT WILL WE DO IN THIS CHAPTER?

- Identify and simplify rates
- Convert rates from one pair of units to another, for example, m/s to km/h
- Solve practical problems using rates, including speed, fuel consumption and unit pricing

HOW ARE WE EVER GOING TO USE THIS?

- Comparing prices of different brands of groceries to select the cheapest
- Calculating how long a trip will take if driving at a certain speed
- Determining quantities required for a painting or tiling job
- Calculating the quantity of fuel a car will use on a trip

12.01 Rates

Rates compare 2 different types of quantities.

Unlike ratios, rates have units. We express these as the units of the first quantity **per** unit of the second quantity. 'Per' means 'for each one'.

EXAMPLE 1

Write each situation as a rate.

a Andrew runs 200 m in 25 seconds.

b The fuel for Boris' cultivator costs $35 for 20 L.

Solution

a The units for this rate will be metres per second, or m/s.
Divide the number of metres by the number of seconds.

$$\text{Rate} = \frac{200 \text{ metres}}{25 \text{ seconds}}$$
$$= 8 \text{ m/s}$$

b The units will be dollars per litre.
Divide the number of dollars by the number of litres.

$$\text{Rate} = \frac{\$35}{20 \text{ litres}}$$
$$= \$1.75/\text{L}$$

Exercise 12.01 Rates

Example 1

1 Write each situation as a rate.

a 200 km travelled in 4 hours   **b** 75 words typed in 3 minutes

c 250 L used in 5 hours   **d** $87.50 for 5 kilograms

e 400 m in 55 seconds   **f** $65 earned in $2\frac{1}{2}$ hours

g 500 g in 2 litres   **h** 1800 revolutions in 3 minutes

2 Marcella uses 90 litres of composting manure on her flower bed which has an area of 5 m². What is this as a rate in L/m²?

3 Goran used his sprinklers to water his garden for $2\frac{1}{2}$ hours. He used 3375 litres of water. What is his rate of water use in L/h?

4 Write each situation as a rate.

a 320 L in 8 containers   **b** 10 litres consumed in $2\frac{1}{2}$ days

c 80 g in 15 cm³   **d** $22.40 to hire 7 DVDs

e 175 mm rain in 5 days   **f** 290 km driven using 20 L of petrol

g $20.52 for 1.8 m of curtain material   **h** 768 vibrations in 3 seconds

i 140 sheep on 3.5 hectares of land   **j** $28.44 for 18 L of petrol

5 Dakota used 8 L of stone sealer to seal 72 m^2 of slate. Calculate this rate in m^2/L.

6 John is preparing his budget for his holiday. For his 10-day holiday he is budgeting $1200 for meals. Calculate John's meal budget in $/day.

7 Marcus runs a barbecue for his sports club's market day. He has purchased the food shown in the table. Calculate the cost rate, including units, for each item.

Item	Cost and amount	Cost rate
Sausages	$57.80 for 6.8 kg	**a**
Steak	$93.60 for 7.5 kg	**b**
Onions	$9.80 for 4 kg	**c**
Rolls	$132 for 240 rolls	**d**
Tomato sauce	$19.60 for 8 bottles	**e**

12.02 Converting rates

Sometimes, it is useful to be able to convert rates from one set of units to another. Doing this helps us to compare rates for different circumstances.

WS

Converting rates

WS

More rates

Converting rates from one set of units to another

- Write the rate as a fraction, including its units
- Convert the units on the numerator of the fraction to the new unit
- Convert the units on the denominator of the fraction to the new unit
- Simplify the rate.

EXAMPLE 2

Converting rates

Convert 90 km/h to metres/second (m/s).

Solution

Convert 90 km into metres and 1 hour into seconds.

$$90 \text{ km} = 90 \times 1000 \text{ metres}$$
$$= 90\,000 \text{ m}$$
$$1 \text{ h} = 60 \text{ minutes}$$
$$= 60 \times 60 \text{ seconds}$$
$$= 3600 \text{ s}$$

Divide the number of metres by the number of seconds.

$$90 \text{ km/h} = \frac{90 \text{ km}}{1 \text{ h}}$$
$$= \frac{90\,000 \text{ m}}{3600 \text{ s}}$$

Simplify the rate.

$$= 25 \text{ m/s}$$

EXAMPLE 3

Convert 2.5 g/m^2 to kg/ha.

Solution

Change 2.5 g to kg and 1 m^2 to hectares.

There are 10 000 m^2 in 1 hectare.

$2.5\ g = 2.5 \div 1000\ kg$
$= 0.0025\ kg$
$1\ m^2 = 1 \div 10\ 000$
$= 0.0001\ ha$

Simplify the rate.

$$2.5\ g/m^2 = \frac{2.5\,g}{1\,m^2}$$
$$= \frac{0.0025\ kg}{0.0001\ ha}$$
$$= 25\ kg/ha$$

Exercise 12.02 Converting rates

In this exercise, round answers to one decimal place where needed.

Example 2

1 Convert each speed into m/s.
   a   20 km/h   **b**   50 km/h   **c**   80 km/h   **d**   110 km/h

2 Alice is walking at a rate of 80 metres per minute. What is her speed in:
   a   km/h?   **b**   m/s?

3 Convert each speed to km/h.
   a   12.5 m/s   **b**   2400 m/minute   **c**   3500 m/h

Example 3

4 Joshua fertilises his land at the rate of 4 g/m^2. Express this rate in kg/hectare.

5 A tap leaks at a rate of 30 mL per minute. What is this rate in litres per hour?

6 The steel mesh used in fencing weighs 1.2 kg/m.
   a   Convert this rate to g/mm.
   b   Convert this rate to tonnes/km.
   c   What do you notice about the answers to parts **a** and **b**?
   d   What is the rate in g/cm?

7 Jesse pumps water from his dam to irrigate his market gardens. The pump delivers water at a rate of 3.5 kL/hour. Express this rate as:
   a   L/h   **b**   L/min   **c**   L/s.

8 A 5 L container of varnish costs $14.
   a   What is the cost in $/L?   **b**   Express this as a cost in cents/mL.

9 Jamaica's Usain Bolt set the world record for the 100 metre sprint. He ran the distance in 9.58 seconds.

Getty Images / AFP

a Express this as a rate in m/s (to one decimal place).

b Convert this speed to km/h (to 2 decimal places).

10 Sophie is painting her house before attempting to sell it. She uses 2 L of decking oil to paint her 38 m^2 wooden decks and 350 mL of black paint to paint the outside surface of her garden pots, an area of 4.6 m^2. Which surface, the wood deck or the garden pots, uses the larger rate of paint?

12.03 Unit pricing

The government requires supermarkets to display the **unit price** for all items. The unit price makes comparing the prices of different-sized packaging easy.

Best buys puzzle

EXAMPLE 4

Jonathan is calculating the unit price for rolls of paper towels. He has 15 m rolls for $1.65 each and 20 m rolls at $2.40 per roll. He decided to use 1 metre as the comparison unit.

Alamy Stock Photo/RosaireneBetancourt 5

a Calculate the unit price for each roll.

b Which roll is the better value for money?

Solution

a For the 15 m roll, calculate the cost of 1 metre by dividing by 15.

For the 15 m roll:
Unit price = $1.65 ÷ 15
= $0.11/m

For the 20 m roll, calculate the cost of 1 metre by dividing by 20.

For the 20 m roll:
Unit price = $2.40 ÷ 20
= $0.12/m

b The better price is the lower unit price.

The 15 m roll is the better value.

EXAMPLE 5

The same cooking oil is available in two sizes of bottle:

500 mL for $4.75 and 750 mL for $6.45.

a Calculate the unit price for each bottle.

b Which size of bottle is the better value?

> A 'unit' varies depending on the items being compared. It can be any convenient unit; for example, 100 g, 1 L, 100 mL or 1 m.

Solution

a For each bottle, calculate the price for 100 mL.
500 mL is 5×100 mL
Divide the price of the 500 mL bottle by 5.
750 mL is 7.5×100 mL
Divide the price of the 750 mL bottle by 7.5.

Unit price of the 500 mL bottle is:
$4.75 ÷ 5 = 0.95 per 100 mL

Unit price of the 750 mL bottle is:
$6.45 ÷ 7.5 = 0.86 per 100 mL

b The smaller unit price is the better value.

The 750 mL bottle is the better value.

Exercise 12.03 Unit pricing

Example **4**

1 Calculate the price of 1 m of wallpaper for each size roll.
   a   5 m for $11.50   **b**   10 m for $22.00   **c**   20 m for $45.00

2 The same seafood sauce is available in 50 mL bottles for $3.60 and 80 mL bottles for $5.60.
   a For each size of bottle, calculate the price per 10 mL.
   b Which size of bottle is the better value?

3 A box containing 1 dozen eggs costs $4.80 and a box containing 6 eggs is $2.10.
   a Calculate the price per egg in each box.
   b Which size box is the better value?
   c Damien is buying 18 eggs. What is the cheapest way for him to do it?

4 Supermarket signs show the packet price and the unit price for 3 packets of breakfast cereal. Which size packet is the best value for money? Justify your answer.
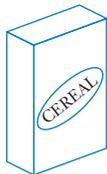
450 g for $4.49
Unit price $1.00 per 100 g

350 g for $3.00
Unit price $0.86 per 100 g

330 g for $4.25
Unit price $1.29 per 100 g

5 Rice is available in 3 different-sized packets:

- 1 kg for $3.50
- 2 kg for $8.00
- 5 kg for $17.99

   a What would be a sensible unit to use for a price comparison?

   b Determine which size packet is the best value.

6 The yellow spice, saffron, is the world's most expensive spice. The price of 1 g of saffron is 3 times the price of 1 g of 24 carat gold.
Carmen is ordering some saffron online.

Example **5**

| 2 g for $290 | 2.5 g for $350 | 5 g for $695 | 7.5 g for $1065 |

   a Calculate the unit (1 g) price for each size.

   b Carmen is going to order 7.5 g. What is the cheapest way for her to do it?

7 Breakfast biscuit cereal QBix are on special because the 'use before date' is only 5 weeks away. A box containing 24 biscuits is priced at $4.56 and a box containing 48 biscuits is $8.64.

Mae likes to have one biscuit for breakfast on most days. Which size box do you recommend she buy?

8 Hair shampoo is available in 2 sizes of bottle:

- 750 mL for $8.95
- 1 L for $11.50

Which size bottle is the better value? Justify your answer.

Chapter problem

You've covered the skills required to solve the chapter problem. Can you solve it now?

12.04 Rate problems

To solve problems involving rates, we either **multiply** or **divide** by the rate:

- Identify the rate and express the units of the rate as a fraction (e.g. $\dfrac{km}{h}$).
- To find the numerator of the fraction, multiply by the rate.
- To find the denominator of the fraction, divide by the rate.

EXAMPLE 6

Noah hires a small car for $42 per day. How much will the hire cost be if Noah keeps the car for 16 days?

Solution

The rate is $42/day. We can express the units as $\dfrac{\$}{day}$. To find the number of dollars, which is the numerator of the fraction, multiply by the rate.

Hire cost $= 16$ days $\times \$42$/day
$= \$672$

Check that the answer is realistic, then write the answer.

It will cost Noah $672 to hire the car for 16 days.

EXAMPLE 7

Amy sends the fruit she grows on her farm to market in cartons that hold 12 kg of fruit per carton. How many cartons will she need to pack 180 kg of fruit?

Solution

The rate is 12 kg/carton. The units are $\dfrac{kg}{carton}$.

To find the number of cartons, which is the denominator, divide by the rate.

Number of cartons
$= 180$ kg $\div 12$ kg/carton
$= 15$ cartons

Check and write the answer.

Amy will need 15 cartons.

Exercise 12.04 Rate problems

1 Lizzie plants tomato seedlings in rows at a rate of 28 seedlings per row. How many seedlings are there in:

a 4 rows?   **b** 7 rows?   **c** 12 rows?

Example
6

2 Jayden earns $12.40/h as a barista in a cafe. How much is he paid for working 20 hours?

3 Kane proudly claims that he can hike at an average rate of 5 km/h even in difficult conditions. At this rate, how long will it take him to hike:

a 15 km?   **b** $7\frac{1}{2}$ km?   **c** 24 km?

Example
7

4 Mandarins cost $3.20/kg. How many kilograms of mandarins can Peter buy for $20?

5 Danielle is growing nectarine trees. She can expect a yield of 80 kg of fruit per tree.

a How many kilograms of nectarines can Danielle expect to produce if she plants 9 trees?

b How many trees would Danielle need to plant if she wanted to produce 1200 kg of nectarines?

6 A plane flies at a speed of 840 km/h.

a How far does the plane travel in $6\frac{1}{2}$ hours?

b Calculate how long it would take the plane to fly from Melbourne to each city, given their distances. Answer in hours correct to one decimal place.

     i Brisbane: 1670 km

     ii Auckland, New Zealand: 2626 km

     iii Perth: 3430 km

     iv Los Angeles, USA: 12 773 km

> We will solve more speed problems in Chapter 15, *Going places*, using a formula for speed.

7 The yields Maxine achieves from different vegetable crops are shown below.

Crop	Yield (vegetables/m²)
Beetroot	40
Lettuce	18
Cabbage	8

a How many beetroots can Maxine expect to get from her 24 m² beetroot plot?

b How many lettuces will she grow in her 15 m² plot?

c What area does she need to grow 450 lettuces?

d What area does she need to grow 760 cabbages?

8 Aaron uses fertiliser on his farm at a rate of 24 kg/hectare. How many kilograms of fertiliser does he require to cover 32 hectares?

9 A dripping tap leaks water at the rate of 25 mL/minute.

a How much water will leak from the tap in 30 minutes?

b How much water will be lost in 1 hour?

> Remember, there are 60 minutes in an hour.

c Convert your answer to part **b** to litres.

d How many litres will be lost in 24 hours?

e How many minutes will it take for the tap to leak 1 litre of water?

> Remember, there are 1000 mL in 1 L.

f How many hours will it take for the tap to leak 60 L of water?

10 Vijay is saving to purchase a car. He can save $400 per week.

a How much can Vijay save in 20 weeks?

b The car he wants costs $14 000. How long will it take Vijay to save this amount?

c A newer car is available but it costs $15 200. How much longer would it take Vijay to save for this car?

11 Chloe earns $24.50/h as a secretary. How many hours will she need to work to earn:

a $441? **b** $857.50? **c** $588?

12 Elise wants to hang curtains on 12 windows in her house. Each window requires 1.8 metres of material, which costs $12.50 per metre.

a How many metres of material will Elise need for all 12 windows?

b How much will it cost?

c Elise has budgeted only $225 for the material. How many metres of material can she buy if she sticks to this budget?

d How many windows can she curtain in this situation?

13 Jacob uses a small aircraft to do crop dusting. His plane uses fuel at a rate of 28 litres per hour. In one week, Jacob flew his plane for 18 hours.

a How many litres of fuel did Jacob use that week?

b That week, aviation fuel cost $2.25/L. How much was his fuel bill for the week?

c Jacob charges $124/h when he is crop dusting. How much did he charge for the week crop dusting?

d In a different week, Jacob had only 420 litres of fuel available. How many hours could he fly in that week?

12.05 Fuel consumption

The **fuel consumption** of a vehicle is the amount of fuel the vehicle uses per distance travelled. It depends on many factors, including the size and efficiency of the engine, the mass of the vehicle and whether it is driven on city or country roads.

Fuel consumption is a rate expressed as the number of litres used per 100 km travelled (L/100 km). The lower the rate, the less fuel the vehicle uses.

Fuel consumption

$$\text{Fuel consumption} = \frac{\text{fuel used in L}}{\text{distance travelled in km}} \times 100$$

For example, the fuel consumption for a Honda Jazz GLi is 5.8 L/100 km, and for the much larger V6 Holden Commodore it is 9.8 L/100 km.

There are 3 types of fuel consumption questions.

- What is the fuel consumption rate in L/100 km? Divide the fuel used by the distance travelled and multiply by 100.

- How much fuel will the car use? To find litres (L), multiply by the rate.

- How far can the car go? To find km travelled, divide by the rate.

EXAMPLE 8

The dashboard computer in Sue's car shows that over the last 5000 km travelled the car used fuel at a rate of 6.9 L/100 km.

a How much fuel did Sue's car use in the last 5000 km?

b At an average price of $1.55/L, how much did the petrol to travel 5000 km cost?

Solution

a Express 6.9 L/100 km as $\dfrac{6.9\ \text{L}}{100\ \text{km}}$

To find litres, multiply by the rate.

$\text{Fuel consumption} = \dfrac{6.9\ \text{L}}{100\ \text{km}} = 0.069\ \text{L/km}$

$\text{Fuel used} = 5000\ \text{km} \times 0.069\ \text{L/km}$
$= 345\ \text{L}$

b Express $1.55/L as $\dfrac{\$1.55}{\text{L}}$

To find cost ($), multiply by the rate.

$\text{Cost} = 345\ \text{L} \times \$1.55/\text{L}$
$= \$534.75$

EXAMPLE 9

Jesse bought a second-hand car. This week, he travelled 425 km and used 32 L of fuel. Calculate correct to one decimal place the car's fuel consumption in L/100 km.

Solution

$$\text{Fuel consumption} = \frac{\text{fuel used in L}}{\text{distance travelled in km}} \times 100$$

$$\begin{aligned}\text{Fuel consumption} &= 32 \text{ L} \div 425 \text{ km} \times 100 \\ &= 7.5294... \\ &\approx 7.5 \text{ L/100 km.}\end{aligned}$$

EXAMPLE 10

Saskia's car has a fuel consumption rate of 7.1 L/100 km. How far (to the nearest kilometre) can the car travel on 60 L of fuel?

Solution

Express 7.1 L/100 km as $\dfrac{7.1 \text{ L}}{100 \text{ km}}$
To find km, divide the fuel used by the rate.

$$\text{Fuel consumption} = \frac{7.1 \text{ L}}{100 \text{ km}} = 0.071 \text{ L/km}$$

$$\begin{aligned}\text{Distance} &= 60 \text{ L} \div 0.071 \text{ L/km} \\ &= 845.0704... \\ &\approx 845 \text{ km}\end{aligned}$$

Exercise 12.05 Fuel consumption

1 The petrol consumption rate of Jack's car is 5.9 L/100 km.

    a How many litres of petrol will the car use on a 850 km trip?

    b How much will the fuel cost for the trip if petrol costs $1.60/L?

2 Tia's old Holden used 25 L of fuel to travel 180 km. Calculate the car's fuel consumption in L/100 km.

3 Jeff's VW Golf uses diesel fuel. It has a fuel consumption rate of 6.1 L/100 km. How far can Jeff travel on 50 litres of diesel fuel?

4 Charles used 18 L of petrol to drive 190 km. Calculate his car's fuel consumption in L/100 km.

5 A motoring website tested the fuel consumption for a number of SUV vehicles by measuring the fuel consumed for the same 790 km journey. Calculate the fuel consumption of each vehicle correct to one decimal place.

	Vehicle	Litres of fuel used
a	Kia SUV	80.1
b	BMW	69.9
c	Toyota Rav4	67.2
d	Subaru Outback	57.7
e	Range Rover	61.6

6 Carol's second-hand Toyota Camry uses 7.5 L/100 km. The petrol tank holds 60 litres of fuel. How far can Carol travel on one tank of petrol?

7 To save fuel, the motor in Lisa's SUV turns itself off when the car stops in traffic. With this fuel-saving option turned on, the car uses 8.9 L/100 km, but with it turned off, it uses 10.0 L/100 km. Each week, Lisa travels 650 km.

    a How much less fuel per week does Lisa use with the fuel-saving option turned on?

    b At an average price of $1.50/L, how much does Lisa save by turning on the fuel-saving option?

8 Alistair's Lexus Sport uses premium fuel (98 petrol) with a fuel consumption of 11.1 litres per 100 km.

    a How much petrol will his car use on a 425 km trip to the vineyards? Answer correct to the nearest litre.

    b Calculate the cost of fuel for the journey at $1.75 per litre.

9 Josh lives on a large property. He uses a ride-on mower to cut the grass, but he's heard that ride-on mowers use much more fuel than a hand mower and he's concerned about the effect on the environment. He decided to investigate. He divided his biggest paddock into two equivalent sections and mowed one with a ride-on and the other with a hand mower. He summarised the results in a table.

Method	Fuel usage rate	Time taken
Hand mower	600 mL/h	3 hours
Ride-on mower	3.6 L/h	30 minutes

a Calculate the actual amount of fuel Josh used to mow each section.

b Which method of cutting the grass would you recommend Josh use? Why?

10 Tara's chainsaw uses fuel depending on the hardness of the wood she is cutting. When cutting large gum trees, it uses fuel at a rate of 310 mL in 45 minutes.

a Calculate this fuel usage in L/h. Answer correct to one decimal place.

b Tara estimates that it will take her 8 hours to cut up a large gum tree. How much fuel will Tara require?

c Tara only has 3 L of fuel. How long will she be able to use the chainsaw?

KEYWORD ACTIVITY

CLUELESS CROSSWORD

Copy this crossword and position the keywords from this chapter in the crossword. Then write a set of clues for your crossword.

COMPARISON	CONVERT	FUEL CONSUMPTION	PER
RATE	SPEED	TIME	UNIT PRICING
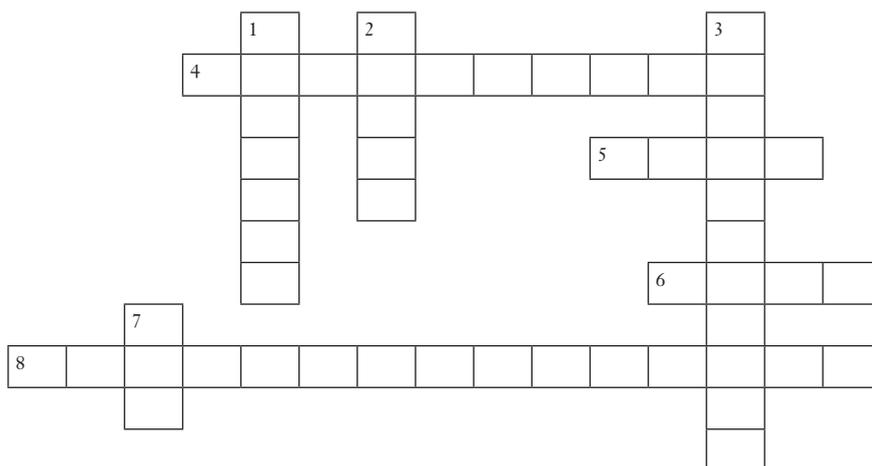
SOLUTION ^{TO}_{THE} CHAPTER PROBLEM

Problem

Suzie needs to buy some concrete sealer to seal the bricks in her new garden wall. She needs 24 litres and the sealer is available in 4 L and 6 L containers.
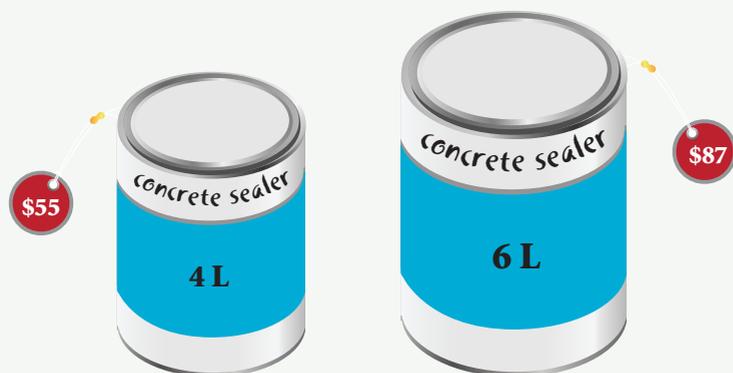
What is the cheapest way for Suzie to buy the sealer?

Solution

Cost of one 4 L container is $55.

Cost of one 6 L container is $87.

Calculate the cost per litre for each container

Cost per litre in the 4 L container = $55 ÷ 4

$$= \$13.75$$

Cost per litre in the 6 L container = $87 ÷ 6

$$= \$14.50$$

It is cheaper to buy the sealer in 4 litre containers, so 6×4 L containers.

Qz
Practice quiz

Applying rates

Exercise 12.01

1 An electrician charged $160 for $2\frac{1}{2}$ hours work. Calculate her rate in dollars/hour.

2 Convert a speed of 75 km/h into m/s. Answer to one decimal place.

Exercise 12.02

3 The Earth travels at approximately 30 km/s in its orbit around the Sun.
What is this speed in km/h?

Exercise 12.02

4 The same brand of olive oil is available in 3 sizes.

	Size	Cost
Small	375 mL	$5
Medium	750 mL	$8
Large	1 L	$13

Exercise 12.03

    a Calculate the cost per 100 mL in each size.

    b Which size is the best value for money?

Exercise 12.04

5 Denis charges $55/m^2 to lay marble tiles. How much will he charge for laying 42 m^2 of marble tiles?

Exercise 12.04

6 A plumber charges a $50 callout fee which includes the first 15 minutes. For calls longer than 15 minutes, he charges an additional $28 per 15 minutes or part thereof.
How much will the plumber charge for a callout that takes 45 minutes?

Exercise 12.04

7 Olivia has been offered a new job. She has to choose her pay rate:
$36.50 per hour or a flat rate of $1400 per week.
In the job, Olivia will be working 40 hours per week. Which pay rate is the better deal?

Exercise 12.05

8 Kim is comparing the fuel consumption of her 2 cars.

Car	Distance travelled	Fuel used
White car	620 km	53 L
Red car	470 km	43 L

    a Calculate the rate at which both cars used fuel in L/100 km. Answer to one decimal place.

    b Which car is the more fuel-efficient?

Practice set 3

Section A   Multiple-choice questions

For each question, select the correct answer **A**, **B**, **C** or **D**.

1 The cost of sending a parcel weighing 5.5 kg to Malaysia is $88.
What is the postage rate?

  A $0.07/kg   **B** $1.60/kg

  C $16/kg   **D** $484/kg

2 What is the time difference between 10:42 a.m. and 2:13 p.m.?

  A   3 h 31 min   **B**   4 h 55 min

  C   8 h 29 min   **D**   12 h 55 min

3 Calculate the simple interest earned on $600 at 5% p.a. for 4 years.

  A $20   **B** $30   **C** $120   **D** $3000

4 Which of the following is NOT numerical data?

  A   The number of shoes each student owns

  B   The average temperature for each month in 2017

  C   Rainfall data for Whyalla measured in millimetres

  D   The star ratings given by the audience of a movie from 1 star to 5 stars

5 Ursula lives in Canberra and rings her friend in Perth at 1:15 p.m.
What time is it in Perth? (The map on page 266 of Chapter 10 may help)

  A   11:15 a.m.   **B**   12.45 p.m.

  C   1:45 p.m.   **D**   3:15 p.m.

6 Which of these graphs is the best for graphing the maximum temperatures each day for a fortnight in Darwin?

  A   Column graph   **B**   Dot plot

  C   Frequency histogram   **D**   Stem-and-leaf plot

7 Danielle invests $4300 at 3% p.a. for 6 months simple interest. How much money will she have at the end of 6 months?

  A $774   **B** $4305.38

  C $4364.50   **D** $5074

8 Cat food is sold in 4 different packages.

Which pack has the cheapest price per 100 g?

A Pack 1: 24 × 250 g cans for $39.99

B Pack 2: 12 × 300 g cans for $24.99

C Pack 3: 9 × 400 g cans for $25.99

D Pack 4: 6 × 1 kg cans for $38.50

9 Use the tide chart in Chapter 10 on page 276 to determine how long it is between the 2 low tides on Tuesday 22nd.

A   1 h 7 min   **B**   1 h 11 min

C   11 h 7 min   **D**   12 h 49 min

10 The Great Gals store is having a new year sale and is offering 27% off all appliances and a further 10% off if you buy the display model in the store. Ali wants to buy a new washing machine. He chooses a 10 kg top load machine with a marked price of $968. What will he pay if he buys the display model?

A $609.84   **B** $635.98

C $706.64   **D** $871.20

Section B   Short-answer questions

1 Identify the outlier(s) in this data set showing the number of goals scored in each game of the season by a local soccer team.

2	1	0	0	7	2	3	2	4
3	2	9	1	2	1	2	4	3

2 Copy and complete each conversion.

a   4 weeks = _____ days

b   84 months = _____ years

c   108 hours = _____ days

d   22 weeks = _____ fortnights

3 A die was rolled 20 times and the number recorded:

| 5 | 2 | 3 | 4 | 2 | 2 | 6 | 2 | 6 | 3 |
| 5 | 1 | 4 | 1 | 2 | 5 | 6 | 2 | 4 | 1 |

- **a** Draw a dot plot for this data.
- **b** How many times was a number greater than 3 rolled?
- **c** What percentage of rolls resulted in a 1 or a 2?

4 Marika is saving for a holiday. So far she has saved $3500. She invests this money for 6 months at a simple interest rate of 4.5% p.a.

- **a** How much interest will she earn?
- **b** How much will she have in total after 6 months?

5 Peter walks to school each day. It takes him 20 minutes to walk 1500 m. Find his walking speed in:

- **a** metres per minute
- **b** kilometres per hour

6 Klaus wants to record a movie on TV. The movie starts at 2130 and lasts for $2\frac{1}{2}$ hours.

- **a** What is 2130 in 12-hour time?
- **b** What time should Klaus set for his finish time? Allow an extra 15 minutes for the recording.

7 *Franken Furniture* buys a lounge suite from its supplier for $2300. The store adds a 60% mark-up to obtain the selling price, then 10% of the selling price must be added for GST.

- **a** Calculate the selling price of the lounge suite.
- **b** Calculate the price including GST.
- **c** In a stocktake sale in June, the lounge suite is discounted by 30%. Find its discounted selling price.

8 In order to improve customer service, NelsonNetBank recorded the waiting times in minutes per customer at one of its biggest branches.

14	11	12	7	6	13	12	21	11	6	13
11	7	3	8	11	10	8	9	7	9	11
10	5	14	12	12	10	13	14	9	15	9
12	7	22	8	9	12	7	6	9		

a Copy and complete this frequency table for the data.

Waiting time	Tally	Frequency
1–5		
6–10		
11–15		
16–20		
21–25		

b On how many occasions was the waiting time from 11 to 15 minutes?

c What percentage of customers waited more than 20 minutes? Answer correct to 1 decimal place.

9 A tap drips water at a rate of 18 mL/h. How much water is wasted from these drips over a week?

10 Use the train timetable from Chapter 10 on pages 268–269.

a Anna catches the 7:57 a.m. train from Gosnells to go to work near Oats Street. What time will she arrive at Oats Street?

b Scott lives in Sherwood. He goes to Cannington to work. He is allowed to arrive any time between 7 a.m. and 9 a.m. What times could he catch the train?

c Deidre catches the 5:07 p.m. train from Perth. What time can she arrive at Seaforth?

11 Judy's car uses diesel fuel. It has a fuel consumption rate of 7.4 L/100 km.

a How far can Judy travel on 50 litres of diesel fuel? Answer to the nearest 5 km.

b Diesel costs 129.9c/L. How much does it cost Judy to put 50 L of diesel fuel into her car?

12 60 Year 11 students were asked 'What is your favourite winter Olympic sport?' Their answers were coded as follows:

I = ice skating, S = speed skating, H = ice hockey, B = bobsled, D = downhill events

These were the results of the survey:

```
I  S  H  B  H  B  D  S  H  B  S  B  I  D  S
H  H  D  B  H  I  D  S  H  H  B  B  H  S  I
B  H  B  B  S  I  D  H  B  S  H  H  B  I  H
B  D  I  H  S  S  D  S  I  B  H  B  S  H  H
```

a Complete a frequency table for this data.

b Draw a column graph for this data.

c What is the most popular winter sport amongst these Year 11 students?

13 Rayna borrowed $26 000 from a finance company to start a small business. She was charged 5.2% p.a. simple interest and agreed to pay the loan back over 5 years.

a How much interest was Rayna charged by the company?

b How much did she repay in total?

c Rayna repaid the loan by making monthly payments. How much did she have to pay each month?

14 a A cricket match starts in Sydney at 4 p.m. What time is this in:

    i Adelaide?   **ii** Perth?

The map on p.266 may help.

b An AFL match starts in Darwin at 11.30 a.m. What time is this in:

    i Mt Isa, Queensland?   **ii** Broome?

15 Alex has the following test marks for his Year 11 exams:

English: 62 out of 80   Physics: 29 out of 40

Mathematics Methods: 46 out of 85   Geography: 47 out of 70

Engineering Studies: 57 out of 65   Visual Arts: 31 out of 45

a Calculate each test mark as a percentage. Give your answers correct to 2 decimal places where necessary.

b On the basis of these results, Alex wants to drop one subject for Year 12 so he can concentrate on his other subjects.

    i Which subject would you recommend that Alex drop? Give a reason.

    ii What other factors should he consider when deciding which subject to drop?

16 A large vat is being filled at the rate of 35 mL/min. Convert this to a rate in L/day.

13.

IT'S BETTER THAN AVERAGE

Chapter problem

Simone is a journalist with a local newspaper. She is writing an article about the prices of home units in the area. Simone has collected some information on sale prices in recent months:

$395 000	$296 000	$415 000	$479 000	$270 000	$269 000
$410 000	$419 000	$289 000	$375 000	$320 000	$440 000
$170 000	$359 000	$369 000	$825 000	$750 000	$495 000

What type of statistics should Simone use in her article? What other information might her readers be interested in knowing?

WHAT WILL WE DO IN THIS CHAPTER?

- Calculate measures of central tendency of a set of data: the mean, the median and the mode
- Choose the best measure of central tendency to use in different situations
- Identify the effect of outliers on the mean and median of a set of data
- Identify deciles and percentiles in a set of data*
- Describe the spread of a graphed set of data
- Calculate measures of spread of a set of data: the range, the interquartile range and the standard deviation
- Use a spreadsheet to calculate statistical measures
- Investigate misuse of data in the media

HOW ARE WE EVER GOING TO USE THIS?

- To calculate summary statistics to allow comparisons of data
- To understand the different 'averages' and know which is best in different situations
- To determine whether data has been analysed correctly in order to support opinions

13.01 What's the average?

WS

Mean, median, mode 1

WS

Mean, median, mode 2

Sets of data are often too big to understand just by looking at them. We need to analyse them and one way to do this is to find a typical or central value to represent all of the data.

There are 3 types of **average** or **measures of central tendency**.

Measures of central tendency

- The **mode** is the most common or frequent score(s).
- The **median** is the middle score (or the average of the two middle scores) when the scores are placed in order from smallest to largest.
- The **mean** is calculated by adding all the scores and dividing by the number of scores. This is what most people call the 'average'.

	Features	When is it best to use?
Mean	• Depends on all the scores • Is affected by extreme scores (outliers)	• When the data set does NOT have many extreme scores (outliers). • Not suitable for categorical data.
Median	• Can be one of the scores • Is not affected by extreme scores	• When the data set has extreme scores (outliers). • Not suitable for categorical data.
Mode	• May be more than one mode, or no mode at all • Is not affected by extreme scores	• Always used for categorical data. • When the most common score is needed.

EXAMPLE 1

The following data shows the daily maximum temperature (in °C) for 15 days in Ceduna, South Australia in November.

| 22 | 25 | 24 | 35 | 22 | 25 | 24 | 20 |
| 23 | 29 | 33 | 32 | 30 | 25 | 21 | |

For this set of data find:

a the mode   **b** the median   **c** the mean

Which measure best represents the data?

Solution

a 25 occurs 3 times, which is more than the number of times any other temperature occurs.

Mode is 25°C.

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b Put the scores in order.

20, 21, 22, 22, 23, 24, 24, 25, 25, 25, 29, 30, 32, 33, 35

There are 15 scores, so the middle one will be the 8th score.

20, 21, 22, 22, 23, 24, 24, (25), 25, 25, 29, 30, 32, 33, 35

Median is 25°C.

c Add all the scores and divide by 15

$$\frac{390}{15} = 26$$

Mean = 26°C.

There aren't any outliers in this data set, so the mean best represents the data.

EXAMPLE 2

Find the mode for each set of data.

a   3 3 4 5 5 6 7 9 10

b   1 2 3 5 7 10

Sometimes there is more than one mode and sometimes there is no mode at all!

Solution

a   Both 3 and 5 occur twice.

The modes are 3 and 5.

b   All scores occur only once.

There is no mode for this data.

EXAMPLE 3

Find the median for this set of data: 68 81 64 57 95 62

When you have an even number of scores in the data, there are 2 middle scores. To find the median, you average the 2 middle scores.

Solution

Arrange the scores in order.

57 62 64 68 81 95

There are two middle scores.

57 62 (64)(68) 81 95

Find the average of the two middle scores by adding them up and dividing by 2.

$$\frac{64 + 68}{2} = 66$$

The median is 66.

Exercise 13.01 What's the average?

Example 1

1 The scores in a class test were:

$$8 \; 9 \; 7 \; 7 \; 10 \; 5 \; 9 \; 10 \; 9 \; 8 \; 9 \; 6 \; 7$$

  a What is the mode for this data?

  b What is the median? ← Remember to put the scores in order.

  c What is the mean?

  Which measure best represents the data?

Example 2

2 What is the mode for each of set of data?

  a 6 9 2 1 2 9 2

  b 67 43 89 45 54 86 45 76 54

  c 12 3 6 5 8 2 7 1

  d blue, green, yellow, green, blue, red, green, yellow, red, green, red, blue

  e heart, spade, spade, diamond, spade, club, heart, heart, diamond, spade

Example 3

3 Find the median for each set of data.

  a 12 17 14 15 16 16 18   **b** 36 40 38 37 40 30

  c 64.1 100 99.2 71.4 91.5 60.8 72.9   **d** 74 50 0 27 14 99 51 66

4 Last week a security company recorded the number of minutes it took one of their security guards, Leon, to respond to each alarm call. The results were:

$$6 \; 12 \; 13 \; 7 \; 26 \; 10 \; 13 \; 9$$

  a How many alarm calls did Leon respond to last week?

  b What is the mode of this data?

  c What is Leon's median response time?

  d Calculate his mean response time.

  e Which of the 3 measures of central tendency most accurately describes the typical response time? Justify your answer.

5 This table shows the number of people who breached their bail conditions in a city over one year.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
19	17	14	12	13	14	12	14	10	11	14	16

For this set of data find:

  a the median

  b the mode

  c the mean (correct to 1 decimal place).

In which months were the number of people breaching bail conditions the highest? Suggest a reason for this.

6 This is the data for the same offence of breaching bail conditions in a country region over one year.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
7	9	7	6	3	4	5	3	2	1	1	4

For this set of data find:

a the median

b the mode

c the mean (correct to 1 decimal place)

7 a What are the differences in the statistics for questions **5** and **6**? Suggest a reason for these differences.

b What are the similarities in the statistics for questions **5** and **6**? Suggest a reason for these similarities.

8 Skye and her dad are having an argument about the number of phone calls Skye makes each night. The data are shown in this table.

Day	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Number of phone calls	9	3	6	2	13	1	1

a Find the mode, the median and the mean for this data.

b Which of these measures of central tendency could Dad use to demonstrate that Skye makes too many phone calls? Explain your answer.

c Which of these measures could Skye use to show that she doesn't make many calls? Explain your answer.

d Which of the three measures gives the best indication of the typical number of calls Skye makes each night? Justify your answer.

9 Andrea asked 50 students how many text messages they sent within the last 2 hours.

a What is the mode for this data?

b Copy and complete the above table.

c Use the formula Mean =

$$\frac{\text{Total of (score} \times \text{frequency)}}{\text{Total of frequency}}$$

to calculate the mean for this data.

No. of text messages (Score)	Frequency	Score × frequency
0	8	$0 \times 8 = 0$
1	4	$1 \times 4 = 4$
2	10	
3	10	
4	15	
5	3	
Total	50	

> You can also use your calculator or a spreadsheet to calculate the mean from a table.

10 Centrelink officers want to encourage jobseekers to keep applying for jobs. They recorded how many jobs each person applied for before they received their first job interview.

Score	Frequency
1	2
2	5
3	10
4	6
5	11
6	13
7	3

   a How many people were surveyed?

   b What is the mode for this data?

   c Copy the table, add a 'score × frequency' column, then complete it.

   d Calculate the mean for this data.

   e Jon applied for 4 jobs and he hasn't got an interview yet. If you were his Centrelink case manager, what could you say to him to encourage him to keep applying for jobs? Mention the mean, mode or median in your answer.

INVESTIGATION

WHAT IS AVERAGE?

Using the Internet, search the word 'average'. Scroll through the results to complete the following questions. You will be looking for articles, blogs and other media uses of the word 'average' – do not use mathematical definitions or maths help websites.

- Find one way the word 'average' has been used in an article. Save it.

- Find a different usage of the word 'average'. Explain the differences and save your work.

- Look for further different uses of the word 'average' and compare them to the first ones you found.

- Make a presentation of your examples and findings and share it with your whole class. Make sure you look at 'Images for average' – pick out your favourites and include them in your presentation.

13.02 What's the outlier?

An **outlier** is a score that is very different from the rest of the data. It can be either much bigger than the other scores or much smaller than the other scores. An outlier can have a significant effect on the mean, but it has no impact on the median.

Exercise 13.02 What's the outlier?

1 This data shows the ages of members of the Binns and Thomson families.

Ages of Binns family: 19 31 21 3 6 14 19 24 11

Ages of the Thomson family: 19 31 21 3 6 14 19 24 91

a Calculate the mean age of each family. Answer correct to one decimal place.

b What is the main difference between these 2 sets of data?

c What effect does the difference identified in part **b** have on the mean?

2 11 houses have been sold in Keswick Street over the last two years. The selling prices are listed below:

| $620 000 | $625 000 | $700 500 | $738 000 | $625 000 | $1 800 000 |
| $598 000 | $612 000 | $696 500 | $720 000 | $705 000 | |

a Find the median sale price for the houses.

b Find the mean sale price.

c Which measure of central tendency best describes the price of the houses in Keswick Street? Justify your answer.

d Which price is the outlier in this data?

e Calculate the mean of the remaining prices when this outlier is removed. Is this mean closer to the median you found in part **a**?

3 Mark and Steve's batting scores for six innings of cricket are shown below.

Mark: 45 48 53 38 32 40 51

Steve: 23 57 6 125 65 5 37

a Calculate the mean score for each player. Answer correct to one decimal place.

b Which player is better if you use the mean?

c Find the median score for each player.

d Which player is better if you use the median?

e Which player would you rather have in your cricket team? Justify your answer.

4 12 people work in a small electronics equipment business. Their annual salaries are:

| $71 000 | $67 000 | $76 000 | $64 000 | $61 000 | $63 000 |
| $72 000 | $66 000 | $73 000 | $70 000 | $275 000 | $890 000 |

a Calculate the mean salary for this company. Answer to the nearest dollar.

b Find the median salary for this company.

c Which measure (mean or median) is the best reflection of a typical salary for this company? Justify your answer.

d If you wanted to attract new employees to the company, which would you advertise as the average salary? Why?

e Which values are outliers in this data?

f Calculate the mean salary of the remaining values if the outliers are removed.

5 Darryl is a market gardener. In the first 5 years of his business, his annual profits were $32 000, $67 000, $71 000, $72 000 and $75 000.

  a Find the mean and the median for this data.

  b Which measure of central tendency gives the most accurate impression of Darryl's usual annual profit? Explain your answer.

  c In what situation might Darryl use the other measure to describe his usual annual profit?

  d Which score is the outlier in this data?

  e Calculate the mean and the median of the remaining scores if the outlier is removed.

6 An obstetrician specialises in providing care for expectant mothers and delivering their babies. The data below shows the number of caesarean deliveries performed by a sample of 20 Australian obstetricians in a 12-month period:

22 38 15 204 3 16 21 13 24 32
19 24 22 31 8 21 14 37 28 21

  a What is the value of the outlier in this set of data?

  b Some people would accuse a doctor who performed a lot of caesarean sections of doing unnecessary operations. Why might one obstetrician need to perform a lot more caesarean deliveries than all the other doctors?

  c Calculate the mean and the median of the 20 values.

  d Calculate the mean and the median without the outlier.

  e What do your answers to parts **c** and **d** show?

7 A property developer has 40 new apartments for sale. The 20 apartments on the first 5 floors are $330 000 each. The 8 apartments on floors 6 and 7 are priced at $380 000, and the 8 apartments on floors 8 and 9 are priced at $425 000. The 3 apartments on the tenth floor are $835 000 each and the penthouse apartment on the top floor is priced at $1.7 million.

  a Determine the median price of the apartments.

  b Calculate the mean price of the apartments.

  c When the developer is advertising the apartments for sale, which 'average' would the developer use? Explain your answer.

  d The developer will be speaking to potential investors in his company. What 'average' might he use to make his company look profitable? Explain your answer.

  e Which price(s) is an outlier in this data?

  f Calculate the mean after removing the outlier(s).

Chapter problem

You've covered the skills required to solve the chapter problem. Can you solve it now?

13.03 Range and interquartile range

Sometimes is it useful to see how the data is spread out. The **range** and the **interquartile range** are both **measures of spread**.

Range = highest score – lowest score

Quartiles divide the data into four equal groups. 25% of the data is in each quartile.

| Lowest score | 1st quartile (Q_1) | 2nd quartile (Q_2) | 3rd quartile (Q_3) | Highest score |
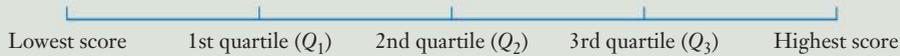
Interquartile range = Upper quartile (Q_3) – lower quartile (Q_1)

50% of the data lies within the interquartile range

EXAMPLE 4

The ages of the 23 people at a café are shown here.

33   23   28   36   27   15   32   18   13   13   38   38

27   7   34   27   12   26   33   21   24   39   20

Find:

a   each quartile

b   the range

c   the interquartile range

Solution

a   Place the ages in ascending order and find the middle score – it is the median but also it is the 2nd quartile.

7, 12, 13, 13, 15, 18, 20, 21, 23, 24, 26, (27), 27, 27, 28, 32, 33, 33, 34, 36, 38, 38, 39

$Q_2 = 27$

The median splits the scores into two halves. Find the middle of each half of the scores. These are the 1st and 3rd quartiles.

7, 12, 13, 13, 15, (18), 20, 21, 23, 24, 26

27, 27, 28, 32, 33, (33), 34, 36, 38, 38, 39

$Q_1 = 18, Q_3 = 33$

The quartiles are 18, 27 and 33.

b   Range = highest score – lowest score

Range = 39 – 7

= 32

c   Interquartile range = 3rd quartile (Q_3) – 1st quartile (Q_1)

Interquartile range = 33 – 18

= 15

Exercise 13.03 Range and interquartile range

Keep your answers to this exercise because you will need them again in Chapter 16, *Comparing data*.

Example 4

1 The number of fish cooked each day at lunchtime in a fish and chip shop during August were:

17   27   28   18   18   17   19   19

25   27   17   19   20   19   21   26

28   18   19   20   17   19   23   24

20   18   17   20   19   27   28

For this data, find:

a the range   **b** each of the quartiles   **c** the interquartile range

2 The daily maximum temperatures (in °C) for 15 days in Cairns in July were:

32   30   31   32   31   30   31   31   31   31   29   25   28   27   29

For this data, find:

a the range   **b** each quartile   **c** the interquartile range

3 The heights of 25 Year 11 students in centimetres were:

151   167   181   172   179   155   159   162   169   174

178   180   158   166   171   168   157   160   175   172

150   169   163   170   176

Find:

a the range   **b** each quartile   **c** the interquartile range

4 A Year 11 class was surveyed to find the number of hours each student spent on homework each week. These are the results:

> If there is an even number of scores, then the quartile is the average of the two middle scores.

4   5   7   8   3   6   9   9   8   4   7   5   3   3   4   9   3   4   7   8

Find:

a the range   **b** each quartile   **c** the interquartile range

5 The monthly number of thefts from retail stores in 2 regions over 2 years are listed below.

Inner City: 13, 13, 13, 12, 16, 25, 23, 20, 33, 25, 27, 25,

   55, 20, 27, 33, 28, 26, 38, 24, 33, 55, 42, 48

Coastal: 62, 60, 52, 62, 52, 63, 60, 65, 74, 61, 36, 66

   36, 69, 70, 47, 39, 64, 69, 55, 40, 60, 58, 52

a For each set of data, find:
   i   the range   **ii**   each quartile   **iii**   the interquartile range
b Comment on the differences between these two sets of data.

6 When Bianca was observing some cases in the traffic court, she recorded the BAC (blood alcohol content) of each person on trial.

0.15	0.09	0.04	0.18	0.00	0.07
0.09	0.00	0.02	0.05	0.12	0.20

a Arrange the data in ascending order.
b Determine the mean, mode, median and range.
c When you arrange the scores into quartiles, how many scores will be in each quarter?
d Calculate the value of the lower quartile and upper quartile boundaries.
e Calculate the interquartile range.
f What fraction of people on trial had alcohol in their bloodstream at the time of their traffic offence?

INVESTIGATION

DECILES AND PERCENTILES*
*Australian curriculum only, not in WA syllabus

Parts of words give us hints about what they mean. Words like 'quad' and 'quart' have something to do with 4. A quadrilateral is a shape with 4 sides, a quad bike has 4 wheels and when a mother has 4 babies at the same time, they are called quadruplets. A quarter is one of 4 equal parts, and when we divide an ordered group into 4 equal subgroups, we are making **quartile** groups.

Words that include 'deci' are about 10. In the decimal number system, we have 10 digits, 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9. When we sort a large, ordered group into 10 equal subgroups, we are making **decile** groups.

Words that have 'cent' in them are about 100, just as there are 100 cents in a dollar. Percent (%) is a value 'out of 100' and a century is 100 years or 100 runs in cricket. Percentile groups are what we get when we sort a large group in order and make 100 equal subgroups.

13. It's better than average

Now imagine that all the students in your school were lined up on the school oval from the shortest to the tallest. Find out how many students there are in your school.

1 If the students were divided into 100 approximately equal groups, how many would be in each group?

2 Each of the 100 groups contains one percent of the whole school.

3 • The height of the tallest person in the shortest group is called the 1st percentile.

  • The height of the tallest person in the second group is called the 2nd percentile.

  • The height of the tallest person in the tallest group is called the 100th percentile.

  Which group do you think you would be in?

4 If the students were divided into 10 approximately equal groups, how many would be in each group?

5 Each of the 10 groups is 10% of the whole group.

  • The height of the tallest person in the shortest group is called the 1st decile.

  • The height of the tallest person in the second group is called the 2nd decile.

  • The height of the tallest person in the tallest group is called the 10th decile.

  Which group do you think you are in?

  In which groups would you expect most of the Year 8 students to fall?

  In which groups would you expect most Year 12 students to fall?

  How many percentile groups are in each decile group?

  How many percentile groups are in one quartile group?

  Why is the 10th percentile same as the 1st decile?

  What percentile is the same as the 9th decile?

13.04 Deciles and percentiles*

*Australian curriculum only, not in WA syllabus

As we discovered in the Investigation, another way of sorting large sets of data into groups is to divide it into decile or percentile groups.

> **Deciles**: values that divide the data into ten equal groups
>
> **Percentiles**: values that divide the data into 100 equal groups

Lowest score	D_1 P_{10}	D_2 P_{20}	D_3 P_{30}	D_4 P_{40}	D_5 P_{50}	D_6 P_{60}	D_7 P_{70}	D_8 P_{80}	D_9 P_{90}	Highest score
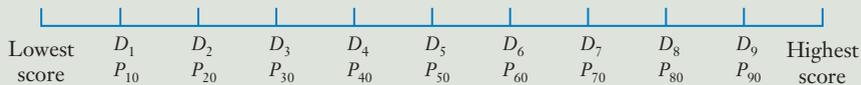
Deciles

While quartiles (Q_1, Q_2 and Q_3) separate data into quarters, **deciles** (D_1, D_2, D_3, D_4, D_5, D_6, D_7, D_8 and D_9) separate data into tenths. 'Deci-' means one-tenth.

- D_1 cuts off the lowest 10% of scores

- D_4 cuts off the lowest 40% of scores

- D_9 cuts off the lowest 90% of scores (or the top 10% of scores)

EXAMPLE 5

This graph shows the changes in annual income over 20 years using the median and the 3rd and 7th deciles.
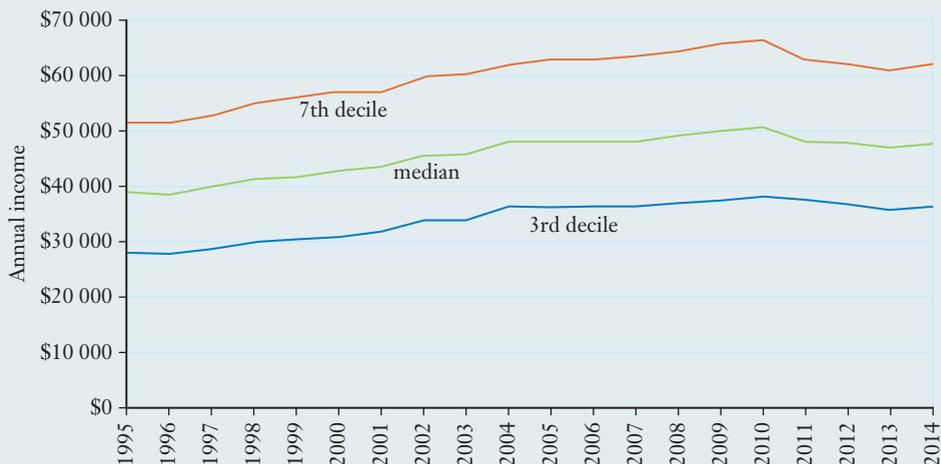
a What decile is the median?

b In 2002, what income was on the 7th decile?

c Grant's annual income in 2008 was above 70% of the population. What was his income?

d Between what two values were the middle 40% of incomes in 1995?

Solution

a The median is the middle. Half of 10 is 5.

The median is the 5th decile.

b Read from the graph to the top line for 2002.

From the graph, approximately $60 000.

c Top 30% means above the 7th percentile. Read from the graph to the top line for 2008.

From the graph, Grant's income was approximately $65 000.

d The middle 40% is between the 3rd and 7th deciles.

In 1995,

- the 3rd decile was approximately $28 000

- the 7th decile was approximately $52 000

So the middle 40% of incomes were between $28 000 and $52 000.

Percentiles

Percentiles $(P_1, P_2, P_3, \ldots, P_{99})$ separate data into hundredths. '**Centi-**' means one-hundredth.

- P_{24} cuts off the lowest 24% of scores

- P_{60} cuts off the lowest 60% of scores

- P_{87} cuts off the lowest 87% of scores (or the top 13% of scores)

EXAMPLE 6

This graph shows the annual income percentiles for last year.
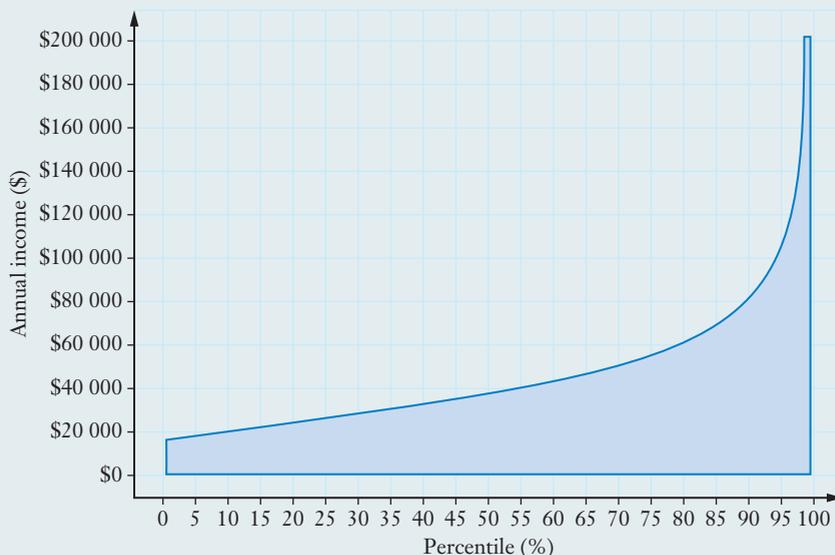
a What income is at the 20th percentile?

b Georgina earns $40 000 per year. What percentile is this?

c What is the approximate difference in income between the 80th and 90th percentiles?

d The graph only goes up to the 99th percentile. Suggest a possible reason for this.

Solution

a Find the 20th percentile on the horizontal axis and read off the value on the vertical axis.

The income is about $26 000.

b Find $40 000 on the vertical axis and read off the value on the horizontal axis.

It is the 54th percentile.

c Find the incomes for the 80th and 90th percentiles.

80th percentile: $64 000

90th percentile: $83 000

Difference means subtract.

Difference: 83 000 − 64 000 = 19 000

The difference in income is approximately $19 000.

d The 100th percentile would have very high incomes.

Including very high incomes makes it difficult, or nearly impossible, to have an appropriate scale on the vertical axis.

Exercise 13.04 Deciles and percentiles

Example 5

1 Use the graph in Example 5 to answer these questions.

   a In 1999, what income was at the 3rd decile?

   b In 2000, what income was at the 5th decile?

   c Indira has an annual income of $50 000. In what year is this at the 5th decile?

   d Between what two values were the middle 40% of incomes in 2014?

   e Harry earns $50 000 per year. In what year(s) does she drop out of the top 50% of the population for income?

Example 6

2 Use the graph in Example 6 to answer these questions.

   a What income is at the 40th percentile?

   b Sue earns $60 000. What percentile is this?

   c What is the approximate difference in income between the 30th and 50th percentiles?

   d What is another name for the 50th percentile?

   e Approximately what percentage of the population earns more than $80 000?

3 This graph shows the results of students on an exam out of 100. The results have been divided into 10 groups.

   a What percentage of students scored 80 or more?

   b Find the value that separates the bottom 70% of students from the top 30%.

   c Krystal's score was on the second decile. What did she score in the exam?

   d Caitlyn scored 75. Between which two deciles did she score?

   e Do you think this exam was easy or difficult? Give reasons for your answer.

4 This graph shows the rainfall in South East Queensland for the 2014–2015 financial year compared to long-term deciles and averages.

Total rainfall for the South East Queensland region: 2014–15

Bureau of Meteorology Australian Government CC BY 3.0 Licence (https://creativecommons.org/licenses/by/3.0/au/)
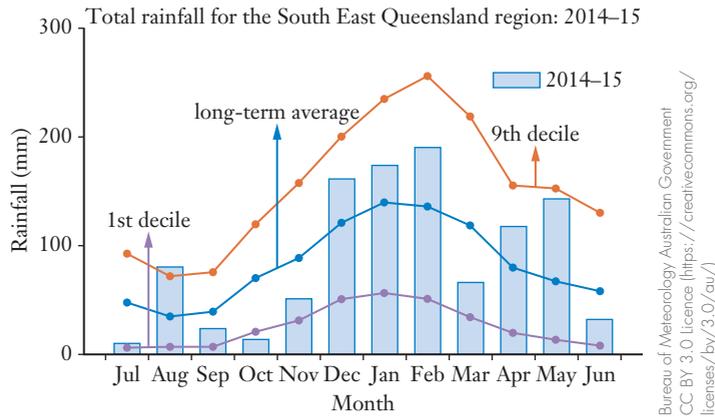
a For how many months of the year was the rainfall below average for the month?

b State the month in which the rainfall was below the 1st decile.

c State the month in which the rainfall was above the 9th decile.

d How often was the rainfall between the long-term average and the 9th decile?

e Was the 2014–2015 financial year a good or poor year for rain? Give reasons for your answer.

5 This percentiles chart shows the range of heights for boys aged 2 to 20.

a Izak is aged 9 and 129 cm tall. What percentage of boys his age are shorter than him?

b Justin is 11 years old and 155 cm tall. What percentage of boys his age are shorter than him?

c A boy's height usually follows the same percentile level as he grows up. How tall should Justin be when he turns 18?

d Liong is 103 cm tall, which is at the 1st decile for boys his age. How old is he?

e Asam is 16 and his height is at the 3rd quartile.

i What is Asam's height now?

ii Predict what Asam's height will be when he turns 20.

Stature-for-age percentiles: Boys, 2 to 20 years
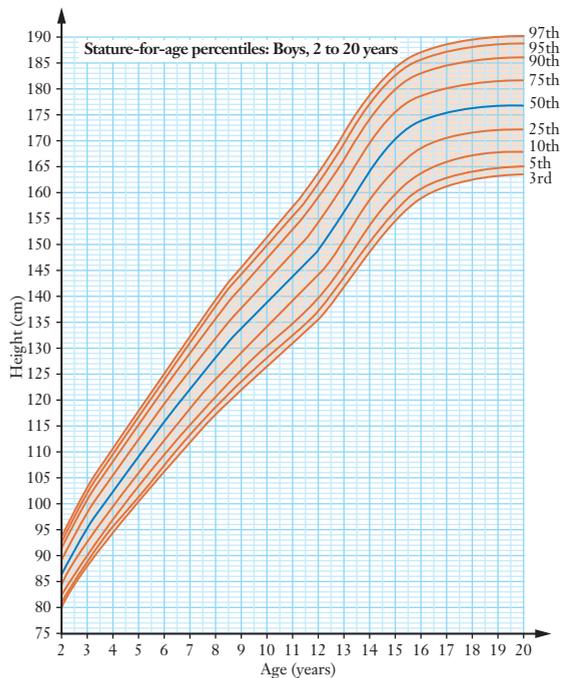
Source: National Center for Health Statistics (US) and National Center for Chronic Disease Prevention and Health Promotion (CDC).

13.05 Describing the spread of data

When we display data on a dot plot, stem-and-leaf plot or histogram, we can make judgements about the spread of the data. Scores can be spread out or clustered or there might be gaps. **Clusters** are where scores are bunched or grouped together.

> ## EXAMPLE 7
>
> Comment on the spread of the scores shown in this dot plot for daily temperatures in Derby in July.
>
>
>
> Temperatures (°C)
>
> ### Solution
>
> | | |
> |---|---|
> | Look for clusters. | These scores are clustered around 31°. |
> | Look for gaps. | There are gaps at the bottom end of the data. |
> | The temperatures range from 25 to 33. | These temperatures are quite spread out. |
> | Write a description. | The temperatures are quite spread out, but they are clustered around 31°. There are gaps towards the bottom end of the data. |
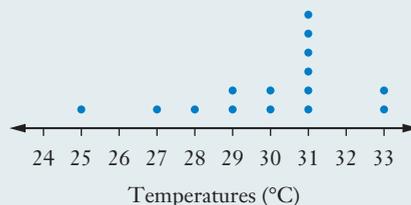
Exercise 13.05 Describing the spread of data

Example 7

1 Ahmed surveyed his class on the number of hours each student spent on the Internet each week. Comment on the spread of the scores shown in this dot plot.

Number of hours
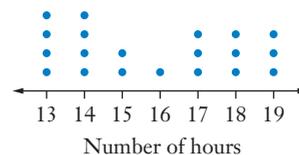
2 This stem-and-leaf plot refers to the monthly number of burglaries per month over the last few years. Describe the spread of scores shown in this data.

Stem	Leaf
3	7 7 8 8
4	1 3 4 4 5 5 6 6 8 9 9
5	1 1 1 2 2 3 3 4 4 5 5 5 8
6	0 2 3 6 6 7
7	0
8	
9	0

3 Ms Thomson gave her class a short quiz. This frequency histogram shows the results.

Marks in the quiz
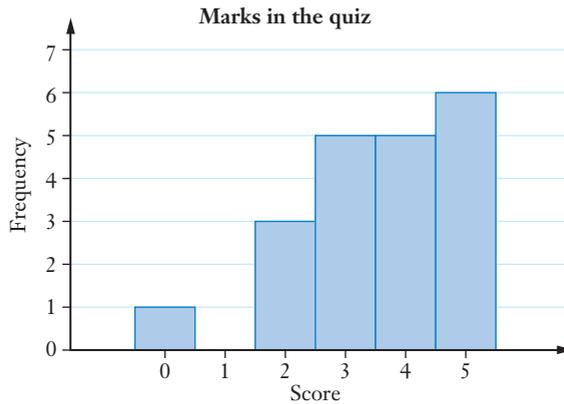
Comment on the spread of the scores.

4 Copy and complete the descriptions of the following sets of data using words from this list.

spread out   tightly-packed   clustered

gaps   more dense   less dense

a This dot plot shows the number of students in each class at St Judy's Primary School.

Class sizes are _____ between 22 and 25.

The class sizes are _____ ___ from 18 to 26.

18 19 20 21 22 23 24 25 26
Number of students in the class
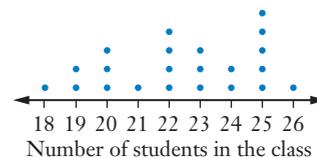
b The ages of people exercising at a gym one evening are shown in the dot plot below.

Ages of gym users
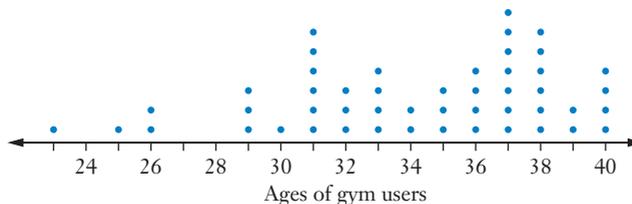
These ages show ____ between 26 and 29. They are ____ _____ between 36 and 38 but ____ _____ between 23 and 26.

c This stem-and-leaf plot shows the heights of students in a fitness class in centimetres.

These heights are _____ _____ in the 150s and 160s. They are _____ ___ from 137 to 177.

Stem	Leaf
13	7
14	0 1 3 5
15	3 4 5 7 7 7 8 9
16	2 2 3 6 6 8
17	0 1 5 5 7

d This stem-and-leaf plot shows the number of people who visited the information desk at Nelson Mall daily over a 3-week period.

Stem	Leaf
7	6
8	1 6 8
9	5 7 8
10	1 5 5
11	2 2 4 7
12	4

These are evenly _____ ____ across the 80s, 90s, 100s and 110s. The data does not show any _____.

e Households were surveyed about how many phones they owned. The results are shown in this histogram.

The scores are _____ at 1 and 2. The responses are not _____ ___ but t_____ _____.

Frequency histogram
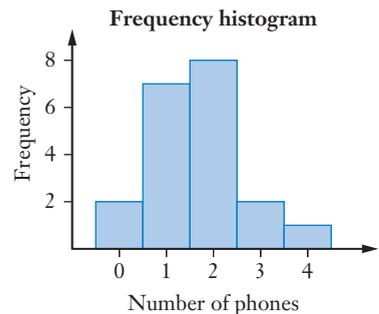
f This histogram shows the water level of a canal recorded over 44 days.

The water level is _____ _____ from 152 to 157. There are no _____.

Water level of the canal
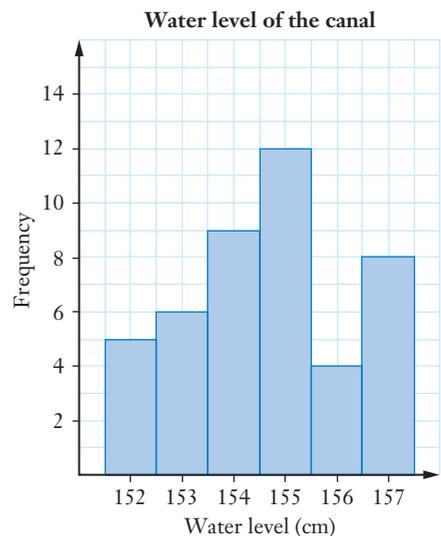
13.06 Standard deviation

The **standard deviation** is another measure of spread, like the range and the interquartile range. It describes how far each score is from the mean. The bigger the standard deviation, the more spread out the scores are.

The symbol for standard deviation is 'σ', which is the Greek letter 'sigma'. The formula for standard deviation is quite complicated, so you don't need to memorise it. Instead, you can use your calculator's statistics mode to calculate it.

EXAMPLE 8

The net weekly wages of 8 casual workers are:

$730 $490 $600 $440 $490 $370 $700 $580

Use your calculator to find the mean and standard deviation.

Solution

Follow the instructions for the statistics mode (SD or STAT) of your calculator:

Operation	Casio scientific	Sharp scientific
Start statistics mode.	MODE STAT 1-VAR	MODE STAT =
Clear the statistical memory.	SHIFT 1 Edit, Del-A	2ndF DEL
Enter data.	SHIFT 1 Data to get table 730 = 490 = , etc. to enter in column AC to leave table	730 M+ 490 M+ , etc.
Calculate the mean. ($\bar{x}$ = 550)	SHIFT 1 Var $\bar{x}$ =	RCL $\bar{x}$
Calculate the standard deviation. (σ = 117.260 ...)	SHIFT 1 Var $x\sigma_n$ =	RCL σx
Return to normal (COMP) mode.	MODE COMP	MODE 0

Mean $\bar{x}$ = $550

The symbol for mean is $\bar{x}$.

Standard deviation $\sigma \approx$ $117.26

EXAMPLE 9

Twenty echidnas from Booderee National Park were tagged and returned to their habitat. Rangers later captured several samples of 10 echidnas and recorded the number tagged in each sample.

Echidnas tagged per sample	Frequency
0	8
1	11
2	5
3	4
4	2
5	1

Shutterstock.com/Stephen Reynolds

Find correct to 2 decimal places:

a the mean number of tagged echidnas per sample

b the standard deviation of tagged echidnas.

Solution

For data presented in a frequency table, follow the instructions for your calculator as shown.

Operation	Casio scientific	Sharp scientific
Start statistics mode.	MODE STAT 1-VAR SHIFT MODE scroll down to STAT Frequency? ON	MODE STAT =
Clear the statistical memory.	SHIFT 1 Edit, Del-A	2ndF DEL
Enter data.	SHIFT 1 Data to get table 0 = 1 = , etc. to enter in x column 8 = 11 = , etc. to enter in FREQ column AC to leave table	0 2ndF STO 8 M+ 1 2ndF STO 11 M+ etc.
Calculate the mean ($\bar{x} = 1.4838$ ...)	SHIFT 1 Var $\bar{x}$ =	RCL $\bar{X}$
Calculate the standard deviation ($\sigma = 1.340$ ...)	SHIFT 1 Var $x\sigma_n$ =	RCL σx

a Mean $\bar{x} \approx 1.48$

b Standard deviation $\sigma_n \approx 1.34$

EXAMPLE 10

Indoor cricket selectors are trying to choose between two pairs of players (Sanjeev/Angus vs Christian/Tyler) for the state team. Their scores (in runs) are:

Sanjeev/Angus	34	30	36	35	29	34
Christian/Tyler	41	26	37	35	25	34

Which pair is the more consistent?

Solution

Use your calculator to find the standard deviation for each pair's scores.

Sanjeev/Angus: $\sigma \approx 2.58$

Christian/Tyler: $\sigma \approx 5.74$

The more consistent pair is the one with the smaller standard deviation.

Sanjeev/Angus are the more consistent pair of cricketers.

Exercise 13.06 Standard deviation

Example 8

1 Find the mean and standard deviation of each set of data, correct to 2 decimal places.

 a 20, 24, 17, 21, 19, 26, 21, 23, 16
 b 60, 51, 82, 65, 27, 38, 32, 64, 18, 20, 74
 c 14, 13, 17, 14, 13, 16, 16, 17, 16, 12, 12
 d 67, 58, 89, 72, 34, 45, 39, 71, 25, 27, 81

2 Martin is looking for a job in the construction industry. He collected information on the wages of apprentices at a large construction company. The following amounts are the weekly wages of 10 apprentices.

 $542 $728 $884 $601 $774 $586 $801 $675 $758 $627

 a Find the mean wage.
 b Find the standard deviation of this data. Answer correct to 1 decimal place.
 c Give a reason for the large standard deviation of this data.

3 Jana is looking for a unit to rent in Highgate Hill. She used a website to find the following data about the weekly rent for a number of units in Highgate Hill.

$400 $450 $600 $530 $529 $430 $430 $390

$550 $450 $350 $420 $540 $495 $480

a Find the mean rental price.

b Find the standard deviation for this data. Answer correct to 2 decimal places.

c Why can places in the same area have different weekly rents?

d If Jana can afford to pay $420 per week, how difficult will it be for her to find a place to rent?

Example 9

4 Students' marks in a quiz out of 10 are shown in this frequency table.
Find, correct to one decimal place:

a the mean

b the standard deviation

Mark	Frequency
5	4
6	3
7	8
8	4
Total:	19

5 Andrea surveyed 50 students on how many text messages they sent within the last two hours. For this data, find correct to 2 decimal places:

a the mean

b the standard deviation

Number of texts	Frequency
0	8
1	4
2	10
3	10
4	15
5	3
Total:	50

6 Centrelink officers recorded how many jobs each person applied for before they received their first job interview. For this data, find correct to 2 decimal places:

a the mean

b the standard deviation

Number of jobs applied for	Frequency
1	2
2	5
3	10
4	6
5	11
6	13
7	3

7 Kate is looking for her ideal place to live. She likes a consistent, warm climate. She is considering two places: Port Paradise and Palm Tree Cove. This table shows the mean monthly temperatures (in °C) of each location.

	J	F	M	A	M	J	J	A	S	O	N	D
Port Paradise	30	28	26	25	24	24	24	24	26	27	28	30
Palm Tree Cove	32	34	28	26	25	22	20	21	25	29	31	32

a Calculate, correct to 2 decimal places, the standard deviations of the temperatures of each place.

b Use your answers to part **a** to advise Kate on which place would suit her better.

8 Brad, Aryn and Kim are keen computer gamers. Each week they play 12 competition games against players of equal ability. The table shows the number of games each of them won during the last 6 weeks.

Brad	8	9	7	10	5	11
Aryn	2	4	6	3	7	5
Kim	10	5	8	3	9	4

a Calculate the mean number of games won out of 12 and the standard deviation of the weekly results for each player. Answer correct to 1 decimal place.

b Which player is the most consistent? Explain your answer.

c You have to select one player to compete at the state contest. Who would you choose and why?

9 Paul's golf scores for 16 rounds of golf are shown on this dot plot.
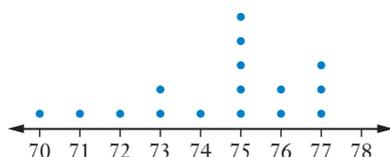
a From smallest to largest, write out a list of Paul's scores for the 16 rounds of golf.

b Calculate the mean and the standard deviation for this data.

c Is Paul a consistent player? Explain your answer.

10 This stem-and-leaf plot shows Carol's pulse rate every 2 minutes while she was exercising on the cross-country machine at the gym.

Stem	Leaf			
12	7	9		
13	0	3	5	
14	3	3	3	6
15	4	5	7	

a Would you expect a large or a small standard deviation for this data? Explain your answer.

b Calculate the standard deviation for this data.

c Why do we NOT want a consistent pulse rate in this situation?

11 During the Christmas season, highway billboards displayed the number of drivers booked for speeding each day, from December 24 to January 4.

146	46	305	102	183	194	210	98
102	208	168	110				

a Arrange the data from smallest to largest.

b Determine the value of the mean, median, mode and range.

c Calculate the interquartile range of the data.

d Calculate the standard deviation of the data. Answer correct to one decimal place.

e A reporter for the local newspaper is writing an article about the number of motorists booked for speeding each day.

   i Which value do you think she should use for the 'average'? Give a reason for your answer.

   ii Which value do you think she should use for describing the spread of scores? Give a reason for your answer.

INVESTIGATION

COMPARING THE SIZE OF MATHS TEXTBOOKS WITH ENGLISH NOVELS

1 Ask your teacher to bring in a copy of every maths textbook they have and your English teacher to lend you a copy of every novel used in senior English classes.

2 Record the number of pages in each book for each of the 2 groups.

3 Calculate the mean and standard deviation for the number of pages in the maths textbooks.

4 Calculate the mean and standard deviation for the number of pages in the English novels.

5 'Maths textbooks have more pages than English novels but there is a greater variation in the number of pages in English novels.' Do you agree with this statement?

Does your data support this? Justify your answer.

TECHNOLOGY

Statistics on a spreadsheet

1 a Enter into a spreadsheet the following data about the daily maximum temperatures in Alice Springs in one week.

	A	B	C	D	E
1	**Day**	**Temperature (°C)**			
2	Sunday	29		Mean	
3	Monday	31		Mode	
4	Tuesday	30		Median	
5	Wednesday	33		Maximum	
6	Thursday	29		Minimum	
7	Friday	28		Range	
8	Saturday	35		Interquartile range	
9				Standard deviation	
10					

b Copy each formula into the given cells.

> Sometimes if you type the first couple of letters, the spreadsheet will suggest the correct word.

Cell E2: =average(B2:B8)

Cell E3: =mode(B2:B8)

Cell E4: =median(B2:B8)

Cell E5: =max(B2:B8)

Cell E6: =min(B2:B8)

Cell E7: =E5−E6

Cell E8: =quartile(B2:B8,3)-quartile(B2:B8,1)

Cell E9: =stdev.p(B2:B8)

c Save your results.

2 a Repeat question **1** for data for the town or city where you live. Go to the Bureau of Meteorology website to find the data.

b Find data for one month instead of for one week. Repeat question **1** for this new data. You will need to adjust the formulas you enter for the statistics.

3 a Enter into a spreadsheet the following data showing the monthly number of motor vehicle thefts in a capital city over 2 years.

	A	B	C	D	E	F
1	**Motor vehicle theft in a capital city**					
2						
3	Jan 2019	20		Jan 2020	15	
4	Feb 2019	19		Feb 2020	19	
5	Mar 2019	26		Mar 2020	17	
6	Apr 2019	17		Apr 2020	21	
7	May 2019	27		May 2020	20	
8	Jun 2019	13		Jun 2020	18	
9	Jul 2019	17		Jul 2020	13	
10	Aug 2019	17		Aug 2020	13	
11	Sep 2019	20		Sep 2020	14	
12	Oct 2019	18		Oct 2020	14	
13	Nov 2019	12		Nov 2020	18	
14	Dec 2019	24		Dec 2020	20	
15						
16	Mean			Mean		
17	Median			Median		
18	Mode			Mode		
19	SD			SD		
20						

Enter the following data into a spreadsheet showing the monthly number of motor vehicle thefts in a capital city for 2 years.

b Copy each formula into the given cells. ◄ The data for 2020 has many modes, but the spreadsheet only lists one of them.

Cell B16: =average(B3:B14)

Cell B17: =median(B3:B14)

Cell B18: =mode(B3:B14)

Cell E16: =average(E3:E14)

Cell E17: =median(E3:E14)

Cell E18: =mode(E3:E14)

Cell E19: =stdev.p(E3:E14)

c Save your results.

d Comment on the differences between the 2 years.

4 Repeat question **3** for your city or town. You will need to use the Internet to find the data. Try looking up crime statistics and looking for motor vehicle theft.

Changing data

It is best to use a spreadsheet to complete this investigation.

1 For the set of data shown in the frequency table, find:

Score	Frequency
5	11
6	13
7	10
8	8
9	3

    a the mean, correct to one decimal place

    b the median

    c the mode

    d the standard deviation, correct to one decimal place

2 In the following challenges, change the frequencies in the table without changing the total frequency of 45 to achieve the given outcome.

    a Increase the mean without changing the mode.

    b Decrease the mean without changing the mode.

    c Make the median bigger by 1.

    d Make the mean equal to 8 in two different ways.

    e Make the mode 7 without changing the mean.

    f Make the standard deviation as small as possible.

    g Make the standard deviation as large as possible.

    h Make the mean 7 and the standard deviation as close to 1 as possible.

CHAPTER SUMMARY

| average | interquartile range | median | mode | number | odd | order |
| outlier | percentiles | | quartiles | range | spread | standard deviation |
| ten |

Copy and complete each sentence using a word from the list. When you have completed this, you will have a summary of the chapter.

1 The _____ is the most frequent score.

2 Another word for the mean is the _____.

3 The mean is the sum of the scores divided by the _____ of scores.

4 The _____ is the middle score when they are arranged in order.

5 There's only one middle score when there are an _____ number of scores.

6 To find the median, you must first put the scores in _____.

7 A score that is much higher or much lower than the other scores is called an _____ .

8 _____ divide the data into 4 equal parts.

9* Deciles divide the data into _____ equal parts.

10* When a large amount of data is divided into 100 equal parts, they are called _____.

11 The standard deviation is a measure of _____.

12 The difference between the highest score and the lowest score is called the _____.

13 The difference between the upper quartile and the lower quartile is called the _____ _____.

14 A measure of spread that describes how far each score is from the mean is called the _____ _____.

SOLUTION ^{TO} ^{THE}
CHAPTER PROBLEM

Problem

Simone is a journalist with a local newspaper. She is writing an article about the prices of home units in the area. Simone has collected some information on sale prices in recent months:

$395 000	$296 000	$415 000	$479 000	$270 000	$269 000
$410 000	$419 000	$289 000	$375 000	$320 000	$440 000
$170 000	$359 000	$369 000	$825 000	$750 000	$495 000

What type of statistics should Simone use in her article? What other information might her readers be interested in knowing?

Solution

People reading the article will be interested in knowing the lowest price ($170 000) and the highest price ($825 000) of home units sold recently in the area.

To calculate the average or typical price:

Mode: There is no mode as all the prices are different. Even if there were 2 prices the same the mode is unlikely to reflect a typical price.

Mean: Total of prices = $7 345 000

Number of sales = 18

Mean = 7 345 000 ÷ 18

≈ $408 056

Median: Put scores in order

$170 000	$269 000	$270 000	$289 000	$296 000	$320 000
$359 000	$369 000	($375 000)	($395 000)	$410 000	$415 000
$419 000	$440 000	$479 000	$495 000	$750 000	$825 000

$$\text{Median} = \frac{\$375\ 000 + \$395\ 000}{2}$$

$$= \$385\ 000$$

In this case, the median is the best measure of central tendency as the mean has been increased by the outliers of $750 000 and $825 000.

Her readers may also want to know how prices have changed over time.

She could include the change in prices over the last few years as a percentage.

She could also include a line graph showing changes in the median price over time.

It's better than average

1 For each set of scores, find:

    i   the mode   **ii**   the median   **iii**   the mean

    a   Computer frauds per year: 808, 1126, 1003, 913, 300

    b   Student incomes (\$): 32, 29, 41, 34, 29, 40, 40, 37, 39, 40, 33

    c   Temperatures at Wittenoom (°C): 25, 24, 23, 20, 16, 12, 11, 12, 17, 20, 23, 25

    d   Rainfall at Newman (mm): 152, 227, 202, 124, 149, 127, 83, 90, 59, 88, 96, 143

2 The following data gives the room occupancy rates for motels and hotels in Australia per quarter (3 months) in recent times. These rates are given as percentages.

    57   62   61   56   58   65   60   59   56   66   64   59   58   70   69   62   61   73   68

    a   Find the median for this data.

    b   What is the mode for this data?

    c   Calculate the mean for this data. Answer correct to one decimal place.

    d   Which of the three measure most accurately reflects the data? Justify your answer.

3 For the computer fraud data in question **1 a** above:

    a   what is the outlier for this data?

    b   calculate the mean of the data without the outlier.

    c   what effect does the outlier have on the mean calculated in question **1**?

4 For the rainfall data in question **1 d** above:

    a   What are the outliers for this data?

    b   Find the mean and the median for the data without the outliers included.

    c   Compare the mean with all scores included to the mean without the outliers included. What effect do the outliers have on the mean?

    d   Compare the median with all scores included to the median without the outliers included. What effect do the outliers have on the median?

    e   Out of all the measures you have calculated, which best describes the rainfall in Newman? Justify your answer.

5 For each set of data in question **1** above, find:

    i   the range   **ii**   the 1st and 3rd quartile   **iii**   the interquartile range

6 Using your answers to question **5**, for which data set is:

    a   the range the better measure of spread?

    b   the interquartile range the better measure of spread?

7* Refer to the graph in Exercise 13.04, question **3** on page 346.

* Australian curriculum only, not in WA syllabus.

a What percentage of students scored more than 91?

b What is the 4th decile?

c Joanna scored 93%. Between which 2 deciles did she score?

8* Refer to the graph in Exercise 13.04, question **4** on page 347.

a For how many months of the year was the rainfall above average for the month?

b State the month(s) where the rainfall was between the 1st decile and the long-term average.

c What is the difference between the 1st and 9th deciles in February?

9 Describe the spread of data in this dot plot using words from this list: spread out, tightly-packed, clustered, gaps, more dense, less dense.

Maximum temperatures (°C)
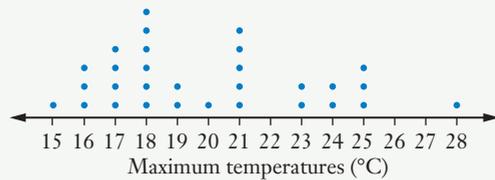
10 Use your calculator to find, correct to 2 decimal places, the standard deviation of these temperatures at Wittenoom (°C) from question 1.

25   24   23   20   16   12   11   12   17   20   23   25

11 Carmelina recorded the number of drinks bought by people visiting her shop during one hour. The results are shown in the table.

Find, correct to 2 decimal places:

a the mean

b the standard deviation

Number of drinks	Frequency
0	7
1	5
2	13
3	4
4	1
5	2
6	1
Total	33

12 Keith is looking to move to the country and set up a market garden. He needs regular, consistent rainfall for his new business to be successful. He is considering two locations: Deevine and Clatchey. This table shows the mean monthly rainfall (in mm) of each location.

	J	F	M	A	M	J	J	A	S	O	N	D
Deevine	76	77	59	20	37	32	23	24	30	58	71	94
Clatchey	117	114	75	38	34	34	25	19	20	35	57	92

a Calculate the mean and standard deviations of the temperatures in Deevine and Clatchey. Answer correct to 2 decimal places.

b Which location would you recommend to Keith as suiting his needs?

14.

COLOURFUL RATIOS

Chapter problem

Lara needs 24 mL of purple paint for a flower scene she is painting. To make the shade of purple she wants, she will mix some cyan and magenta paint in the ratio of 1 : 2. How much of each colour should she use?
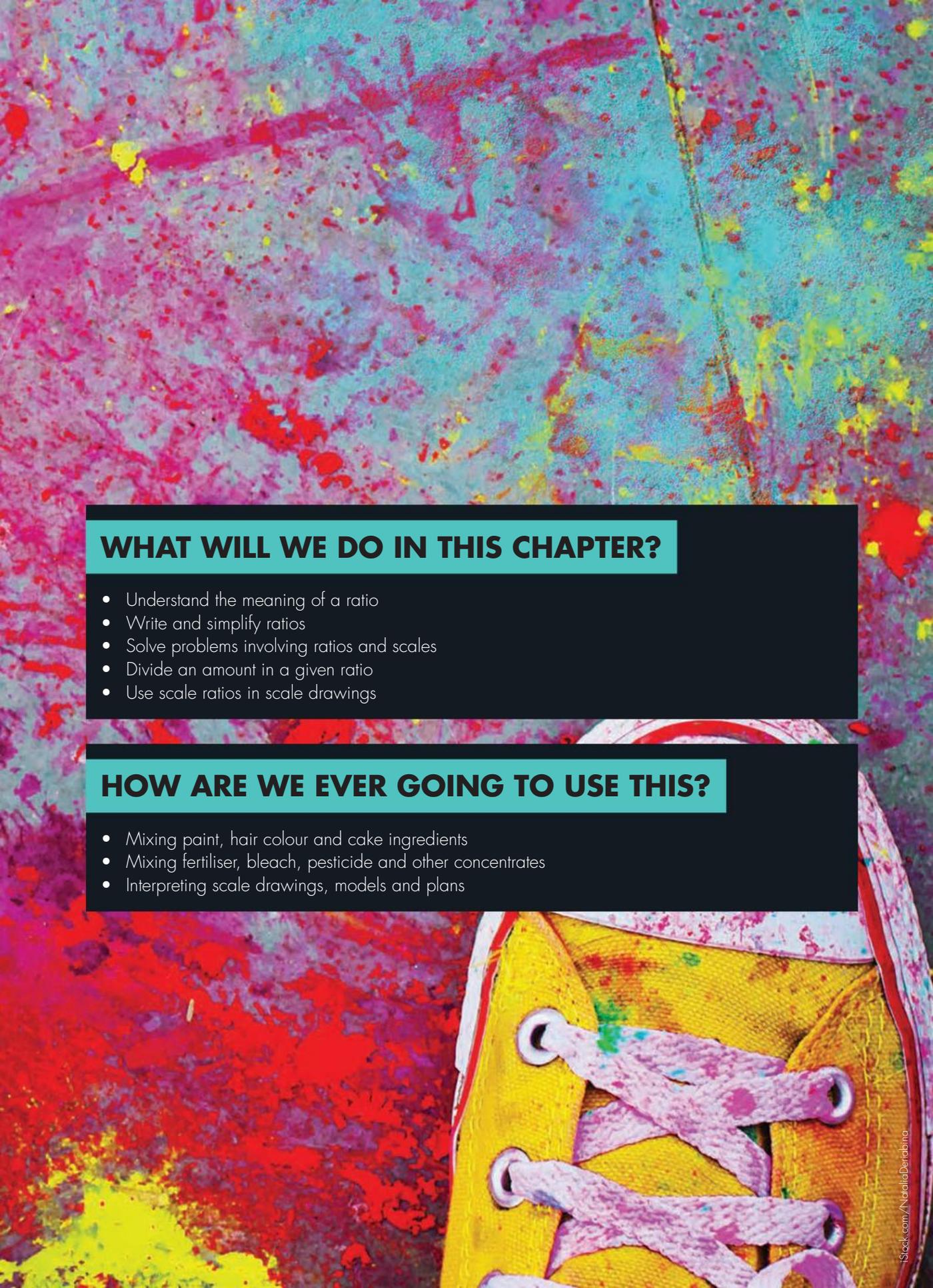
WHAT WILL WE DO IN THIS CHAPTER?

- Understand the meaning of a ratio
- Write and simplify ratios
- Solve problems involving ratios and scales
- Divide an amount in a given ratio
- Use scale ratios in scale drawings

HOW ARE WE EVER GOING TO USE THIS?

- Mixing paint, hair colour and cake ingredients
- Mixing fertiliser, bleach, pesticide and other concentrates
- Interpreting scale drawings, models and plans

14.01 Ratios

A **ratio** consists of 2 or more numbers that compare the parts or shares of things of the same type, in the same units. For example, if a cake recipe uses sugar to flour in a ratio of 1 to 2, written '1 : 2,' it means that for every 1 part of sugar we need 2 parts of flour.

> ## Ratios
>
> A ratio compares quantities of the same type given in the same units.
>
> We say '*a* to *b*' and write *a* : *b*, where *a* and *b* are numbers.

Each number in a ratio is called a **term** of the ratio.

Jerry mixes cordial and water in the ratio 1 : 5, meaning that for every 1 part of cordial there are 5 parts of water.

Nina prefers a stronger flavour, so she uses a cordial : water ratio of 1 : 3.
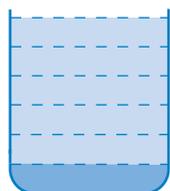
1 : 5 (read as '1 to 5')
1 part cordial to 5 parts water

1 : 3 (read as '1 to 3')
1 part cordial to 3 parts water

For a picnic, Nina can make a bottle of her drink by mixing one **cup** of cordial to 3 **cups** of water.
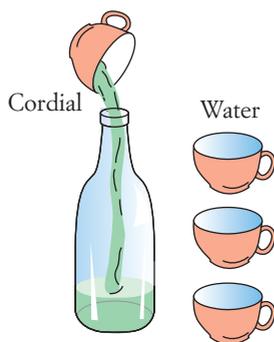
For a party, Nina can make a tub of her drink by mixing 1 **bucket** of cordial to 3 **buckets** of water.
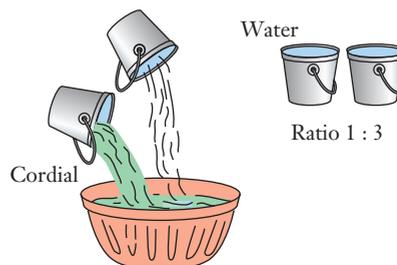
Ratio 1 : 3

Ratio 1 : 3

EXAMPLE 1

For this box of chocolates, write each ratio:

a dark brown chocolates to light brown chocolates

b rectangular chocolates to circular chocolates

c white-topped chocolates to all chocolates

Shutterstock.com/PHB.cz (Richard Semik)

Solution

> The order in which you write the numbers in a ratio is very important. 4 : 10 is not the same thing as 10 : 4.

a There are 4 dark brown chocolates and 10 light brown chocolates.

Dark chocolates to light chocolates = 4 : 10

b There are 6 rectangular chocolates and 2 circular chocolates.

Rectangular chocolates to circular chocolates = 6 : 2

c There are 6 white-topped chocolates, and 20 chocolates in total.

White-topped chocolates to all chocolates = 6 : 20

EXAMPLE 2

Express each pair of quantities as a ratio.

a A mass of 69 kg to a mass of 80 kg

b A time of 44 minutes to a time of 2 hours

c A distance of 87 cm to a distance of 5 metres

Solution

a Since the quantities are in the same units (kg), the ratio is simply 69 : 80.

$$69 \text{ kg} : 80 \text{ kg} = 69 : 80$$

b The quantities are in different units (minutes, hours), so change 2 hours to minutes first.

$$2 \text{ hours} = 2 \times 60 \text{ min}$$
$$= 120 \text{ min}$$
$$44 \text{ min} : 2 \text{ h} = 44 \text{ min} : 120 \text{ min}$$
$$= 44 : 120$$

c Change 5 metres to centimetres first.

$$5 \text{ m} = 5 \times 100 \text{ cm}$$
$$= 500 \text{ cm}$$
$$87 \text{ cm} : 5 \text{ m} = 87 \text{ cm} : 500 \text{ cm}$$
$$= 87 : 500$$

Exercise 14.01 Ratios

1 For each diagram, write the ratio of shaded to unshaded parts.

a

b

c

d

e
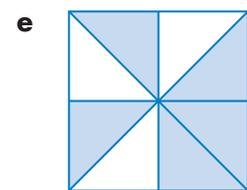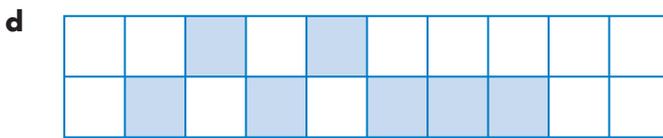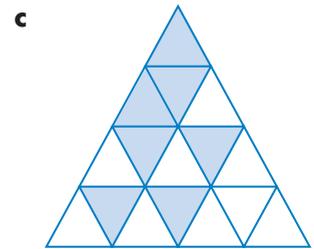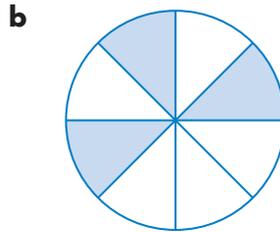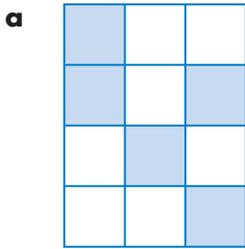
2 a Johnny likes to make a drink with a ratio of 2 parts cordial to 5 parts water (or 2 : 5). Draw a diagram to show this ratio in a glass.

b Lisa made a drink mixed with the ratio shown in the diagram. Estimate the ratio of cordial to water used.
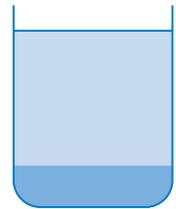
3 In your classroom, find the ratio of:

    a teachers to students   **b** girls to boys

    c chairs to tables   **d** students to chairs

4 In the 1950s, the average ratio of teachers to students in classrooms was 1 : 45, in the 1970s it was 1 : 35, and in the 1980s the ratio was set at 1 : 30 for most classes. Today, it is 1 : 24. What does it mean when we say that the teacher : student ratio has improved?

5 In a class of 25 students, Hadid found that 13 students in his class have brown eyes, 8 students have blue eyes, 3 students have green eyes and 1 student has hazel eyes. Find each ratio of student eye colours:

    a blue to brown   **b** green to blue

    c brown to hazel   **d** hazel to the total

6 Out of every 100 people at the football, 39 were men, 23 were women, and the rest were children. Find each ratio:

    a men to women   **b** women to the total

    c children to men   **d** women to children

7 Express each pair of quantities as a ratio.

- **a** 13 g to 25 g
- **b** $17 to $100
- **c** 5 litres to 12 litres
- **d** 150 km to 1 km
- **e** 0.5 kg to 43 g
- **f** $3.50 to 83 cents
- **g** 3 kL to 1421 L
- **h** 27 mm to 4 cm
- **i** 59 minutes to 3 hours
- **j** 15 years to 7 months
- **k** 9 days to 7 weeks
- **l** 77 m to 17 cm

8 Write each statement as a ratio.

- **a** For each teacher, there were 25 students.
- **b** To cook steamed rice, you need 1 cup of rice to 2 cups of water.
- **c** Rock-climbing activity supervision requires one teacher for every 4 students.
- **d** There are 11 girls for every 9 boys in the school.
- **e** Samantha and James agreed to share the Lotto prize equally.
- **f** Brody is twice as tall as Tegan.

14.02 Simplifying ratios

Ratios can be simplified in the same way that fractions are simplified.

Ratio match-up puzzle

Ratios code puzzle

Simplifying ratios

To **simplify** a ratio, divide each term in the ratio by the same amount.

EXAMPLE 3

Simplify each ratio.

a 10 : 6   **b** 21 : 7   **c** 10 : 15 : 20

Solution

a Both 10 and 6 can be divided by 2.

$$10 : 6 = 10 \div 2 : 6 \div 2$$
$$= 5 : 3$$

We can also use the fraction key on our calculator: enter 10 $a^b/_c$ 6 $=$ and the calculator will display $\frac{5}{3}$, which we write as 5 : 3.

b Divide both 21 and 7 by 7.

$$21 : 7 = 21 \div 7 : 7 \div 7$$
$$= 3 : 1$$

For 21 $a^b/_c$ 7 $=$, the calculator will display 3, which we can write as 3 : 1.

c All 3 terms can be divided by 5.

$$10 : 15 : 20 = 10 \div 5 : 15 \div 5 : 20 \div 5$$
$$= 2 : 3 : 4$$

When there are more than 2 terms in the ratio, we can't use the calculator to simplify.

We should always check our answer to see if it can be simplified further.

Exercise 14.02 Simplifying ratios

Example **3**

1 Simplify each ratio.

a	8 : 6	**b**	9 : 12	**c**	15 : 10	**d**	20 : 10
e	21 : 14	**f**	27 : 9	**g**	18 : 12	**h**	150 : 25
i	120 : 24	**j**	56 : 49	**k**	28 : 52	**l**	200 : 50
m	8 : 12 : 4	**n**	6 : 3 : 18	**o**	15 : 25 : 50	**p**	90 : 60 : 120

2 Simplify each ratio using your calculator.

a 4.5 : 9   **b** 1.8 : 2.7   **c** $2\frac{1}{2} : 7\frac{1}{2}$ **d** $14 : 3\frac{1}{2}$

e $\frac{1}{2} : \frac{3}{4}$ **f** 2.9 : 5.8   **g** 3.5 : 2.1   **h** 3.6 : 1.2

3 Karen uses a soil conditioning solution on her vegetable garden. The ingredients are listed on this label shown.

Express in simplest form the ratio of:

a seaweed extract to water

b organic acid to water

c seaweed extract to organic acid

d seaweed extract to total solution

e seaweed extract to organic acid to water.

FERTILISER

Ingredients

Seaweed Extract	135 mL
Organic Acid	45 mL
Water	900 mL

4 The table shows the average annual yield in kilograms from various fruit and nut trees.

What is the yield ratio of:

a apple to pear?

b nectarines to walnuts?

c apricot to apple?

d pear to fig?

e apples to nectarines to figs?

Apple	144
Apricot	36
Pear	54
Nectarine	63
Fig	9
Walnut	27

5 Steven runs a small gourmet business producing specialty fruits, vegetables and cereal products. He also has poultry producing a variety of eggs. The drawing shows the area of land he has dedicated to each activity. Find the ratio of the following production areas.

Fruit orchard (75 m²) · Poultry (20 m²) · Cereal crops (45 m²) · Vegetables (120 m²)
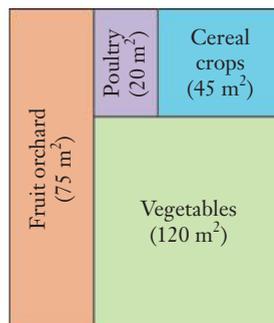
  a fruit to vegetables

  b egg to total area

  c vegetables to total crop area (the area excluding poultry)

  d cereal crop to the total crop area

  e vegetable to fruit to cereal crop area.

6 Robyn is cleaning the floor with a cleaning liquid she has mixed from a detergent concentrate and water. The instructions say to mix concentrate to water in the ratio 3 : 16 for light cleaning or 5 : 16 for heavy-duty cleaning. Robyn has mixed 22.5 mL of concentrate with 72 mL of water for this job.
Is she doing light or heavy-duty cleaning

7 Kris buys avocados at the market for $2 each and sells them in his grocery store for $3 each.

  a How much profit does Kris make on each avocado?

  b What is the ratio of:

  i selling price to cost price?   **ii** selling price to profit?

  iii cost price to profit?   **iv** profit to selling price?

8 Of the 75 people who attended a bush dance, 27 were men, 29 were women and the remainder were children. Find the following ratios:

  a men to women   **b** children to men   **c** women to the total

  d women to children   **e** men to women to children.

9 Write the simplified ratio for:

  a 30 cents to $2.50   **b** 24 mm to 3 cm   **c** 30 minutes to 2 hours

  d 4 years to 18 months   **e** 14 days to 5 weeks   **f** 0.3 km to 175 metres.

10 The diagram shows a cluster of yellow, green, purple, grey, red and black balls. Write the colours that are in the ratio:

  a 6 : 1   **b** 4 : 3   **c** 2 : 5

  d 2 : 21   **e** 2 : 1 : 6   **f** 3 : 4 : 5

11 Eva is saving as much as she can from her wage in her weekend job. She is planning to travel when she finishes school. She receives $180 each week from her job. From her pay, she puts $15 into her clothes budget, spends $20 on fares to travel to work and she saves the remainder.

  a What is the ratio of the money she spends on fares to what she puts into her clothes budget?

  b What percentage of her pay does Eva put in her clothes budget, correct to 1 decimal place?

  c What is the ratio of Eva's savings to her pay?

14.03 Mixing paint

Lara uses ratios to make the colours she needs for her paintings. She knows that the order of a ratio is very important. If she gets it wrong, the resulting colour is wrong and she wastes paint.

Lara mixed yellow and blue paint. When she used the ratio of 5 : 1, she mixed 5 parts yellow with 1 part blue. When she used the ratio of 1 : 5, she mixed 1 part yellow and 5 parts blue. The images here show that the resulting 2 colours were quite different.

Yellow   Blue

5 : 1   1 : 5

EXAMPLE 4

Lara mixed 12 mL of white paint with 8 mL of red paint to make dark pink paint.

a What is the ratio of red to white paint in the mixture?

b What fraction of the mixture was red paint?

Solution

a The order is important. For red : white we need to write the quantity of red first.

Red: white = 8 : 12
= 2 : 3

b 12 + 8 = 20 mL of total paint and 8 mL came from red paint. That's 8 mL out of 20 mL.

Fraction of the paint that was red paint $= \dfrac{8}{20} = \dfrac{2}{5}$.

EXAMPLE 5

Zack is painting his lounge room. He wanted the colour to be white with a hint of brown. He mixed 10 mL of brown with 8 L of white paint. What ratio of brown to white should he write on the lid of the paint tin so that he can make the same colour in the future?

Solution

Change 8 L into mL so the units are the same.

8 L = 8000 mL

Write the brown amount first.

Brown : white = 10 mL : 8000 mL
= 10 : 8000

Simplify the ratio.

= 1 : 800

Exercise 14.03 Mixing paint

1 Lara mixed 5 mL of red with 9 mL of green paint to make brown to create a painting of some trees.

   a What is the ratio of green to red paint in the brown mixture?

   b What fraction of the brown paint is red?

2 Lara mixed 6 mL of green with 2 mL of blue paint to make a blue-green paint for the leaves.

   a What is the ratio of green : blue paint in the blue-green mixture?

   b Simplify your answer to part **a**.

   c What fraction of the blue-green mixture came from the green paint?

3 Lara made 2 containers of orange paint by mixing red and yellow. She mixed 20 mL of red with 40 mL yellow in one mixture and 8 mL of yellow with 4 mL of red in the other.

She is confused. Both colours are the same! Why?

Basic colours   Mixed colour

4 Zack mixed 5 mL of brown and 2 L of white paint to paint the woodwork in his lounge room.

   a What is the ratio of brown to white paint in mL?

   b Write your answer to part **a** in its simplest form.

iStock.com/Highwaystarz-Photography

5 Lara needs to make a particular shade of blue-green she wanted by mixing blue and green in the ratio of 4 : 1, but when she mixed the paint she got the wrong colour (see images). What could she have done wrong?

Blue   Green

Basic colours

Correct   Wrong

Mixed colours

6 Lara makes colours lighter by mixing them with white; the more white, the lighter the colour. Here are 4 shades of blue Lara made by mixing blue and white in the ratios of 3 : 1, 3 : 2, 1 : 1 and 1 : 2 but she forgot to label the diagrams. Match the ratios to the colour samples.

a   **b**   **c**   **d**

7 Lara makes this shade of purple by mixing red and blue paint in the ratio of 3 : 1. How much red paint does she need to add to 24 mL of blue to make this shade of purple?

8 Lara makes different shades of pink paint by mixing red and white, as shown in the table.

Calculate the amount of white paint Lara should add to 5 mL of red to produce each shade of pink.

	Colour sample	Ratio red : white
a		1 : 1
b		1 : 2
c		1 : 3
d		1 : 4

9 Compared to adults, children have bigger heads in relation to their bodies. This table shows values for males of different ages.

Age	head length : height	Typical height in cm
1 year	1 : 4	60
3 years	1 : 5	81
5 years	1 : 6	105
Adult	1 : 8	180

a What fraction of a 1-year-old boy's height is the length of his head?

b Lara is painting a picture of 5-year-old Tyson. In the picture, Tyson is 12 cm tall. How long should she make his head in the picture?

c What is the ratio of an adult man's height to the height of a 1-year-old boy?

d Lara is sketching a picture of a man with his 1-year-old son. In the picture, the man is 20 cm tall, so what length should Lara make:

i the man's head?   **ii** the son's height?

10 To make a fertiliser for his rose garden, Ahmed mixes manure and grass clippings in the ratio of 3 : 2.

    a How many spades of grass does Ahmed need to mix with 15 spades of manure?

    b When he uses 6 spades of grass, how much manure will he need to mix with it?

11 Nickel brass is a metal that contains copper, zinc and nickel mixed in the ratio 14 : 5 : 1. It is used to make many musical instruments as well as the old English pound coin.

    a A manufacturer used 70 g of copper to make a batch of nickel brass. How much zinc and nickel did he need?

    b Vinh has 8 g of nickel. How much copper and zinc will he need to mix with it to make nickel brass?

    c How much nickel brass can Vinh make?

12 When Padmina makes scones for the school fete, she mixes self-raising flour and milk in the ratio 3 : 1.

    a How much milk does she add to 15 cups of flour?

    b If she uses 6 cups of milk, how many cups of flour are required?

13 Abi makes a spray to kill weeds by mixing a concentrated solution of poison with water.

Weed	Ratio of poison to water
Flat-leaf weeds	1 : 10
General perennial weeds	3 : 20
Woody weeds	1 : 50

    a Abi needs to kill some blackberries, which are woody weeds. How many millilitres of water should she mix with 40 mL of poison to make the spray?

    b How many litres of water is this?

    c Abi is going to clear a small area infested with perennial weeds to make a new garden. How much poison does she need to add to 1 L of water to make a spray to kill the weeds? (Convert 1 L to mL first).

    d Abi has flat-leaved weeds coming up in her lawn. How much poison should she mix with 250 mL of water to make the spray for these weeds?

    e Abi has made a spray using 45 mL of poison mixed with 300 mL of water. For what type of weed will she use this spray?

PRACTICAL ACTIVITY

MAKING COLOURS

You need some red, yellow and blue paint (the **primary colours**), a surface for mixing paint and some paint brushes.

What you need to do

Find which primary colours need to be mixed to make each colour in the table below. Copy and complete the table with the correct colours and ratios. Purple has already been done for you.

	Colour	Primary colour parts used	Ratio
	■	1 part red, 1 part blue	1 : 1
1	■		
2	■		
3	■		
4	■		

14.04 Dividing a quantity in a ratio

Sometimes we want to divide or share quantities into unequal amounts. For example, the owners of businesses often share the profits and expenses according to the size of their share in the business.

EXAMPLE 6

Lara mixes red, white and green paint in the ratio of 5 : 1 : 2 to make a red shade for painting house bricks. She needs to make 10 L of paint for the bricks. How much of each colour should she mix?

WS

Ratios in other contexts

WS

Dividing a quantity in a given ratio

WS

Ratio problems

WS

Calculating quantities in ratios

Solution

5 parts red, 1 part white and 2 parts green makes 8 parts.	$5 + 1 + 2 = 8$ parts 8 parts make up 10 L
Find the size of one part by dividing 10 L by 8.	1 part $= 10 \div 8$ $= 1.25$ L
For each colour, multiply by the appropriate number of parts.	Amount of red $= 5 \times 1.25$ (5 parts) $= 6.25$ L Amount of white $= 1.25$ L (1 part) Amount of green $= 2 \times 1.25$ (2 parts) $= 2.5$ L

Check that your answer is correct by adding up the parts to see whether they make up the whole: $6.25 + 1.25 + 2.5 = 10$ L.

EXAMPLE 7

Janet and Darryl own a small market garden, which made a profit this year of $135 000. They have agreed to share the profit in the ratio 2 : 3. How much does each person receive?

Solution

Find the total number of parts. Find the size of one part.	Total number of parts $= 2 + 3 = 5$. 1 part $= \$135\,000 \div 5$ $= \$27\,000$
For each share, multiply by the appropriate number of parts.	Janet's share $= 2 \times \$27\,000$ $= \$54\,000$ Darryl's share $= 3 \times \$27\,000$ $= \$81\,000$

Check that the parts add up to the whole: $\$54\,000 + \$81\,000 = \$135\,000$.

Exercise 14.04 Dividing a quantity in a given ratio

1 Lara needs to mix blue and black in the ratio of 14 : 1 to make paint for a sky. She needs to make 60 mL. How much of each colour will she need?

2 Lara needs 24 mL of this shade of red to paint some waratahs in a bush scene. The colour is a 3 : 1 mix of red and yellow. How much of each colour will she need?
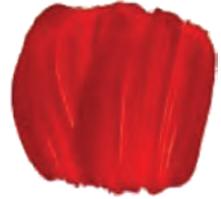
3 This shade of red will show the parts of the waratahs in the direct sunlight. It consists of red, yellow and white in the ratio of 4 : 1 : 1. Lara requires 12 mL of this colour. How much red, white and yellow paint should she mix together?

4 Lara needs 140 mL of a golden paint for the sand dunes in an outback scene. She will make the colour by mixing red, yellow and white in the ratio of 1 : 4 : 2. How much of each colour will she need?

5 At the end of each painting session, Lara cleans her equipment with commercial cleaner. She needs to dilute the concentrated cleaner with water in the ratio of 1 : 9, concentrate to water. How much concentrate will she need to make 4 L of diluted cleaner?

6 Lara sells her paintings in an art gallery. Her agent and she share the sale price in the ratio of 1 : 7. How much did Lara receive when one of her paintings sold for $4800?

7 Hamish needs to mix 180 kg of concrete. Concrete is made using cement, sand and gravel in the ratio 1 : 2 : 3. How much of each product will Hamish need?

8 Divide a prize of $2100 between Toby and Vinson in the ratio:

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

9 At Jemma's school there are 741 students. The ratio of boys to girls is 7 : 6. How many boys are there in the school?

10 Asher is making a bracelet using silver beads, porcelain balls and crystal eyedrops in the ratio of 4 : 3 : 2. She uses 45 pieces to make the bracelet. How many of each type will she require?

11 A flat white coffee contains black espresso coffee and steamed milk in the ratio 1 : 2. How much milk is there in a 240 mL mug of flat white coffee?

12 Rose gold is used in jewellery and high-quality flutes because of its attractive appearance. It is an alloy of gold, copper and silver blended in the ratio 15 : 4 : 1.

    a How much silver is in a 40 g piece of rose gold jewellery?

    b A flute made of rose gold weighs 420 g. How much gold and copper does it contain?

13 Sam makes mocktails using 3 parts grape juice, 2 parts cranberry juice and 4 parts sparkling mineral water.

Shutterstock.com/wavebreakmedia

    a How many millilitres of grape juice will he need to make two 225 mL mocktails?

    b How much mineral water does Sam use to make 900 mL of the mocktail?

    c How many mL of cranberry juice does this mixture require?

Chapter problem

You've covered the skills required to solve the chapter problem. Can you solve it now?

14.05 Ratios of body parts

Artists use body part ratios to make sketches of people look realistic. The diagram shows some of the important ratios for sketching images of adults.

Men and women's bodies have a different shape. Women's necks and waists are thinner, while their hips and thighs are wider. This table shows some of the ratios that are different in adult males and females.

	Males	Females
Shoulder width : head length	7 : 3	2 : 1
Waist width : head length	15 : 7	1 : 1
Hips width : head length	2 : 1	3 : 2
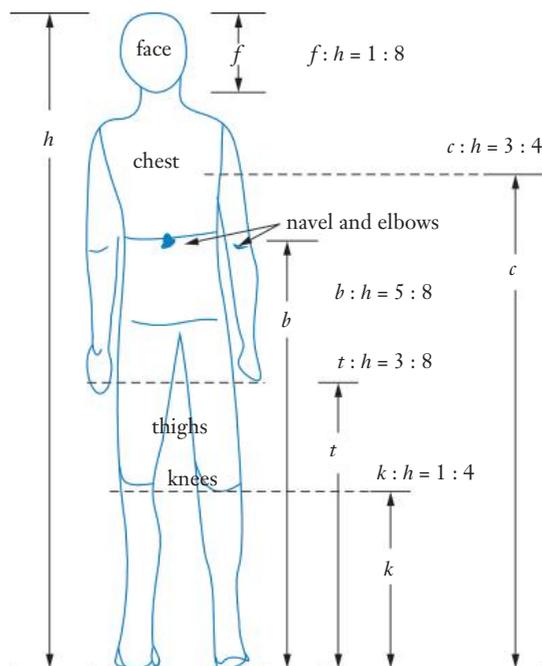
EXAMPLE 8

Lara is sketching an adult male. Her sketch will be 20 cm tall. In her sketch, how big should she make each of the following features?

a The man's head length

b The height of his chest

c The width of his shoulders

Solution

a $f : h = 1 : 8$ from the diagram.

A person's head length is $\frac{1}{8}$ of his height.

Height in sketch = 20 cm.

Head length $= \frac{1}{8} \times 20$

$= 2.5$ cm

b $c : h = 3 : 4$ from the diagram.

A person's chest height is $\frac{3}{4}$ of his height.

Chest height $= \frac{3}{4} \times 20$

$= 15$ cm

c Shoulder width : head length = 7 : 3.

His shoulder width is $\frac{7}{3}$ times the length of his head (2.5 cm from part **a**).

Shoulder width $= \frac{7}{3} \times 2.5$

$= 5\frac{5}{6}$ cm

Exercise 14.05 Ratios of body parts

1 Lara is going to make a sketch of a man 12 cm tall. Calculate the size of each body part on the sketch.

- **a** length of head
- **b** height of knees
- **c** height of mid-thighs and fingertips
- **d** height of navel and elbows
- **e** height of chest
- **f** width of shoulders
- **g** width of hips

2 In the same sketch, Lara is going to draw a woman 10 cm tall. Calculate the size of each body part on the sketch.

- **a** length of head
- **b** height of knees
- **c** height of mid-thighs and fingertips
- **d** height of navel and elbows
- **e** height of chest
- **f** width of shoulders
- **g** width of hips

3 Use the answers to questions **1** and **2** to sketch a drawing of the man and woman.

INVESTIGATION

RATIOS AND TV SCREENS

123RF.com/Erik Reis

1 Measure the width and height of a variety of TV screens. Alternatively, find the measurements of TV screens on the Internet.

2 Calculate the width : height ratio for each TV. Comment on any similarities and differences.

3 Experts recommend that the distance you sit from the TV and the length of the TV's diagonal should be in a ratio of 3 : 1 or bigger. What is the length of the diagonal of the largest TV you should have in your TV room?

14.06 Scale drawings

A **scale drawing** is a reduced or enlarged diagram of a real object, whose lengths are in the same ratio as the actual lengths of the object. The **scale** on a scale drawing can be given as a statement, for example, 1 cm represents 5 m, or a ratio, for example, 1 : 500. The order of the numbers in a scale ratio is important. The first number is about lengths on the diagram, and the second tells us what the measurement is in real life. A scale of 1 : 500 means that 1 unit of length on the drawing represents 100 of the same unit in real life.

The most common scale drawings are maps and house plans. By taking measurements on the scale drawing we can calculate the size of objects in real life using the scale given on the diagram.

To calculate a real length on a scale drawing:
- measure the scaled length on the scale drawing
- multiply by the scale factor
- convert your answer to the required units if necessary

EXAMPLE 9

Barry, a farmer, used a scale of 1 cm : 100 m when he drew this scale drawing of one of his paddocks.

a What are the actual dimensions of Barry's paddock?

b Express the scale as a ratio.

Solution

a Measure the scaled length.
Multiply by 100 m.

Scaled length = 4 cm
Actual length = 4 × 100 m
$\qquad\qquad$ = 400 m

Measure the scaled width and multiply by 100 cm.

Scaled width = 2.5 cm
Actual width = 2.5 × 100 m
$\qquad\qquad$ = 250 m

b Change 100 m to centimetres, then simplify.

Scale = 1 cm : 100 m
$\qquad$ = 1 cm : 100 × 100 cm
$\qquad$ = 1 cm : 10 000 cm
$\qquad$ = 1 : 10 000

Olga, an architect, made a scale drawing of a house using a scale of 1 : 50.

a The actual length of the house is 20 m. What is the length of the house in the drawing?

b The width of the house in the drawing is 24 cm. What is the actual width of the house?

Solution

a Convert 20 m to cm first.

Actual length = 20 m
$\qquad\qquad\quad$ = 2000 cm

Divide by 50 for the scaled length.

Scaled length = 2000 cm ÷ 50
$\qquad\qquad\quad$ = 40 cm

b Multiply by 50 for the actual width.

Scaled width = 24 cm
Actual width = 24 × 50 cm
$\qquad\qquad\quad$ = 1200 cm
$\qquad\qquad\quad$ = 12 m

Exercise 14.06 Scale drawings

1 For each scale drawing, find the actual length shown by measurement and calculation, then express each scale as a ratio.

Example
9

a

Height
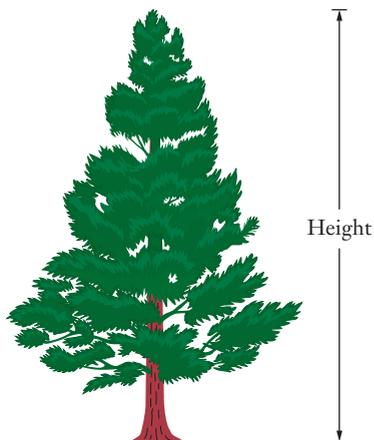
Scale:
1 cm represents 2 m

b

Height

Scale: 1 cm represents 5 m

c

Width
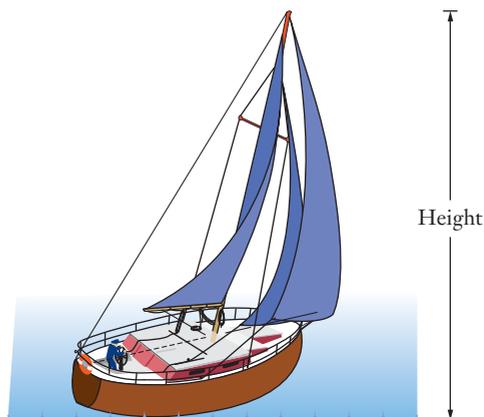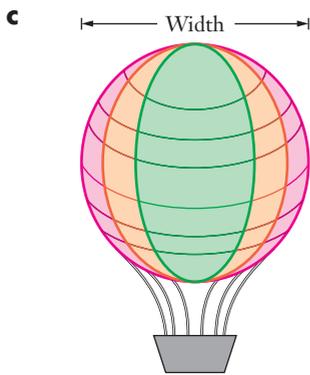
Scale: 1 cm represents 1.5 m

d

Width
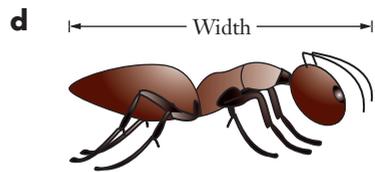
Scale: 1 cm represents 5 mm

e

Height
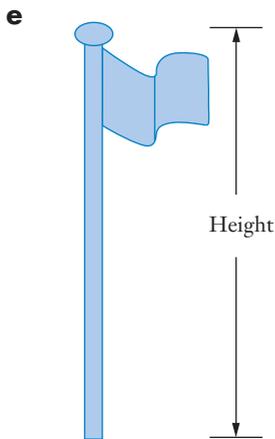
Scale: 1 cm represents 3 m

f

Width
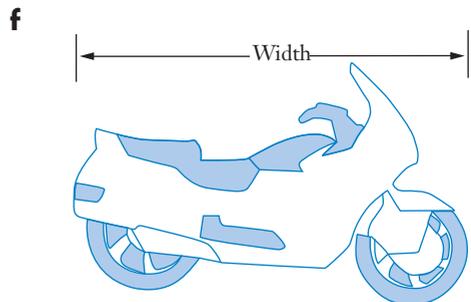
Scale: 1 cm represents 40 cm

2 A street map uses a scale such that 1 cm represents 200 m. Leanne walks from the Town Hall to the shopping centre, a distance that measures 5.5 cm on the map. How far does she walk?

3 Alan has a model of his favourite yacht in his study. The model has been made on a scale such that 2 cm represents 1 m. The model is 50 cm long. How long is the yacht?

Example
10

4 Nagala used a scale of 1 : 50 when she constructed a scale drawing of her courtyard.
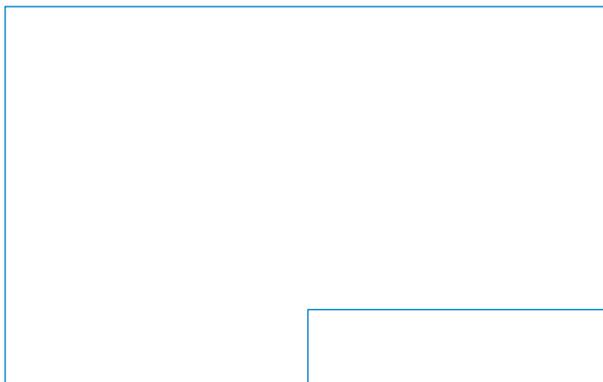
Find the length and width of Nagala's courtyard in metres.

5 Measure the length of each scaled image below, then use the scale ratio to calculate its actual length.

a Fish 1 : 3

Length

Shutterstock.com/Andrew Burgess

b House 1 : 300

Height

Shutterstock.com/Alexmisu

c Pen 1 : 4

Length

Shutterstock.com/Coprid

d Tennis racquet 1 : 16

Length

Shutterstock.com/Jocic

6 Lena collects model cars made in the ratio 1 : 43. Her favourite model is 9.3 cm long. Calculate the actual length of the car to the nearest metre.

7 A map has a scale of 1 : 50 000. Dean has to travel a distance measured as 128 mm on the map. How far does Dean have to travel? Express your answer in kilometres.

KEYWORD ACTIVITY

DEFINITIONS AND EXPLANATION

1 What key words can you find in this chapter? Search through the chapter and list the keywords together with their meaning.

2 Use your own words to describe the process of dividing a quantity in a ratio.

ws

Ratio word blanks

14. Colourful ratios

SOLUTION ^{TO}_{THE}
CHAPTER PROBLEM

Problem

Lara needs 24 mL of purple paint for a flower scene she is painting.
To make the shade of purple she wants, she will mix some cyan and magenta paint in the ratio of 1 : 2. How much of each colour should she use?

Solution

Lara needs 1 part cyan to 2 parts magenta. That's 3 parts.

Each part will be 24 mL ÷ 3 = 8 mL

Lara will need 8 mL of cyan and 16 mL of magenta.

Check: 8 mL + 16 mL = 24 mL and there's twice as much magenta.
✓ Correct!

Colourful ratios

1 Lara mixed 24 mL of white paint with 8 mL of blue paint.

   a   What ratio of blue to white paint did she use?

   b   What percentage of the mixture was white paint?

2 Simplify each ratio.

   a   10 : 25   **b** 8 : 4   **c** 50 : 20   **d** 300 : 500

3 A recipe for making pizza dough mixes plain flour and water in the ratio 8 : 5. Jasmine uses 400 g of flour to make pizza. How much water does she add?

4 Lara is mixing yellow and red paint in the ratio of 4 : 1. She is using 12 mL of yellow. How much red should she add?

5 a   Divide $80 between Manal and Eddie in the ratio of 4 : 1.

   b   Divide 72 km in the ratio of 1 : 2.

6 Lara needs 24 mL of a shade of blue that is obtained by mixing blue, green and white in the ratio of 3 : 2 : 1. How much of each colour should she use?

7 The ratio of the length of a man's head to his total height is 1 : 8. Lara is sketching a man and makes his head 6 mm long. How long should she make the rest of his body?

8 Measure the length of each drawing, and use the scale to find the actual length in centimetres.

a

Scale 1 : 6

b

Scale 5 : 1

15.

GOING PLACES

Chapter problem

Nina and Michelle are planning a 9 km bushwalk. They plan to walk at a speed of 2.5 km/h over the steep and bushy land. They will leave the car park at 10 a.m. and for safety they will log their walk with the park ranger. At what time should Nina and Michelle tell the park ranger to expect them back at the car park?

WHAT WILL WE DO IN THIS CHAPTER?

- Solve problems involving speed, distance and time
- Interpret distance–time graphs
- Calculate stopping distance for different speeds and road surfaces
- Read grid references and information on street maps
- Interpret and use scale on maps
- Find the shortest distance between 2 places
- Plan trips involving distances, speeds, times and costs

HOW ARE WE EVER GOING TO USE THIS?

- Planning holidays and journeys
- Travelling in unfamiliar locations
- Finding an alternate route to avoid traffic problems

WS

Distance,
speed and
time

WS

Speed problems

WS

Racing rates

WS

Speed stories

WS

Speed formula
practice

Speed, distance
and time

15.01 How fast are we going?

The question 'How long will it take to get there?' can be answered easily with a little mathematics. The values for the distance covered, the speed and the time taken are related. When we know two of the values, we can calculate the third value.

Speed formula

Distance covered = speed × time

$$D = S \times T$$

The units for speed tell us the units for distance and time.

When the speed is in km/h, the distance is in kilometres and the time is in hours.

Some students find it easier to use the 'distance, speed and time triangle' to solve problems involving speed. Place the letters D for distance, S for speed and T for time in alphabetical order in the triangle.
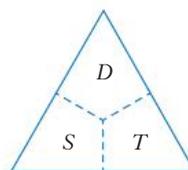
To calculate the **speed**, cover up S, which leaves $\dfrac{D}{T}$.
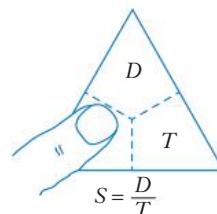
This means that $S = \dfrac{D}{T}$, or $S = D \div T$.
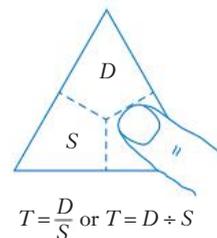
To calculate the **time**, cover up T, which leaves $\dfrac{D}{S}$.

To calculate the **distance**, cover up D, which leaves $S \times T$.
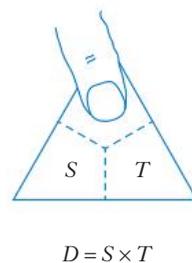
EXAMPLE 1

A racing greyhound runs at a speed of 18 m/s.

a How far will it run in 4 seconds?

b How long will it take the greyhound to complete a 1200 m race? Answer correct to the nearest 0.1 s.

Solution

a Use the triangle. To find the distance, cover the D.

$D = S \times T$

where $S = 18$ m/s and $T = 4$ s.

Write your answer.

$D = S \times T$

$= 18 \times 4$

$= 72$ m

The greyhound will run 72 m.

b To find the time, cover the T.

$T = \dfrac{D}{S}$

where $D = 1200$ m and $S = 18$ m/s.

$T = \dfrac{D}{S}$

$D = \dfrac{1200}{18}$

$= 66.666\ldots$

≈ 66.7 s

Write your answer.

The greyhound will complete the race in 66.7 seconds.

EXAMPLE 2

A kangaroo bounds at a speed of 48 km/h. How far will a kangaroo bound in 20 minutes?

Solution

$D = S \times T$

The speed is in km/h, so we need the time in hours as well. Divide 20 min by 60 to change it to hours.

$S = 48$ km/h

$T = \dfrac{20}{60} = \dfrac{1}{3}$ h

$D = S \times T$

$= 48 \times \dfrac{1}{3}$

$= 16$ km

Write your answer.

The kangaroo will bound 16 km in 20 min.

EXAMPLE 3

Calvin is driving through a school zone at a speed of 40 km/h.
Convert 40 km/h to a speed in m/s, correct to one decimal place.

Solution

To convert 40 km/h to m/s, change 40 km to metres and 1 hour to seconds.

$40 \text{ km} = 40 \times 1000 \text{ m}$

$= 40\,000 \text{ m}$

$1 \text{ h} = 60 \text{ min} = 60 \times 60 \text{ seconds} = 3600 \text{ s}$

$40 \text{ km/h} = \dfrac{40 \text{ km}}{1 \text{ h}}$

$= \dfrac{40\,000 \text{ m}}{3600 \text{ s}}$

$\approx 11.1 \text{ m/s}$

Write your answer.

40 km/h is equivalent to 11.1 m/s.

A **distance–time graph** is a line graph that describes a journey, by comparing distance with time (on the vertical and horizontal axes respectively). The slope or steepness of the graph indicates speed.

EXAMPLE 4

This graph shows Monique's cycling trip.

a   At what time did Monique leave home?

b   When was Monique's first stop? How far from home was she?

c   Find her average speed over the first 2 hours.

d   What time was it when Monique began her journey home?

e   How far did she travel all together?

f   Find her average speed during the trip home.

g   For how long did Monique stop altogether during the trip?

Monique's cycling trip

NELSON SENIOR MATHS 11. Essential Mathematics   ISBN 9780170443906
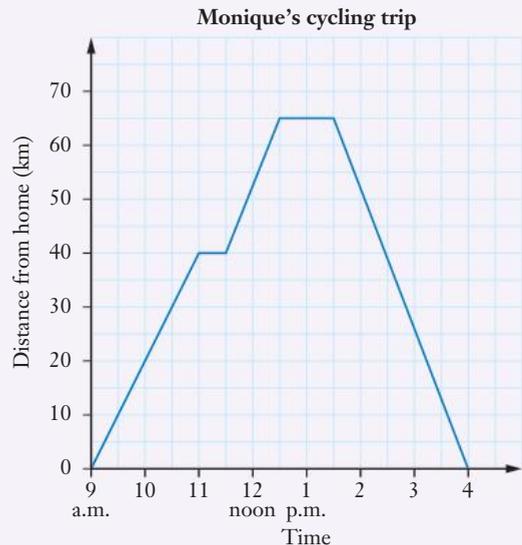
Solution

a Monique left home at the start of the graph, when the distance was 0.

Monique left home at 9 a.m.

b Monique first stopped where the graph is flat. The distance from home does not change, which means Monique has stopped.

Monique first stopped at 11 a.m., 40 km from home.

c Distance = 40 km, time = 2 h.

$$S = \frac{D}{T}$$

$$\text{Average speed} = \frac{40\,\text{km}}{2\,\text{h}}$$

$$= 20\ \text{km/h}$$

d Monique started returning home where the graph points downward.

Monique started returning home at 1:30 p.m.

e Monique travelled 65 km, then returned home.

$$\text{Total distance} = 2 \times 65\ \text{km}$$

$$= 130\ \text{km}$$

f Distance = 65 km, time = $2\frac{1}{2}$ h

$$S = \frac{D}{T}$$

$$\text{Average speed} = \frac{65\,\text{km}}{2\frac{1}{2}\,\text{h}}$$

$$= 26\ \text{km/h}$$

g Look at the places where the graph is flat.

First stop: $\frac{1}{2}$ hour.

Second stop: 1 hour

Total stopping time $= \frac{1}{2} + 1 = 1\frac{1}{2}$ hours

On a distance–time graph:

- a horizontal (flat) section on the graph indicates a stop
- the steeper the line, the greater the speed (more distance covered in less time)
- a section going down, towards the right, indicates a change in direction or that the traveller is returning towards the start.

Exercise 15.01 How fast are we going?

1 a Use the formula $T = \dfrac{D}{S}$ to determine the value of T when $D = 80$ and $S = 16$.

b In the formula $D = S \times T$, what is the value of D when $S = 80$ and $T = 3$?

2 a Corrina is driving at a speed of 60 km/h. How far will she drive in 3 hours?

b How long will it take her to drive 240 km?

3 Anton has an appointment 160 km away. He must be there in 2 hours. At what speed must he travel to arrive in time?

4 Go-karts can race at a speed of 110 km/h. At this speed, how many kilometres can a go-kart travel in a $2\frac{1}{2}$-hour race?

5 Wasim is driving through heavy traffic at a speed of 32 km/h. How far will he travel in 15 minutes?

6 An ambulance is racing to the scene of a serious freeway accident, at a speed of 100 km/h. The accident is 15 km from the ambulance station.

a How long will the ambulance take to reach the accident? Express your answer as a decimal of an hour.

b Multiply your answer to part **a** by 60 to change the time to minutes.

7 A tactical response team is travelling at 80 km/h to reach a hostage situation 10 km away. How long will it take the team to arrive at the scene? Express your answer in minutes.

8 A whitewater rafting team completed 3 sets of rapids and 1.6 km of calm water in 30 minutes. The lengths of the sets of rapids were 150 m, 80 m and 170 m.

a Calculate the distance that the rafting team covered in 30 minutes. Express your answer in kilometres.

b Explain why you can't use $T = 30$ in the equation $S = \dfrac{D}{T}$ to calculate the speed of the raft in km/h.

c Calculate the raft's average speed in km/h.

9 Cheetahs are the fastest animals on land, and can run at a speed of 31 m/s in short bursts.

a How far can a cheetah run in 9 seconds?

b How long does it take a cheetah to run 140 m? Answer in seconds, correct to 1 decimal place.

10 A peregrine falcon's top speed is 90 m/s.

a How far can the falcon fly in one minute?

b How long will it take the falcon to fly 1 km?

11 The table shows the distances between several eastern Australian cities in kilometres.

	Albury	Brisbane	Canberra	Goulburn	Sydney	Tamworth
Albury	–	1610	190	380	600	1040
Brisbane	1610	–	1300	1225	1020	575
Canberra	190	1300	–	95	300	750
Goulburn	380	1225	95	–	205	660
Sydney	600	1020	300	205	–	460
Tamworth	1040	575	750	660	460	–

a How far is it from Canberra to Tamworth?

b How long will it take to drive from Canberra to Tamworth at an average speed of 75 km/h?

c Glen took 5 hours to drive from Goulburn to Albury. What was his average speed?

d Max and Sanjay left Brisbane at 6 a.m. on Monday to drive to Albury. They shared the driving and completed the trip at an average speed of 70 km/h. At what time did they arrive in Albury?

12 Convert each speed to m/s.

a 60 km/h

b 90 km/h

Example **3**

13 The minimum speed a rocket needs to escape the Earth's gravity is 11.2 km/s. What is this speed in km/h?

14 a Use a stopwatch to time how long it takes you to walk across your classroom.

b An international space station travels at a speed of approximately 28 000 km/h. How far does the space station travel in the time it takes you to walk across your classroom?

Getty Images Plus/iStock

Example
4

15 Kyle and Ashley are at the cinema. The distance–time graph shows the distance they were from Kyle's house after the movie finished.

Kyle's distance from home
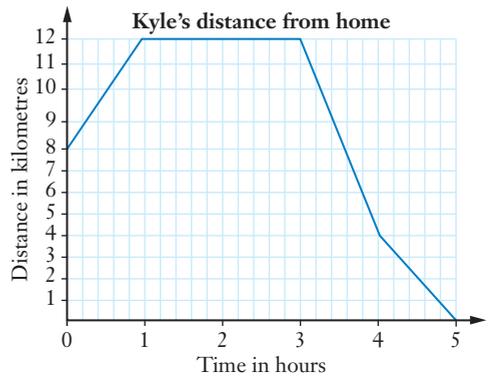
a How far is the cinema from Kyle's house?

b After the movie finished, Kyle and Ashley rode their bikes to Ashley's house. How far is Ashley's house from the cinema?

c How long did it take them to ride from the cinema to Ashley's house?

d What was their average speed riding to Ashley's house?

e How long did Kyle stay at Ashley's house?

f Calculate Kyle's average speed when he was riding home.

g Part of the trip home is downhill and part of it is uphill. Did he ride the uphill section during the first or second hour of his ride home? Justify your answer.

16 This graph shows a cyclist's day trip.

A cycling trip
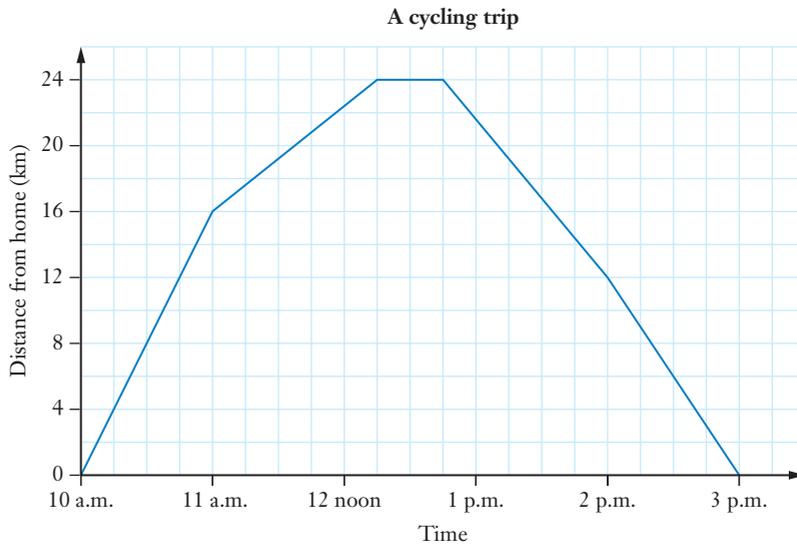
a At what time did the speed of the cyclist

   i increase?   **ii** decrease?

b When did the cyclist start to return home?

c How far did the cyclist travel altogether on this day?

d How long did the cyclist spend 'on the road'?

e Find the cyclist's average speed for:

   i the first hour   **ii** 11:00 a.m. to 12:15 p.m.

   iii 12:45 p.m. to 2:00 p.m.   **iv** the entire day

17 Brian travels from Bligh to Macquarie, while Sam travels from Macquarie to Bligh.

Brian and Sam's journey

a How far is it between the 2 towns?

b Who is travelling faster? How can you tell?

c How far is Brian from Macquarie at 11 a.m.?

d How far is Sam from Macquarie at 11 a.m.?

e At what time do Brian and Sam pass each other? How far are they from Macquarie when they pass?

f Is Sam travelling faster before 9 a.m. or after 9:15 a.m.? How does the graph show this?

g Calculate Brian's average speed before he stops.

h For how long did Sam stop altogether on the trip? Select the correct answer **A**, **B**, **C** or **D**.

    A 60 minutes   **B** 75 minutes   **C** 5 minutes   **D** 90 minutes
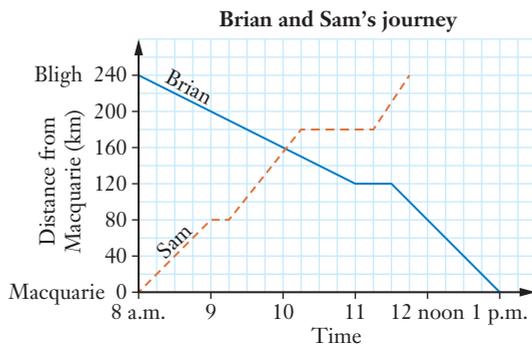
18 Use the clues to determine which person matches with each graph. Copy and complete the table below to record your answers.

Four friends' trips home from school

Clues

• Shelby walks home at a speed of 4 km/h.

• Wayne rides his bike at an average speed of 12 km/h.

• Peta travels on the slow bus. With all the stops, the bus averages only 8 km/h.

• Luke drives home at an average speed of 60 km/h.
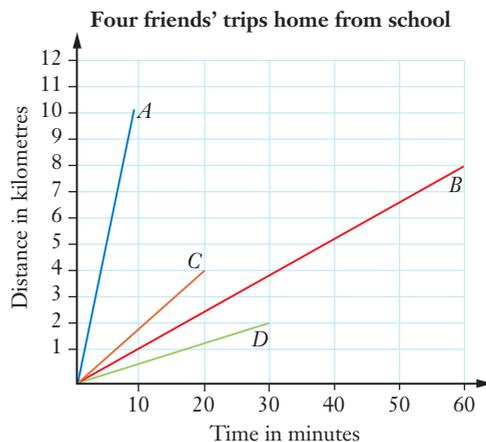
Graph	Person	Distance from school
A		
B		
C		
D		

19 Construct a graph, similar to the graph in question **18**, which shows the trips home from school made by you and 3 other people in your class.

Chapter problem

You've covered the skills required to solve the chapter problem. Can you solve it now?

INVESTIGATION

SPEED UNITS

Use the Internet to investigate a variety of speeds shown in the table below.

Decide on the appropriate units to express the speed: m/s, km/h, km/s, m/h or more than one. Develop a rule for answering the question: 'What units should I use?'

Copy and complete this table or print a copy from NelsonNet.

Activity	Typical or record speed
Slow speeds Moving snail Adult walking Adult swimming Athlete running	
Medium speeds Cruise ship Car Downhill cross-country skiing Olympic speed-skating	
Fast speeds Queensland tilt train Japanese high-speed train International airline jet	
Very fast speeds Bullet fired from an assault weapon Fighter jet International Space Station Sound Light	

Group discussion questions

1 In what situations do we use the following speed units: m/h, m/s, km/s, km/h?

2 Why might we decide to measure the same speed using different speed units?

REACTION TIME

A driver's reaction time is crucial in avoiding road accidents. In this activity, you will measure your reaction time. You will need a 30 cm ruler and work in pairs.

What you have to do

1 Position the ruler with the 30 cm measure at the top and 0 cm at the bottom. One person holds the top of the ruler and the other person holds their hand at the 0 cm mark, ready to catch it.

2 Without warning, the person holding the ruler lets it go and the other person has to catch it. Record the measurement on the ruler where it is caught.

3 Change places and repeat steps 1 and 2.

4 Use the table of values to determine your reaction time.

Measurement (cm)	6	8	10	12	14	16	18	20	22	24	26
Reaction time (seconds)	0.11	0.13	0.14	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23

5 To determine the distance you will travel during your reaction time at different driving speeds, multiply your reaction time in seconds by the speed in m/s. For example, suppose that your reaction time is 0.24 s and you are travelling at 100 km/h = 27.8 m/s. You will travel $0.24 \times 27.8 = 6.67$ m in your reaction time.

Copy and complete this table of values.

Speed (km/h)	40	60	75	80	100
Speed (m/s)	11.1	16.7	20.8	22.2	27.8
Reaction distance (m)					

15.02 Stopping distance

The distance required to stop a car is a combination of the distance the car travels during the driver's reaction time and the distance the car travels after the brakes have been applied.

A formula can be used to calculate the distance required for a car to stop at different speeds on different road surfaces.

The number of metres, D, required for the average driver to stop a car can be calculated by:

$$D = \frac{V}{1000}(210 + 97R)$$

where D = distance covered in metres, V = velocity (or speed) of the car in km/h and R = road surface index, shown by the table.

Road surface index, R	
Dry asphalt	1.3
Wet asphalt	1.6
Gravel	2
Hard snow	6.6
Ice	14.3

EXAMPLE 5

Kelly is driving at a speed of 60 km/h on a gravel road. What distance does she require to stop?

Solution

$V = 60$, $R = 2$ (from table)

Substitute the values into the formula:

$$D = \frac{V}{1000}(210 + 97R)$$

$$D = \frac{60}{1000}(210 + 97 \times 2)$$
$$= 24.24 \text{ m}$$

Write your answer.

Kelly needs 24.24 metres to stop.
(She should allow 25 m).

Exercise 15.02 Stopping distance

Round all answers to 1 decimal place.

Example 5

1 What distance will Kelly travel before she stops when she is travelling at 80 km/h on a gravel road?

2 Anthony was driving on a dry asphalt road at 60 km/h.
   a What distance did his car travel after he decided to stop?
   b How much further would it take him to stop on a wet asphalt road at 60 km/h?
   c What advice would you give Anthony if it started raining when he was driving on an asphalt road?

3 When Myles was driving at 50 km/h on a dry asphalt road, a young child ran onto the road 18 metres in front of him.
   a Can Myles avoid hitting the child? Use a calculation to justify your answer.
   b Would the situation have been different if it was raining? Explain your answer.

4 Iris likes to go to the snow.

   a How far will it take her to stop her car at a speed of 60 km/h on hard snow?

   b Iris drove slowly on the road around the ski lodge because the road was covered with ice. How far will it take her to stop at 15 km/h on the ice?

5 Alana's family often travels in the country. In dry weather, on an asphalt road, Alana usually drives at 100 km/h. What is a safe distance for Alana to leave between her car and the car in front? Explain your answer.

6 Matthew said 'If I double my speed, I need to allow double the stopping distance'. Explain why you agree or disagree with Matthew's statement.

7 The maximum speed, V km/h, a car can be travelling to stop within a distance D m, on a road with surface index R, can be found by using the formula:

$$V = \frac{1000D}{210 + 97R}$$

When she is driving on country roads, Elyse likes to allow herself 32 m to stop.

   a What is the maximum speed Elyse can travel on a gravel road?

   b How much faster can she travel on a dry asphalt road than on a gravel road, with a 32 m stopping distance?

In the previous practical activity you calculated your reaction time. Use your reaction time to answer each question.

8 The distance a car travels during the driver's reaction time, that is, the distance a car travels before the brakes are applied, can be calculated with the formula $D = \dfrac{5Vt}{18}$, where:

D = the distance the car travels in metres

V = the car's velocity, or speed in km/h

t = the driver's reaction time in seconds.

Calculate your own reaction distances for a speed of:

   a 50 km/h   **b** 60 km/h   **c** 100 km/h   **d** 120 km/h

9 The total distance, D m, it takes to stop a car at different speeds on a dry asphalt road can be found by using the formula $D = \dfrac{5Vt}{18}(5t + 2.27)$, where:

V = the car's velocity in km/h

t = the driver's reaction time in seconds.

   a When you are driving on a dry asphalt road at 60 km/h, what is your car's stopping distance?

   b A special speed limit of 40 km/h is applied to roads near schools. How much shorter is your stopping distance on dry asphalt at 40 km/h than at 60 km/h?

   c Why do you think that this special speed limit is necessary?

15.03 Street maps

Street maps have a grid coordinate system to help us locate places. Usually we read the **coordinates** by starting with the horizontal (across) letters, then the vertical (up and down) numbers.

EXAMPLE 6

This is a street map of Manly in Sydney.

a On this map, what is the name of the park at F3?

b What are the position coordinates of Manly Oval?

c What direction is it from Manly Oval to Manly Wharf?

Solution

a Find the position where column F meets row 3 (red).

Ivanhoe Park is located at F3.

b Manly Oval is in column H and rows 3 or 4 (purple).

Manly Oval is at H3 or H4.

c This symbol shows the compass directions on the map. On this map, North (N) is straight up.

Manly Wharf is south of Manly Oval.

An imaginary line from Manly Oval to Manly Wharf points south (blue).
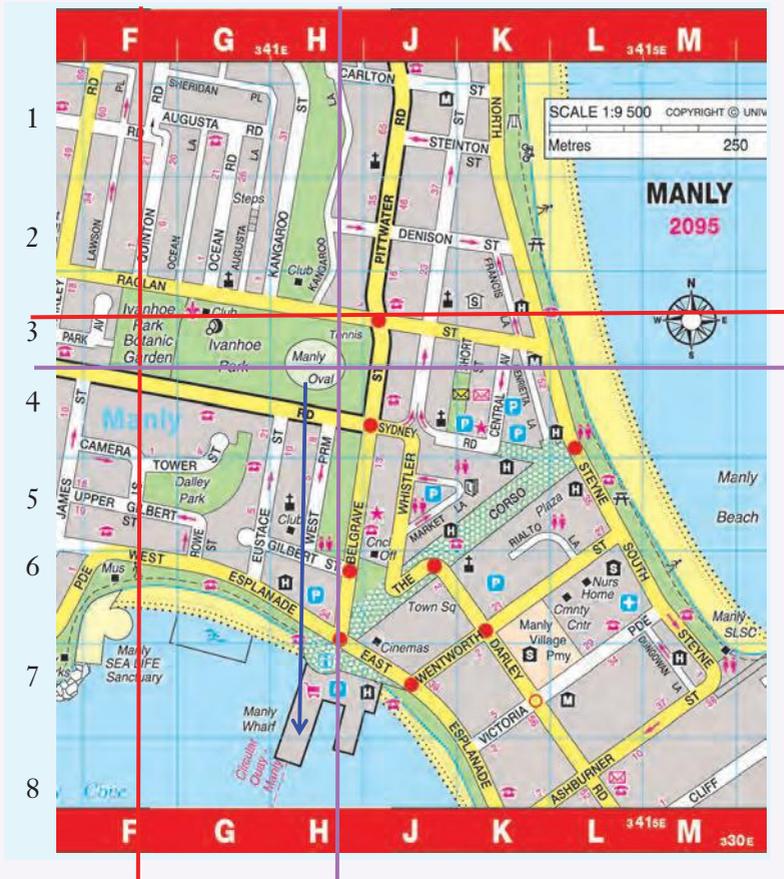
UBD Gregory's Sydney Street Directory Map 29, With permission from Hardie Grant Publishing.

Distances on a street map

Street maps have a scale, which is shown on the map as a diagram or ratio. The scale on the Manly map is 1 cm represents 95 m, also shown as the ratio 1 : 9500 or as a diagram.
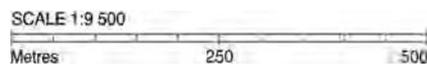
EXAMPLE 7

On this street map of the Melbourne CBD, each grid square represents a distance of 62.5 m. Use this scale to calculate the length of the Royal Melbourne Institute of Technology campus along Swanston St.
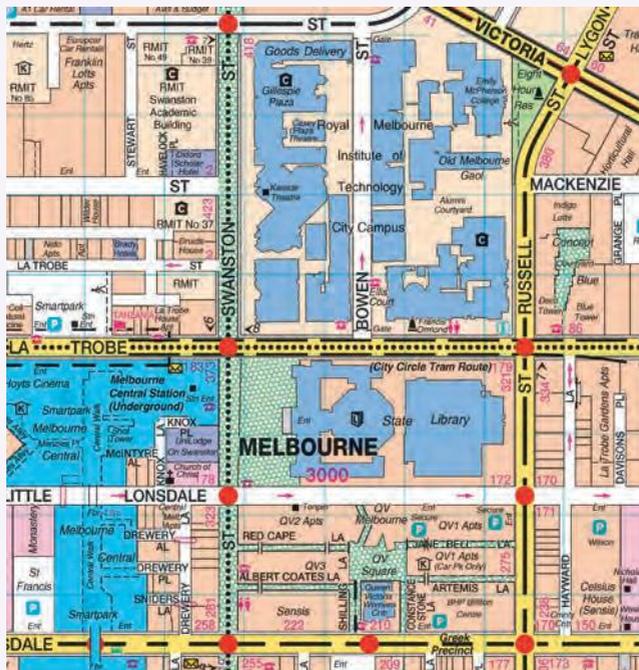
UBD Gregory's Melbourne Street Directory Map 2, With permission from Hardie Grant Publishing.

Solution

The length of the campus along Swanston St covers 4 grid squares. Multiply by 62.5 m.	Boundary length $= 62.5 \times 4$ $= 250$ m
Write your answer.	The Swanston St boundary is 250 m long.

If we need to calculate a distance that isn't along the side of a grid square we can place a chain or piece of string along the distance, then compare the distance to the sides of the grid. In this picture, the length of the chain is roughly 3 grid squares.
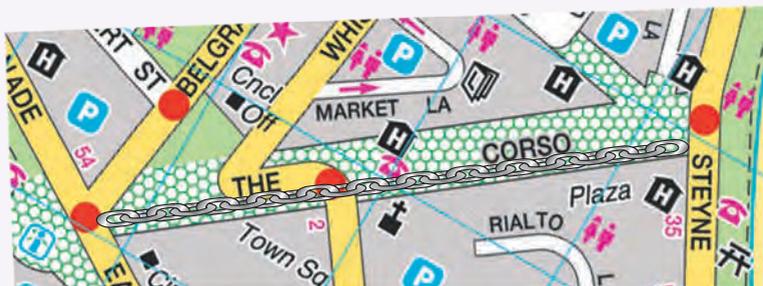
Exercise 15.03 Street maps

Use map 17 next page to answer questions **1** to **8**.

1 a What is the name of the school at F9?

  b What features indicated by small black squares are located in B5?

  c Which shopping centre is located at H12 and H13?

  d There is an ambulance station at J18 on the side of Kingston Drive. What symbol represents an ambulance station?

2 State the position coordinates of each place.

  a Westfield Helensvale

  b Warner Bros Movie World

  c Aveo Tranquility Gardens

3 Name the compass direction from:

  a Westfield Helensvale to Jubilee Primary School (A14)

  b Jubilee Primary School to Warner Bros Movie World

  c Helensvale Primary School to Arcare Helensvale (F12, F13)

  d Arcare Helensvale to Helensvale Plaza

4 On the map, 1 grid square represents a length of 250 metres. Use the grid squares to find:

  a the distance between the traffic lights on Discovery Drive, near the community centre (J10) to the traffic lights at the intersection of Discovery Drive and Lindfield Rd (H11).

  b the direct distance from the roundabout at Helensvale High School (E1) to Helensvale railway station (K13).

  c the length of the Pacific Motorway from the on-ramp in A5 to the off-ramp in E13.

  d the length of the bike track from the Philip Grey roundabout at (H15) to the traffic lights at Warner Bros Movie World (A6).

5 After Kelly got off the train at Helensvale station, she walked home. She walked north along Town Centre Drive. She crossed over the Gold Coast Highway and turned into the second street on the left, then the first on the right. Where does Kelly live?

6 Anna lives on the corner of Ashford Rd and Quirindi Ct (F4). Write instructions for her friend to walk from Hession Oval (E6) to Anna's house.

7 Dinesh is trying to drive west along the Gold Coast Highway to join the Pacific Motorway and head north towards Brisbane. At present he is at K11. There is a traffic jam ahead following a serious road accident. Describe an alternate route Dinesh could take to avoid the traffic.

8 An ambulance has been called to attend the accident on the Gold Coast Highway in front of the Westfield Shopping Centre. Describe a route for the ambulance to follow from the ambulance station in J18 to the accident in H13.

MAP 17
1 KILOMETRE EQUALS 4 GRID SQUARES
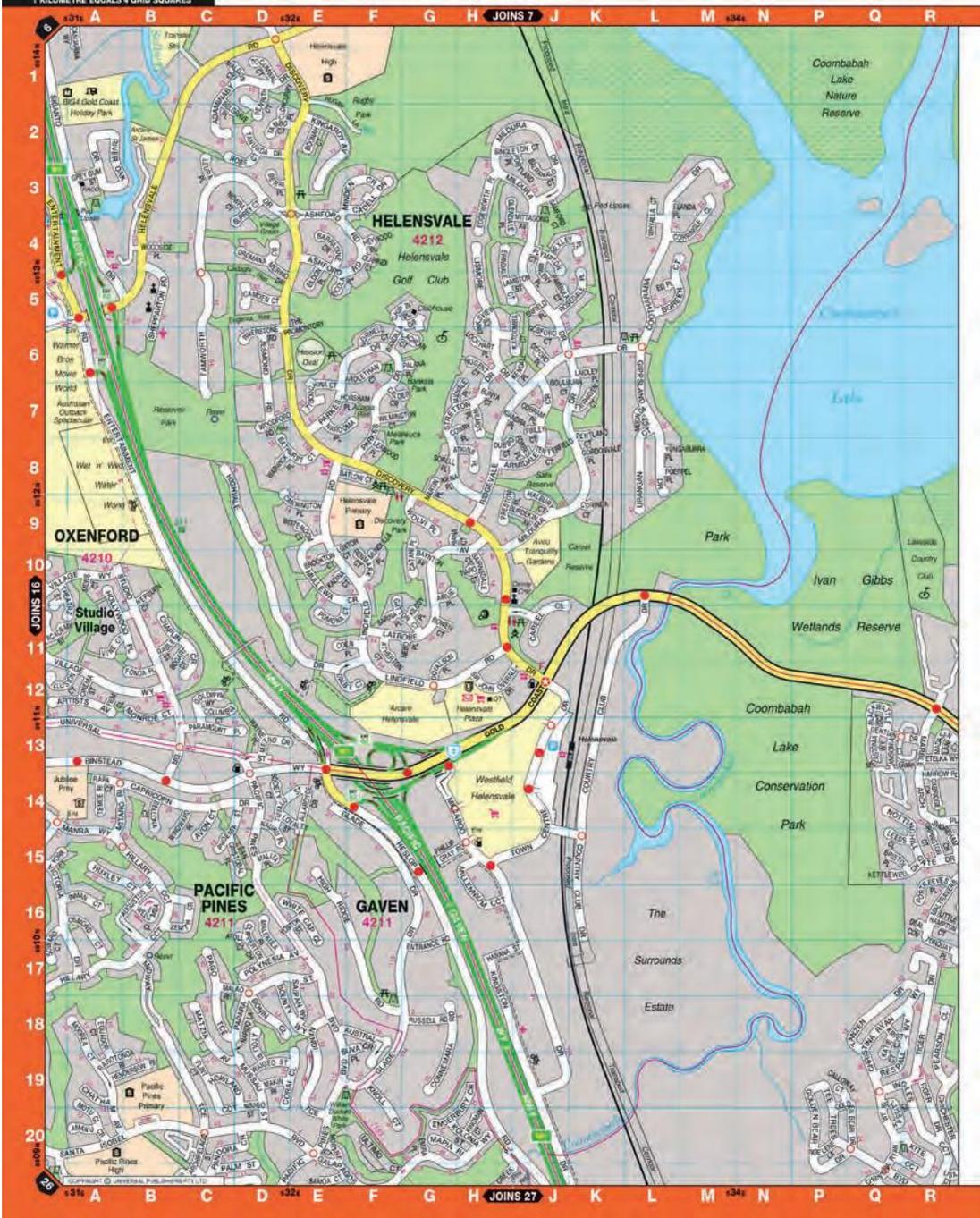
JOINS 7

HELENSVALE
4212

OXENFORD
4210

PACIFIC
PINES
4211

GAVEN
4211

Coombabah
Lake
Nature
Reserve

Coombabah
Lake
Conservation
Park

The
Surrounds
Estate

JOINS 27

Use this map to answer questions **9** and **10**.
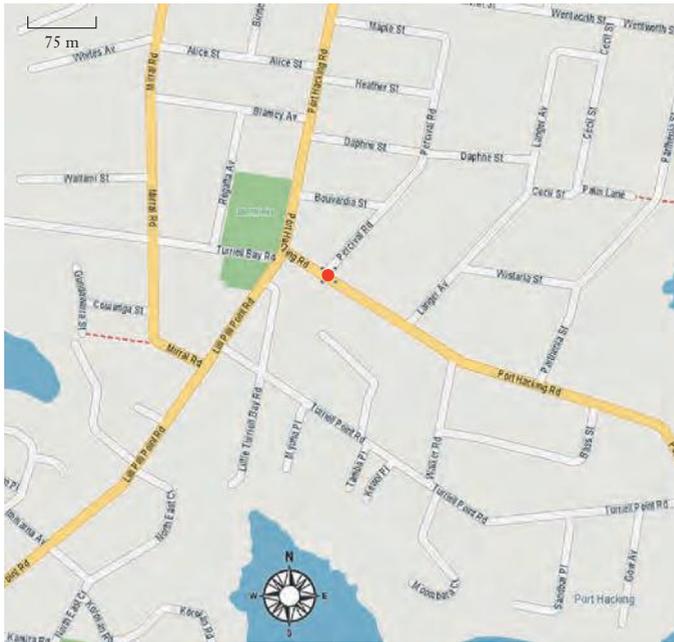
9 Katarina lives on the corner of Port Hacking Rd and Percival Rd (position of the red dot). She walks southeast along Port Hacking Rd and Parthenia St to Zhi's house on the corner of Wisteria St and Parthenia St.
   a What compass direction is it from Katarina's house to Zhi's house?
   b Place a chain or piece of string on the map along the Katarina's route and use the scale on the top left corner to calculate the approximate distance she walks.

10 The next day, Katarina walks northwest from her home to the corner of Mirral Rd and Blamey Ave.
   a Describe the shortest route she could take.
   b Approximately how long is this route?
   c At an average speed of 4 km/h, approximately how many minutes will the walk take her?

INVESTIGATION

DIRECTIONS TO YOUR HOME

Imagine your friends are going to visit your home but they have never been there before. They will be arriving at the closest train station, bus stop, ferry terminal or airport and then require directions to your place.

What you need to do

• Use either a street map or Google Maps to write instructions for your friends to walk, ride a bike or catch a taxi to your place.

• Include distance and direction indications such as left and right as well as compass directions to make following your instructions easy.

15.04 Scales on maps

In Chapter 14, *Colourful ratios*, we learned about scale drawings. We can use a map's scale to calculate lengths on the map.

EXAMPLE 8

The scale on a bushwalking map is 1 : 5000. On the map, a walking trail is 4.5 cm long. How long is the trail in real life?

Solution

1 : 5000 means that 1 unit on the map means 5000 units in real life. Multiply 4.5 cm on the map by 5000 to find the real length.

$$\text{Real length} = 4.5 \times 5000$$
$$= 22\,500 \text{ cm}$$

Convert to metres.

$$= 22\,500 \div 100 \text{ m}$$
$$= 225 \text{ m}$$

Write your answer.

The trail is 225 m long.

Exercise 15.04 Scales on maps

Example 8

1 A map's scale is 1 : 2000. Calculate the real lengths of each feature.
   a Lake 1.5 cm wide
   b Walking track 5.8 cm long
   c Creek 9.5 cm long

2 The map shows 3 walking trails that start at the lodge.
   a What is the scale?
   b What length in real life is represented by 10 cm on the map?
   c How long is the section of river?
   d Calculate the length of the moderate (outer) walking track.
   e Jude started walking along the moderate walking track at 11 a.m. She is walking at a speed of 3 km/h. When will Jude finish walking the track?
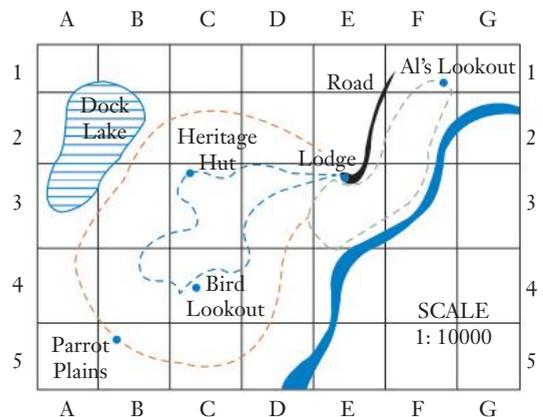
Walking key
- – - Easy
- – - Moderate
- – - Challenging

Remember! You can use a chain or a piece of string to help you measure lengths on a map.

3 Zack lives in Corona Lane. The red star on the map shows the position of his house.
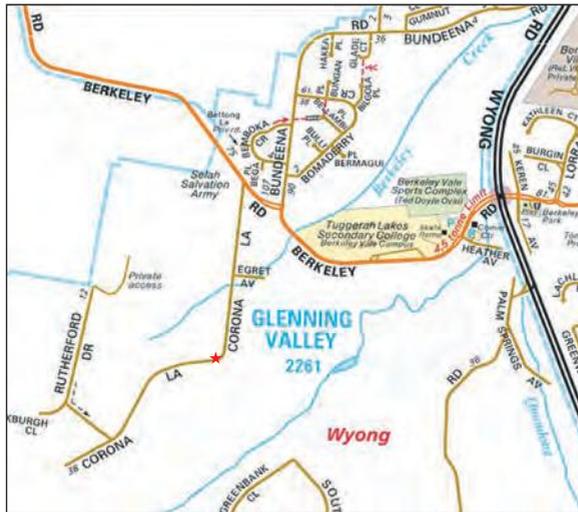
a Use the scale 1 : 18 000 to calculate the distance Zack walks along roads to the entrance of Tuggerah Lakes Secondary College each day.

b Zack walks to school at a speed of 1 m/s. How many minutes does it take him to walk to school?

4 This map shows the road around East MacDonnell National Parks in Central Australia. The scale is 1 : 1 000 000.
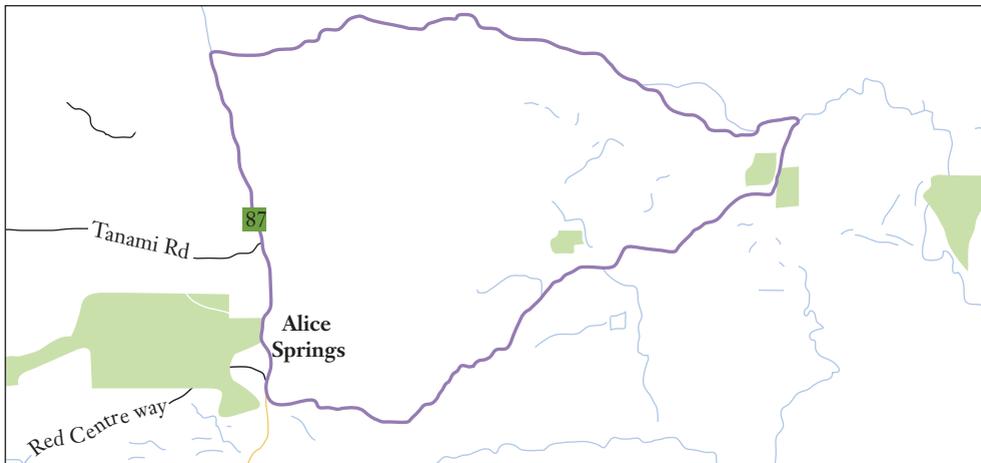
a Use the scale to calculate the length of the road (the circuit outlined in purple).

b The suggested time to drive one circuit of this road is $5\frac{1}{2}$ hours. At what average speed do drivers need to travel to complete the circuit in $5\frac{1}{2}$ hours?

Express your answer correct to the nearest km/h.

c What do you think the surface of the road is like? Give a reason for your answer.

5 Cadastral maps show the boundaries of properties. This part of a cadastral map shows the dimensions of a block of land and the buildings on the land.
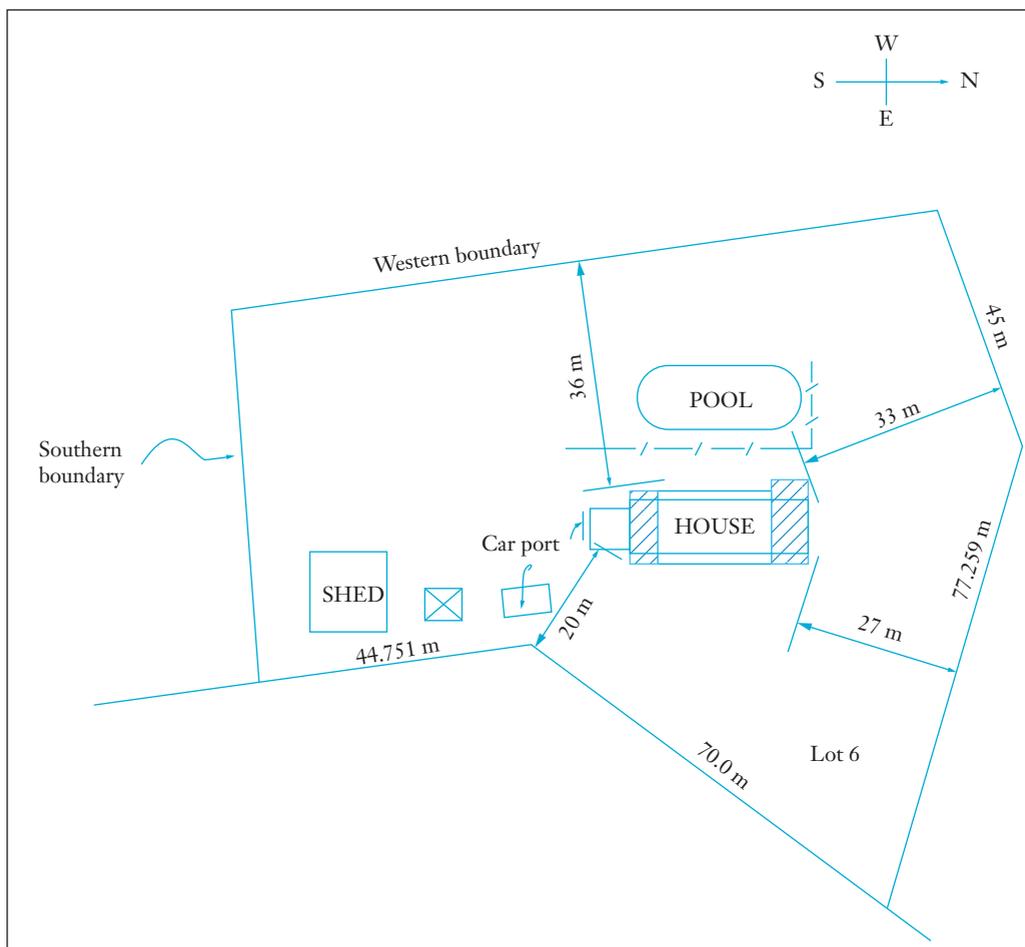
a Approximately how close to the house is the nearest boundary?

b The scale is 1 : 1200. Calculate the length of the southern and western boundaries.

c The owners are going to replace the fence on the southern and western boundaries. The fencing costs $28/m for materials and labour. Calculate the cost of replacing the fencing.

6 The town of Gympie in South-East Queensland is prone to flooding. The map shows the areas affected when the height of the Mary River is 18 m and 23.5 m at the Kidd Bridge (not shown on the map but south of the map). The scale is 1 : 2260.

Source: http://www.streetdirectory.com.au/

—— when Mary River reaches 18 m   —— 1-in-50 year flood level 23.5 m

a Which properties in Mary Street flood when the Mary River reaches 18 m?

b Calculate correct to the nearest metre the length of Reef St that is under water when the Mary River is at 18 m.

c Calculate the length of Mary Street that is under water during a 1-in-50 year flood.

d Estimate the height of the Mary River when the shop at 187 Mary St floods.

e Rhys is considering buying the hotel at 135 Mary Street. What recommendation could you give him?

Shutterstock.com/Philip Schubert

7 Jose, Isaac and Chase were hiking along the coastal track in the National Park. They left their bikes at Otford lookout and set out for Garie Beach.
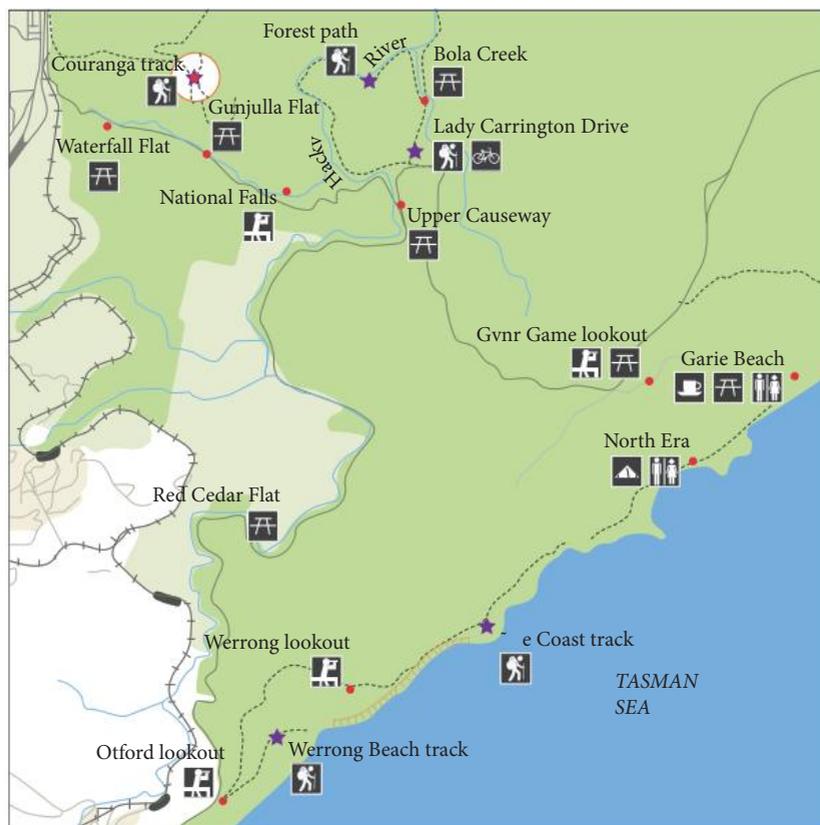
a The map scale is 1 : 127 500. How long to the nearest 0.1 km is the walk from the Otford lookout to Garie Beach?

b The boys hike at an average speed of 4 km/h. How long should the hike take them?

c When they had been hiking for 2 hours, Chase lost his footing, fell and broke his leg. Isaac phoned emergency services for help. Approximately where on the track should he tell the rescue helicopter they are?

INVESTIGATION

A CADASTRAL MAP OF YOUR SCHOOL

A cadastral map shows information about the boundaries of individual and surrounding blocks of land. In this investigation, you are going to make a cadastral map of your school and surrounding properties. Make the map suitable for display in the school's front office foyer.

On the map you should include a compass rose, a scale, the lengths of all boundaries and the position of buildings.

Start your investigation by downloading a map and a picture of the terrain from Google Earth.

15.05 What's the best way to get there?

We can use roughly-drawn diagrams called **mud maps** to represent roads. Here is an example of a map of some roads linking towns A, B, C and D, with all the measurements written in kilometres.

Map
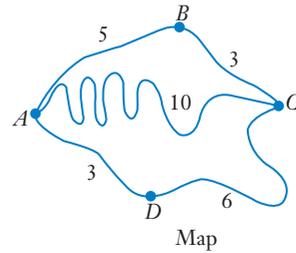
EXAMPLE 9

a In the mud map above, list 3 different ways to travel from towns A to C and the length of each route.

b Which route is the shortest?

Solution

a We could travel directly from A to C, which is 10 km. We could also go via B or D. We can calculate the distances via B or D by adding the distances on the roads.

There are 3 routes:

$AC = 10$ km

$ABC = 5 + 3 = 8$ km

$ADC = 3 + 6 = 9$ km

b Compare the three distances and determine the shortest route.

$ABC = 8$ km.

The shortest routes from A to C is via B.

Exercise 15.05 What's the best way to get there?

In this exercise, all measurements are in kilometres.

1 a List 3 different routes from A to D.

b Calculate the length of each route from A to D.

c Which route from A to D is the shortest?

Example **9**

2 a List 3 possible ways to travel from A to B and the distance involved with each route.

b How long is the route from A to B via C and D?

c What is the shortest distance from A to B?
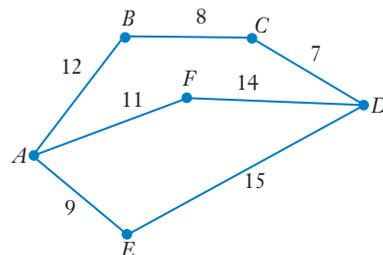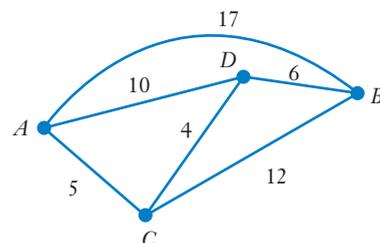
3 a List 4 ways you could travel from A to C.

b Which one of the 4 ways from A to C is the longest?
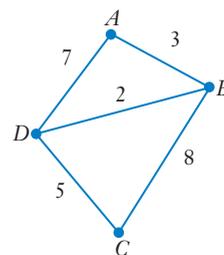
4 Jack is visiting a wine region of the Darling Downs. He sketched a mud map of the places he wants to visit. The numbers are the distances in kilometres.

a Jack is at the chocolate shop. What is the shortest way to the restaurant?

b What is the shortest distance from the restaurant to the winery?

c Calculate the shortest distance from the winery to the cheese factory.
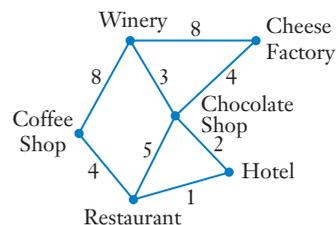
5 The local fire station has a mud map of the area to help get fire trucks to locations efficiently.

There are fires at The Ridge and One Hill Lookout. Describe the shortest routes for the fire trucks to get to the fires.
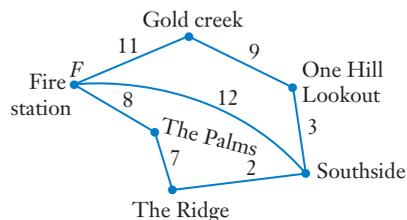
6 Use the map of Manly on page 403 to find the shortest way by road from the corner of Victoria Parade and East Esplanade to Manly Oval in Raglan Street. Check your answer using Google Maps.

SHORTEST DISTANCE FROM HOME

You will need a street map of your local area to complete this investigation.

Locate your home and a useful location on the map, for example, hospital, bank, library, police station or pool.

Determine the shortest way to get from your home to the location you selected travelling on roads. Check your route using Google Maps.

15.06 Regional maps

Josie is travelling from Tamworth to Walcha. How far is it by road?

Bendemeer
50
Walcha
Tamworth
33
NOT
TO
SCALE
8
Nemingham
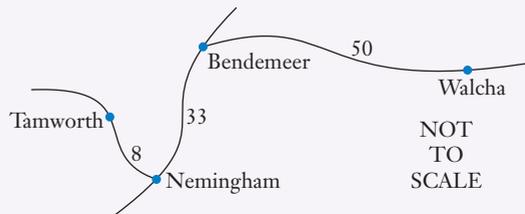
Solution

It's 8 km from Tamworth to Nemingham, then 33 km to Bendemeer and 50 km to Walcha.

Write your answer.

Total distance = 8 + 33 + 50 km

= 91 km

It is 91 km from Tamworth to Walcha.

Exercise 15.06 Regional maps

Use this map from Tasmania to answer questions **1** to **4**.

Launceston
Deloraine
51
57
N
26
Walls of   6
Jerusalem   Conara
NOT
TO   40
SCALE   Miena
3   64
45   19   79
84 Bothwell
Jericho
Bronte Park   37
23
Hobart

Example
10
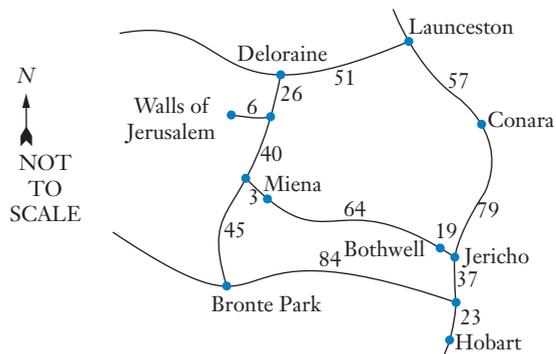
1 Terry drove from Launceston to Bothwell via Jericho. How far did he drive?

2 How far is it from Launceston, via Deloraine, to Miena?

3 Luana drove from her hotel in Miena to see the Walls of Jerusalem and she drove back to her hotel for lunch. What distance did she travel on the round trip?

4 When Luana left Miena to travel to Hobart, the odometer on her car showed $\boxed{3\,|\,5\,|\,2\,|\,1}$ She drove south-east and then south.

    a What was the reading on her odometer when she reached Hobart?

    b The trip took 2 hours and 15 minutes. Calculate her average speed from Miena to Hobart, correct to the nearest km/h.

5 Mick left Emerald in Queensland to go sapphire mining in the nearby gemfields.
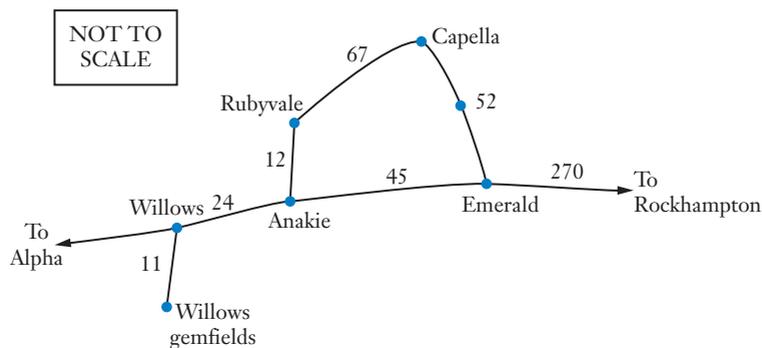
    a How far is it from Emerald to the Willows gemfields?

    b How long will it take Mick to drive from Emerald to the Willows gemfields at an average speed of 75 km/h?

    c Sapphire mining is very hard work in the sun. Mike didn't take sufficient water with him and the closest shop that sells water is in Anakie. At 1:10 p.m., he left the gemfields to get water. If he averages 70 km/h, what time should he arrive at the shop?

    d Mike found a big star sapphire in the gemfields and was very excited! He drove to Rubyvale in 20 minutes to have it valued. He was booked by a speed camera for travelling 120 km/h in a 100 km/h zone.

       i Calculate Mike's average speed from the gemfields to Rubyvale.

      ii So how can the speed detected by the speed camera be explained?

6 Linda drove from Darwin to Katherine in the Northern Territory and then on to see the spectacular red sandstone cliffs in Keep River National Park.

When she left Darwin, the car's odometer reading was 7 3 4 7 5 , and when she reached the Keep River National Park, it was 7 4 2 6 1 .

Darwin

330

Katherine

Timber Creek

NOT TO SCALE

Keep River National Park
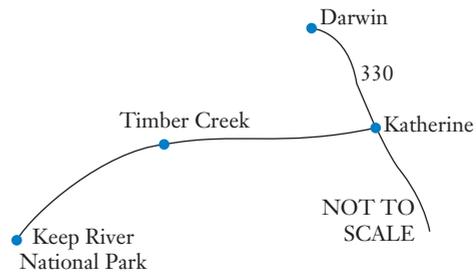
a How far is it from *Katherine* to the Keep River National Park?

b Linda drove at an average speed of 60 km/h. How long did the drive take her?

7 Claire and Jimmy drove southwest from Sydney for 123 km and stopped for lunch.

Lithgow   40

Katoomba   123

Sydney

N

NOT TO SCALE

Wombeyan Caves   123

32   62   Mittagong

Taralga

Crookwell   48   90

44   Goullburn   Bowral

Gunning   50   23   12

Collector

Canberra
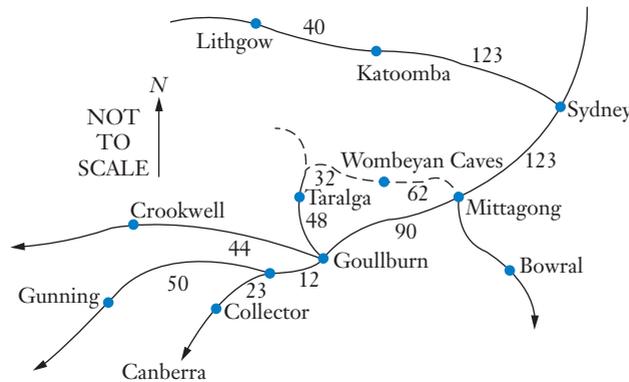
a Where did they stop for lunch?

b Wombeyan Caves was their next stop. They thought the dirt road directly to the caves looked too rough, so they went via Goulburn. How far did they travel?

c Their average speed after lunch was 90 km/h. How long did it take them?

d Their friends Jorja and Gilbert met them at the caves. They drove the 'short', dirt road route from Mittagong to the caves. It took them 1 hour and 40 minutes. What was their average speed?

15. Going places

8 At Wombeyan Caves, Claire and Jimmy camped in their tent while Jorja and Gilbert stayed in an on-site caravan.

Accommodation charges

- **Cabin units $85 per night**
- **On-site caravan $72 per night**
- **Guest cottage $124 per night**
- **Caravan park site $25 per night per site**
- **Camp site $19 per site per night**

Calculate the total accommodation costs for the 4 friends to stay for 2 nights.

9 a Claire and Jimmy went on an afternoon tour of the Junction Cave. At what time did the tour start?

Cave tours times

Fig Tree cave (Self guided)	9 am to 5 pm
Wollondilly	1:45 pm
Junction	11 am and 2:30 pm
Mulwaree	11:30 am
Kooringa	3:15 pm

Cave inspection fees

	Adult	Child	Family
Self guided (Fig Tree cave)	$15	$7	$35
Guided tour	$18	$9	$40
Two-cave package	$22	$12	$50

b How much did the tour cost?

c Jorja and Gilbert toured both the Wollondilly and Fig Tree Caves. How much did they save altogether by buying the two-cave package instead of separate tickets?

10 The next day, the 4 friends had breakfast in Goulburn. Then they left Goulburn at 10:15 a.m. and drove at an average speed of 85 km/h to Gunning. What time did they arrive in Gunning?

THE GREAT TRAILBIKE RACE

Renaldo and Megan were racing against each other in a trailbike competition.

Renaldo completed the first half of the course at an average speed of 5.5 m/s and the second half at an average speed of 4.5 m/s.

Megan rode at an average speed of 5.0 m/s for the whole race.

1 Which rider completed the race in the faster time? Justify your answer.

2 A common misconception is that Renaldo's average speed is $(5.5 + 4.5) \div 2 = 5.0$ m/s, which is the same speed as Megan, so they should finish the race at the same time. Write a paragraph explaining why this thinking is wrong.

> Trying a few different values for the length of the race, such as 4000 m or 1000 m, could help you solve the problem.

Alamy Stock Photo/Marc Oeder/Westend61

15.07 Are we there yet?

The Winslow family of 2 adults and 3 children are travelling from Brisbane to South Australia for a holiday. They plan to stay in motels, caravan parks and the occasional luxury hotel.

Exercise 15.07 Are we there yet?

1 Buses travel from Brisbane to Adelaide every day. Adelaide's local time is 30 minutes behind Brisbane and the times in the bus timetable are local times.

Location	Arrival time	Departure time
Brisbane (Roma St)		8:00 am
Goondiwindi	12:15 pm	1:00 pm
Dubbo	6:40 pm	7:00 pm
Wilcannia	1:00 am	1:15 am
Cockburn	3:47 am	
Time change		
Burra	7:33 am	8:13 am
Adelaide		

a The family plan to arrive at Roma St bus terminal 30 minutes before the bus is due to leave. What time did they plan to be at Roma St?

b The bus stopped at Goondiwindi for the passengers to have lunch. How long was the lunch stop?

c How long does the bus take to travel from Dubbo to Wilcannia?

d Calculate the average speed of the bus between Dubbo and Wilcannia, a trip of 557 km. Answer correct to the nearest km/h.

e Cockburn is on the NSW/SA border and the bus doesn't stop in Cockburn. What is the South Australian local time as the bus travels through Cockburn?

f The bus stops in Burra for the passengers to have breakfast. The family ordered breakfast and it arrived at 7:55. How long do they have to finish it?

g The trip from Burra to Adelaide takes 2 hours and 7 minutes. At what time does the bus arrive in Adelaide?

h How long does it take to travel from Brisbane to Adelaide on the bus?

i The adult bus fare is $210 each way and children pay 70% of the adult fare. How much did it cost the Winslow family of 2 adults and 3 children to travel from Brisbane to Adelaide on the bus?

j The cheapest budget airline tickets from Brisbane to Adelaide are $170 each and the flight takes approximately 8 hours, including a stopover. How much more does it cost the family to travel by bus to Adelaide compared to flying? Suggest some reasons why the family might have decided to go by bus.

2 From Adelaide, the family visited Kangaroo Island in South Australia. They stayed here for 2 days and enjoyed watching its friendly wildlife.

> **Kangaroo Island Tours**
> 2 days/night
> $170 per person

or

> Organise the trip yourself
> Return bus trip from Adelaide $180 family ticket
> Ferry trip $40 each way/person
> Kangaroo Island motel (price per night)
> $130 $30 per child

How much did the family save by using Kangaroo Island Tours instead of organising the trip themselves?

3 The Winslows returned to Adelaide and hired a 4-wheel-drive vehicle to travel north to Peterborough, and then Quorn.
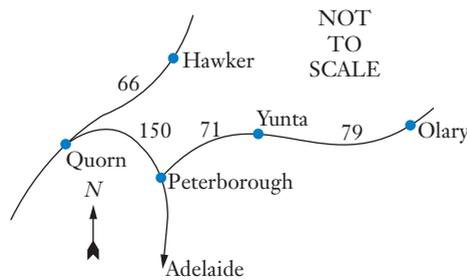
a What compass direction is it from Peterborough to Quorn?

b They left Peterborough at 11 a.m. and arrived at Quorn at 1 p.m. Calculate their average speed.

4 The Winslows stayed at the Quorn Caravan Park.

> Cabin (acc. up to 6) $75 $10
> On-site Van (acc. up to 4) $55 $5
> Tariff/night

a How much did it cost the family to stay in the cabin for 2 nights?

b How much more would it have cost them to use the on-site vans for 2 nights?

c Why would it have cost more for the Winslow family to stay in the on-site vans rather than the cabin?

d Will it always be more expensive to stay in vans than in cabins? Explain your answer.

5 The region around Quorn is shown on this map.
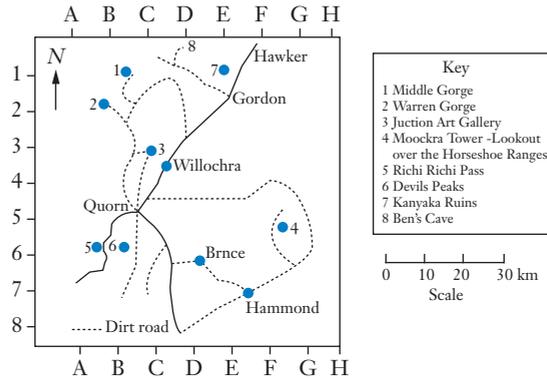
a What scenic attraction is at F6?

b What is the name of the town at D7?

c The children wanted to see some kangaroos. The park manager gave them these directions to a place frequented by kangaroos:

'Travel north-east from Quorn for 24 km and turn left onto a dirt track. Travel another 24 km, then take the track to the right.'

Where did they go to see the kangaroos?

d Mrs Winslow wanted to see the Horsehoe Ranges. She asked for directions to get there from Quorn. What could the directions have been?

6 The next part of the road trip involved travel from Hawker to Arkaroola.
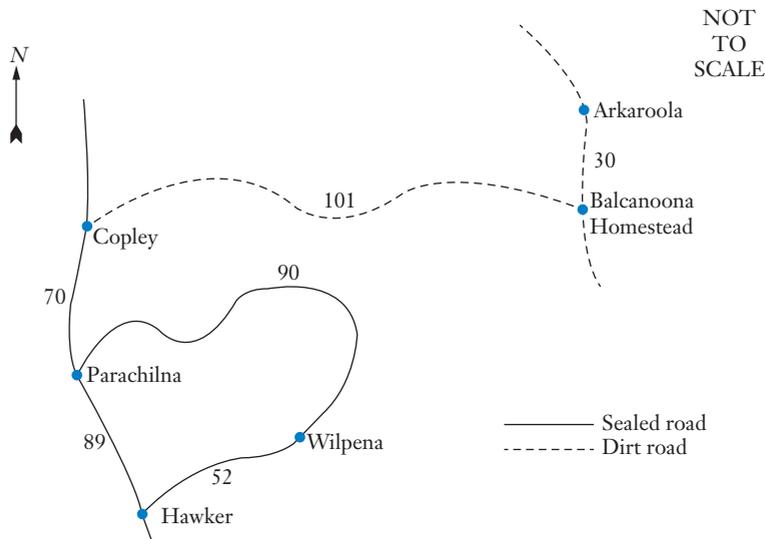
a How far is it from Hawker to Arkaroola via the shortest route?

b The recommended average speed from Hawker to Copley is 80 km/h and from Copley to Arkaroola is 40 km/h. The Winslows followed the recommended average speeds. How long did it take them to drive from Hawker to Arkaroola?

7 At Arkaroola, the Winslows had a choice of 2 luxury lodges.

Greenwood Lodge	Room rates per night
Basic charge	$199 (per double or single)
Additional adult	$36 (each)
Children (sharing) with adults	$30 (each)
Child aged 2 to 12 Family room size	1 double bed and 1 single bed

Mawson Lodge	Room rates per night
Basic Charge	$219 (Per double or single)
Additional adult	$36 (each)
Children (Sharing with adults)	$30 (each)
Child aged 2 to 12 Family room size	1 double bed and 3 single beds

The Winslow children are aged 13, 11 and 8.

a Explain why Mawson Lodge is the more suitable accommodation for the family.

b Calculate the cost of one night's accommodation for the family in Mawson Lodge.

8 The family decided to fly from Arkaroola to Adelaide. The flight takes 2 hours and their plane back to Brisbane leaves Adelaide at 1700. Flights leave Arkaroola at 0600, 0715, 0900, 1345, 1445 and 1600.

a What flight do you recommend they catch from Arkaroola to Adelaide to be on time for their flight home to Brisbane? Give a reason for your answer.

b The flight from Adelaide to Brisbane takes 2 hours and 40 minutes. Calculate the local time when the flight arrives in Brisbane.

PLANNING A TRIP

Some people are required to drive long distances in their job. In this activity, you are going to plan a driving trip for a travelling salesperson from Bunbury to Geraldton. The trip will start at 7.30 a.m.

To complete this activity, you will need access to the internet.

What you have to do

1 Use Google Maps to determine the best route to follow from Bunbury to Geraldton.

2 How long is the trip in kilometres?

3 List several towns on the route and the distances between the towns.

4 How long does the website suggest it will take to complete the drive?

5 Safety experts suggest drivers take a break every 2 hours. At an average speed of 80 km/h, how far will the sales person travel in 2 hours?

6 How many rest stops should you plan to include during the trip?

7 Print a map for the trip and locate some possible rest stop sites.

8 Visit the Main Roads WA website and search for 'Rest areas'. Locate some recommended rest stops near the locations you determined in step 3.

9 List some things that the salesperson should be aware of as they drive this route.

GOING PLACES CROSSWORD

Copy this crossword, then use the clues to complete it.
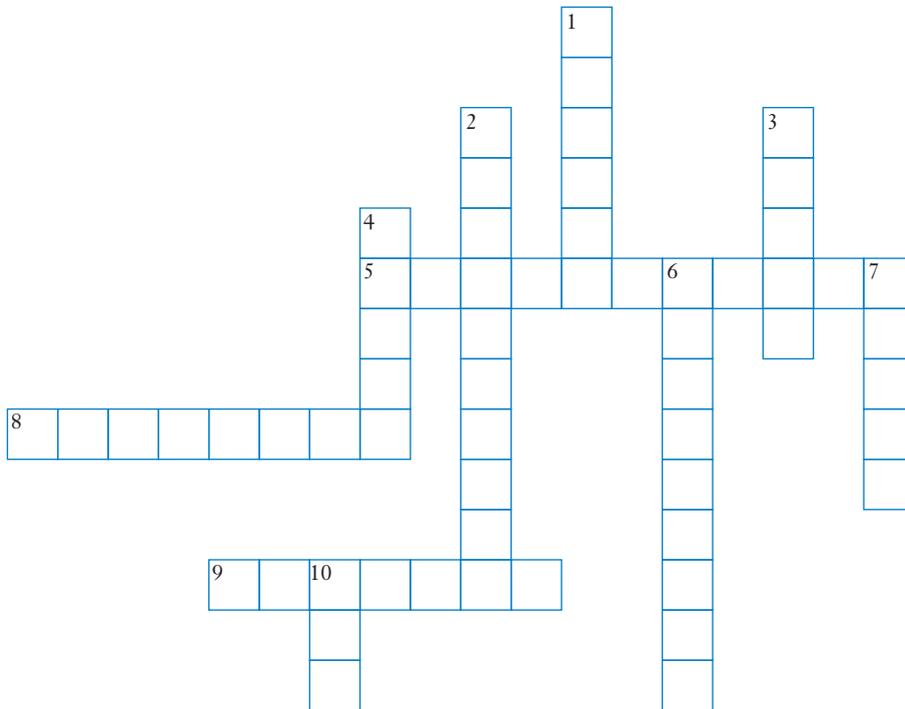
Across

5 The letter-number combination that gives the position of a street or object on a street map

8 What D stands for in the formula $D = S \times T$

9 A type of direction, for example, north, south, east and west

Down

1 What 's' stands for in the speed units m/s.

2 Speed is often measured in _____ per hour.

3 On a map, the compass direction that is usually pointing down

4 A ratio that allows us to calculate real distances from a map

6 The opposite direction to southeast

7 Distance ÷ time

10 A scale diagram of a city or region

SOLUTION ^{TO THE}
CHAPTER PROBLEM

Problem

Nina and Michelle are planning a 9 km bushwalk. They plan to walk at a speed of 2.5 km/h over the steep and bushy land. They will leave the car park at 10 a.m. and for safety they will log their walk with the park ranger. At what time should Nina and Michelle tell the park ranger to expect them back at the car park?

Solution

Leaving 10 a.m.

Walking at 2.5 km/h

9 km walk

Use a formula to calculate time taken.

$$T = \frac{D}{S}$$
$$= \frac{9}{2.5}$$
$$= 3.6 \text{ hours}$$
$$= 3 \text{ hours } 36 \text{ minutes}$$

Nina and Michelle will start the walk at 10 a.m. and finish 3 h 36 min later. They will finish at 1:36 p.m.

Nina and Michelle should tell the park ranger to expect them to return before 2 p.m.

Going places

1 How long will it take Bianca to ride 24 km at an average speed of 8 km/h?

2 Kane is driving at an average speed of 60 km/h. How far will he drive in 15 minutes?

3 Ava travelled 900 m in 45 seconds. Calculate her average speed in m/s.

4 Convert a speed of 90 km/h to a speed in m/s.

5 The graph shows the distance that Kelly was from home. What was Kelly's average speed?

Kelly's distance from home
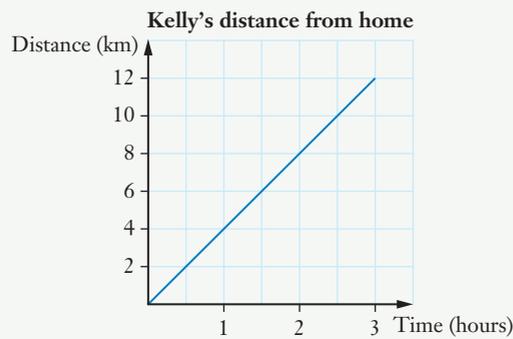
6 The formula $D = \dfrac{V}{1000}(210 + 97R)$ gives the number of metres, D, the average driver takes to stop a car when it is travelling at V km/h and the road surface index is R.

Mason is driving a car at 96 km/h on a gravel road with a road surface index of 2. Calculate the distance it takes to stop the car, correct to the nearest metre.

Use Map 17 from Exercise 15.03 on page 406 to answer questions **7**, **8** and **9**.

7 What village is located at A11?

8 Approximately how far is it from the traffic lights in A13 along Binstead Way to the lights at the motorway off ramp in D13?

9 Describe a route you could follow to walk from Cannington Place (E9) to Wilmington Ct (F7).

10 The map shows the Mount Ngungun walking trail in the Glasshouse Mountains.

Chris is going to walk from the cark park at *P* to Mount Ngungun.
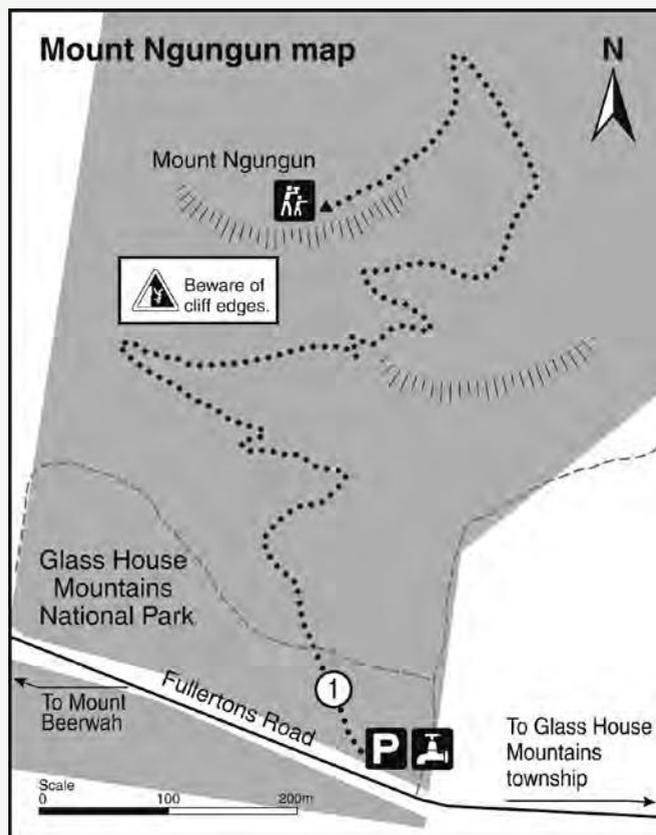
a In what compass direction will Chris travel for the first part of the walk?

b Use the scale to calculate the length of the walk.

c The walk is quite challenging and Chris will only be able to walk at an average speed of 24 m/min. Approximately how long will the walk to the top take?

d Chris plans to leave the car park at 9 a.m. and walk to the top, spend 40 minutes at the top and then walk back to the car park. At approximately what time will he be back at the car park?

11 Find the shortest distance from *A* to *C* in each diagram.

a
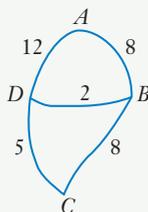
b
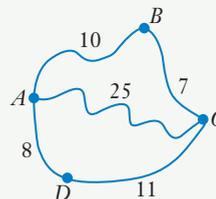
12 Calculate the shortest distance from *A* to *C* on this mud map.
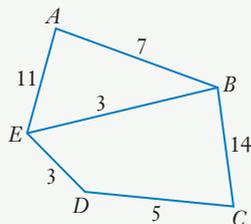
13 The map shows the central region of the Northern Territory that contains Uluru.
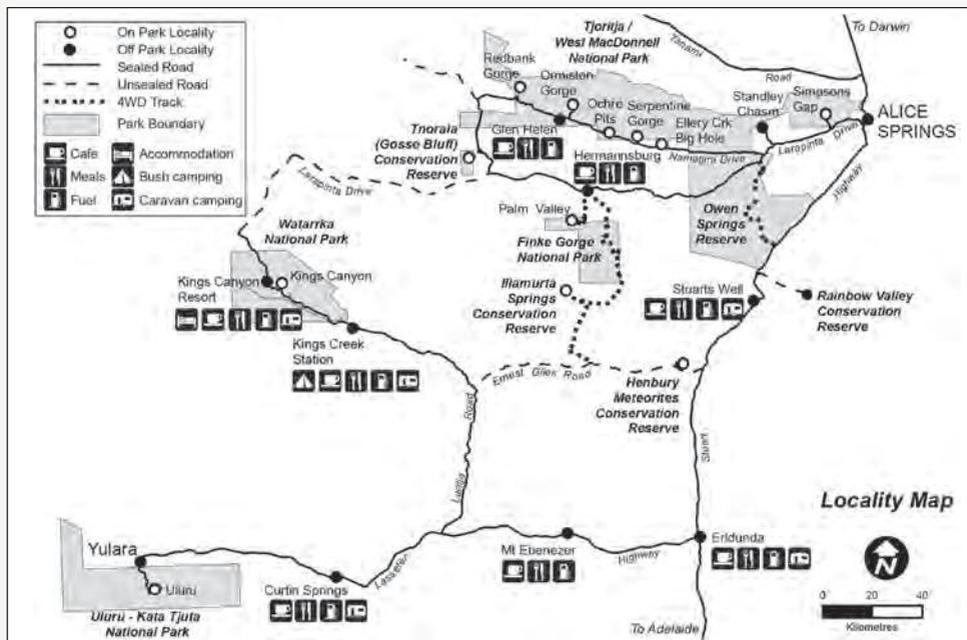
Map of Tjoritja/West MacDonnell National Park supplied by Parks and Wildlife Commission of NT © Northern Territory of Australia.
The Northern Territory of Australia does not warrant that the product or any part of it is correct or complete and will not be liable for any loss,
damage or injury suffered by any person as a result of its inaccuracy or incompleteness.

a What type of vehicle can travel to Finke Gorge National Park?

b Jess wants to drive from Alice Springs to Kings Canyon, but she doesn't want to travel on any unsealed roads. Describe a route she could take.

c Describe a route Jess could take to drive from Kings Canyon to Yulara.

d Damian is having coffee at Mt Ebenezer on the way to visit Uluru. Approximately how far is it from Mt Ebenezer to Yulara?

e Damian plans to spend the night in a caravan park on the way to Yulara. Where do you suggest he should stay?

f What compass direction is the trip from Mt Ebenezer to Yulara?

g Tegan is driving from Stuarts Well to Alice Springs. In what compass direction is she heading?

16.

COMPARING DATA

Chapter problem

Ziad and Adrian are arguing about which local football team is better. The number of goals scored by their favourite teams in each match over the previous season are listed here:

Eagles: 20, 10, 40, 12, 17, 20, 22, 20, 34, 19, 36, 18, 24, 12, 38, 34, 24, 36, 32, 22, 6, 7, 38, 18

Cougars: 14, 18, 24, 39, 14, 4, 4, 14, 10, 13, 28, 22, 16, 18, 18, 12, 18, 28, 21, 6, 10, 18, 36, 12

a What is the best graph to use to show this data? Construct this graph.

b Which is the better team based on this data? Justify your answer.

c What additional data might you need to know to decide which is the better team?

WHAT WILL WE DO IN THIS CHAPTER?

- Calculate a five-number summary for a set of data and create a boxplot for the data
- Compare 2 sets of data using back-to-back stem-and-leaf plots and parallel boxplots
- Analyse and describe the shape of a set of data using words such as symmetrical, skewed and bimodal

HOW ARE WE EVER GOING TO USE THIS?

- When comparing products for sale
- When examining performances in a variety of sports
- To interpret data presented in the media

16.01 Boxplots

The 3 quartiles Q_1, Q_2 and Q_3 for a set of data and the lowest and highest scores together make a **five-number summary** for the data, which can then be graphed on a **boxplot**, also called a **box-and-whisker plot**.

Five-number summary and boxplot

The **five-number summary** for a set of data consists of:

- the lowest score
- the first or lower quartile, Q_1
- the second quartile, the median, Q_2
- the third or upper quartile, Q_3
- the highest score

A **boxplot** is a graphical representation of a five-number summary.
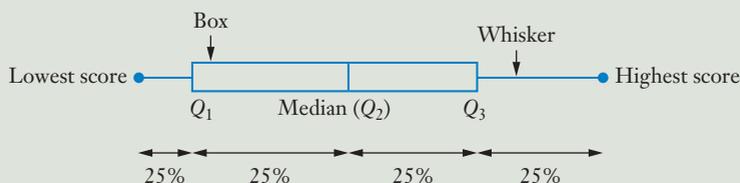
EXAMPLE 1

In Example 4 of Chapter 13, *It's better than average*, on page 339 we found the quartiles for the ages of people at a cafe.

a Write the five-number summary for this data.

b Draw a boxplot for this data.

Solution

a List the required information from Example 4.

The five-number summary is:

Lowest score = 7

$Q_1 = 18$, $Q_2 = 27$, $Q_3 = 33$

Highest score = 39

b Show the five-number summary on a boxplot.
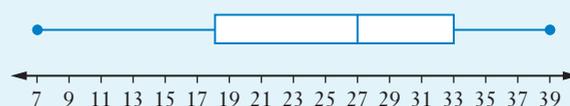
Exercise 16.01 Boxplots

In this exercise you will use your answers to Exercise 13.03.

1 Use your answers to question **1** to:

   a write a five-number summary for the data

   b draw a boxplot for the data.

2 Use your answers to question **2** to:

   a write a five-number summary for the data

   b draw a boxplot for the data.

3 Use your answers to question **3** to draw a boxplot for the data.

4 The monthly number of break-and-enter offences in a rural region was recorded for 27 months.

21   25   17   23   16   21   41   22   25   20   22   11   20   12

13   12   6   12   10   19   30   22   21   14   34   33   24

   a What is the five-number summary for this data?

   b Draw a boxplot for this data.

5 This boxplot represents the amount of pocket money earned by a sample of 60 children.

Pocket money ($)
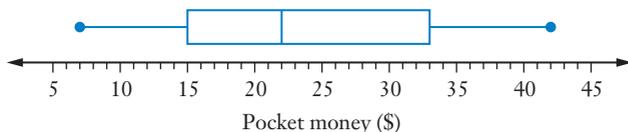
   a Find the median.

   b Find the range.

   c How many children earned between:

      i $33 and $42?   **ii** $15 and $42?

   d Find the interquartile range.

6 This stem-and-leaf plot shows the number of students served at the school canteen over a three-week period.

   a Find the five-number summary for this data.

   b Draw the boxplot for this data.

Stem	Leaf
7	6
8	1 6 8
9	5 7 8
10	1 5 5
11	2 2 4 7
12	4 Key: 7|6 = 76

7 This back-to-back stem-and-leaf plot shows the heights in centimetres of boys and girls in a Year 11 class:

Boys	Stem	Girls
4 4 4 3	16	0 1 3 4 4
9 8	16	5 7
4 2 1 1	17	0 1 2 2 4
6 9 9	17	5 7
2 1 0	18	

Key: 3|16| = 163
|16|0 = 160

a Find the five-number summary for each set of data.

b Draw the boxplot for each set of data.

c Summarise the differences between the heights of boys and girls.

8 This boxplot illustrates the number of cigarettes smoked per day by a sample of 60 smokers who are trying to quit.

a What is the median number of cigarettes smoked per day?

b What is the interquartile range?

c What is the lowest score?

d How many people smoked between 20 and 25 cigarettes per day?

e How many people smoked fewer than 20 cigarettes per day?

9 a Use your answers to question **5** in Exercise 13.03 on page 341 to make a five-number summary for each set of data.

b Draw a boxplot for each set of data.

c In which region do you think it would be safer to open a shop? Justify your answer.
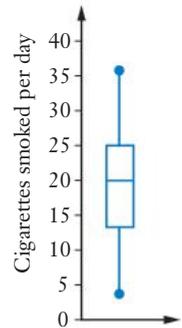
16.02 Back-to-back stem-and-leaf plots

We can use **back-to-back stem-and-leaf plots** to compare 2 data sets.

> ### EXAMPLE 2
>
> Madeline compares the ages of people attending two local gyms.
>
> **Allfit:** 17, 22, 51, 12, 27, 43, 39, 20, 21, 15, 15, 45, 15, 20, 32, 21, 23, 16, 34, 22
>
> **Superfit:** 19, 20, 32, 46, 27, 16, 8, 32, 38, 21, 13, 22, 32, 35, 23, 31, 20, 19, 22, 35
>
> **a** Draw a back-to-back stem-and-leaf plot for this data.
>
> **b** Find the median age for each gym.
>
> **c** Find the range for each gym.
>
> **d** Are there any outliers in either gym? If so, state the outliers.
>
> **e** State one similarity between the two sets of data.
>
> **f** State one difference between the two sets of data.

Solution

a The stem is in the middle.

Allfit		Superfit
7 6 5 5 5 2	1	1 3 6 6 9
7 3 2 2 1 1 0 0	2	0 0 1 2 2 3 7
9 4 2	3	1 2 4 4 5 8
3 3	4	6
1	5	

Key: $2|1| = 12$

$|1|6 = 16$

b Each gym has 20 scores, so the middle scores are the 10th and 11th scores.

Allfit: middle scores are 21 and 22.

$$\text{Median for Allfit} = \frac{21+22}{2}$$

$$= 21.5$$

Superfit: middle scores are 22 and 23.

$$\text{Median for Superfit} = \frac{22+23}{2}$$

$$= 22.5$$

c Range = highest score – lowest score

Range for Allfit = $51 - 12$

$$= 39$$

Range for Superfit = $46 - 11$

$$= 35$$

d An outlier is an extreme score.

51 is an outlier for Allfit.

e Look for similar things about the data.

The medians for both sets of data are quite close. Both sets of data are also clustered in the 20s.

f Look for different things about the data.

Allfit's ages are more spread out than Superfit's. Superfit's ages are spread evenly across the 10s, 20s and 30s; the Allfit ages are clustered in the 10s and 20s.

Exercise 16.02 Back-to-back stem-and-leaf plots

1 The results of 2 Year 10 classes in their final mathematics exam are listed.

10A: 84, 71, 79, 82, 78, 89, 71, 95, 93, 81, 85, 65, 70, 95, 91, 89, 89, 75, 62, 71, 69, 88, 94, 81, 85, 76, 80, 67, 60

10B: 88, 60, 66, 74, 42, 59, 61, 68, 54, 65, 56, 46, 65, 71, 57, 72, 40, 65, 41, 38, 35, 39, 51, 47, 39, 42, 39, 42

a Draw a back-to-back stem-and-leaf plot for this data.
b How many students are in 10A?
c Find the median score for each class.
d Find the range for each class.
e Are there any outliers in either class? If so, state the outliers.
f If one class is the top class and one class is the middle class, which class is which?

2 The school principal Mr Farley is concerned about absences in Year 11 and Year 12. The following shows the daily number of absentees over a 4-week period.

Year 12: 20, 22, 12, 8, 19, 13, 14, 23, 7, 22, 18, 20, 13, 19, 21, 15, 24, 10, 26, 24

Year 11: 30, 15, 30, 23, 39, 20, 31, 42, 22, 41, 30, 25, 23, 30, 22, 30, 29, 15, 15, 44

a Draw a back-to-back stem-and-leaf plot for this data.
b Find the median score for each year group.
c Find the range for each year group.
d Are there any outliers in either year group? If so, state the outliers.
e State one similarity between the two sets of data.
f State one difference between the two sets of data.
g Mr Farley believes there is more absenteeism in Year 11 than in Year 12. What other information would we need to evaluate this statement?

3 For a PE assignment, Kayne compares the heights of males and females in Year 11. The following data he collected are in centimetres.

Males: 178, 183, 167, 184, 181, 170, 190, 181, 181, 200, 183, 160, 165, 172, 178, 178, 168, 191, 181, 190, 180, 184, 180, 175, 170

Females: 178, 166, 166, 150, 168, 166, 163, 162, 167, 159, 157, 185, 176, 164, 165, 164, 160, 185, 176, 177, 171, 152, 173, 173

  a   Draw a back-to-back stem-and-leaf plot for this data. Use stems of 15, 16, …
  b   How many males were measured?
  c   How many females were measured?
  d   Find the five-number summary each for the males and the females.
  e   Are there any outliers in each group? If so, state the outliers.
  f   State one difference between the 2 sets of data.
  g   Write two or three sentences that Kayne could use as a conclusion for his assignment.

4 The following are the daily maximum temperatures for Townsville, Qld and Kiama, NSW in the month of February.

Townsville: 32.1, 32.3, 33.1, 33.4, 31.8, 31.0, 33.7, 34.3, 32.7, 32.7, 31.0, 33.4, 33.6, 34.2, 32.3, 32.5, 31.9, 32.1, 32.8, 31.7, 29.3, 31.9, 31.2, 31.7, 31.2, 32.2, 29.5, 31.0

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Kiama: 33.0, 27.9, 32.6, 27.6, 36.3, 29.6, 21.0, 23.0, 22.5, 25.0, 26.4, 22.1, 20.7, 22.3, 24.9, 25.6, 25.5, 24.5, 27.0, 32.5, 21.8, 20.3, 22.5, 24.7, 25.6, 25.9, 26.7, 25.4

  a   Draw a back-to-back stem-and-leaf plot for this data. Use stems 20, 21, 22, … up to 36.
  b   How many days are there in February?
  c   Find the median for each city.
  d   Find the range for each city.
  e   Are there any outliers in the data for either city? If so, state the outliers.
  f   State one difference between the 2 sets of data.
  g   Write 2 or 3 sentences comparing the temperatures in the 2 cities.
  h   Which town would you prefer to live in based on this data? Justify your answer.

5 This back-to-back stem-and-leaf plot shows the number of points scored in each match by two basketball teams during last season.

Langley Lynx		Blakely Bears
6 6 5 4 3	4	4 9
8 8 3 0	5	2 3 3 6 8
8 8 6 6 3 1 1	6	5 6 8 9
7 4 3 0	7	0 0 1 3 6
6 6 5	8	2 5 7 7 9 9
2 2	9	0 3 4

Key: 3|4| = 43

|4|4 = 44

a How many games were played in this season?

b Find the range for each team.

c Find the median for each team.

d Find the five-number summary for each team.

e Draw a double boxplot for both teams.

f Comment on the similarities and differences of the points scored by the 2 teams.

g Which is the better-scoring team?

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Chapter problem

You've covered the skills required to solve the chapter problem. Can you solve it now?

16.03 Double boxplots

In statistics, there are many opportunities to compare 2 sets of data. We can compare sets of data by drawing two or more boxplots using a common scale. Other types of graphs can also be used to make comparisons.

EXAMPLE 3

The five-number summaries below describe the number of rainy days per month over 2 years for Sydney and Melbourne.

Sydney: 9, 11, 13, 14, 15

Melbourne: 7, 10, 14, 16, 19

a   Draw double boxplots for these summaries.

b   Find the median for each city.

c   What is the interquartile range for each city?

d   Which city has more rainy days per month?

e   If Corrina prefers a more consistent pattern of rainy days, which city would you recommend for her? Justify your answer.

Solution

a   Use one scale for both boxplots.
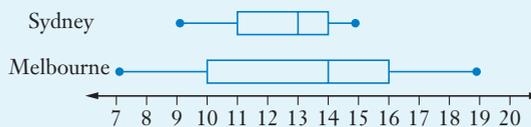
b   The median is the middle number in the five-number summary or the middle bar in the boxplots.

Median for Sydney = 13.

Median for Melbourne = 14.

c   Interquartile range = $Q_3 - Q_1$.

In a five-number summary, Q_1 is the 2nd value and Q_3 is the 4th value, or use the ends of the boxes in the boxplots.

Interquartile range for Sydney = $14 - 11$

$= 3$.

Interquartile range for Melbourne = $16 - 10$

$= 6$

d   Compare the medians and boxes of the boxplots.

Melbourne has more rainy days per month. Its median is higher and half its scores are above 14, compared to one-quarter of scores for Sydney.

e   Consistent means the data is less spread out.

Sydney has the more consistent pattern of rainy days because its range and interquartile range are smaller than Melbourne's. This is shown by the shorter boxplot.

Exercise 16.03 Double boxplots

1 The following five-number summaries are for the half-yearly exam in Rigby's class and Alex's class.

Rigby's class: 48, 64, 75, 87, 96

Alex's class: 47, 57, 69, 80, 97

  a Draw double boxplots for these summaries.

  b What is the median for :
   i Rigby's class?   **ii** Alex's class?

  c What is the range for :
   i Rigby's class?   **ii** Alex's class?

  d Both Rigby and Alex scored 85 in the half-yearly exam. Who performed better in relation to their own class? Justify your answer.

  e Which class generally performed better in the half-yearly exam? Justify your answer.

  f Can we calculate the mean from the given information? Explain.

2 These are the waiting times in minutes for calls to customer service in two phone companies.

Chatphone: 10, 7, 6, 8, 7, 5, 6, 9, 7, 3, 8, 8, 9, 7, 9, 7, 9, 8

Oztel: 10, 5, 9, 9, 9, 10, 11, 9, 8, 7, 9, 7, 7, 6, 9, 8, 11, 11

  a Find the five-number summary for each set of data.

  b Construct double boxplots for this data.

  c Find the median for each company.

  d Find the mode for each company.

  e Find the interquartile range for each company.

  f Chatphone claims that its waiting times are generally lower than those of Oztel. Is this correct? Justify your answer.

  g Is this sufficient information to decide which company you would choose to have your mobile phone with? What other information would you need, if any?

3 The Mayor of Middleton claims that his town is safer for drivers than the nearby town of Blakewell. To test this, James measured the speed (in km/h) of a sample of 20 cars in each town.

Middleton: 60, 65, 70, 68, 62, 75, 80, 83, 82, 69, 73, 75, 85, 72, 67, 88, 90, 85, 72, 63

Blakewell: 76, 64, 58, 82, 72, 70, 68, 75, 63, 67, 74, 70, 79, 80, 73, 75, 71, 68, 72, 73

a Find the five-number summary for each town's data.

b Construct double boxplots for this data.

c Find the median for each town.

d Find the mode(s) for each town.

e Find the mean for each town.

f Find the interquartile range for each town.

g Is the Mayor of Middleton correct? Justify your answer.

4 Janine surveyed a selection of Year 7 and Year 12 students at her school about their favourite drinks, and graphed the results on this **clustered column graph**.

Favourite drink
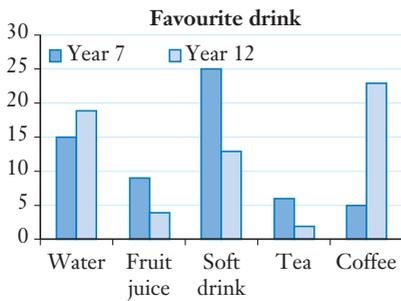
a How many Year 7 students did Janine survey?

b How many Year 12 students did Janine survey?

c What was the most popular drink in Year 7?

d What was the most popular drink in Year 12?

e Why do you think the most popular drink is different in Year 7 and Year 12?

5 The workers across different age groups in two regions were surveyed to find out who belonged to a workers' union. The results are displayed in a back-to-back histogram.

Union membership by age and region

Percentage belonging to a workers' union

a What percentage of 45- to 54-year-olds in the eastern region belonged to a union?

b Which age group had about the same percentage of union members across both regions?

c Compare the shapes of both distributions.

d Comment on the statement 'People in the eastern region are more likely to join a union'. Justify your answer.

6 The monthly average minimum temperature for Bourke and Coffs Harbour in NSW are displayed on this radar chart.

a What was the average minimum temperature in Coffs Harbour in January?

b In which month did both cities have the same average minimum temperature?

c In which months did Bourke have the lower average minimum temperature?

d Estimate the range of temperatures in Coffs Harbour.

e Which town would you choose to live in, if you don't like hot summers and cold winters? Justify your answer.
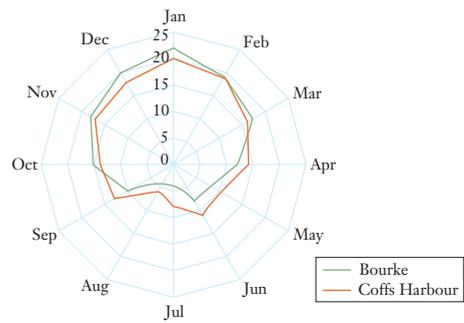
16.04 The shape of a distribution

When there is an overall pattern to the data in a histogram we can draw a smooth curve around the histogram to represent the data. We can also draw a curve around dot plots and stem-and-leaf plots to see the shape of the data.

Here are 3 examples of smooth curves that represent the general **shape of a distribution**.
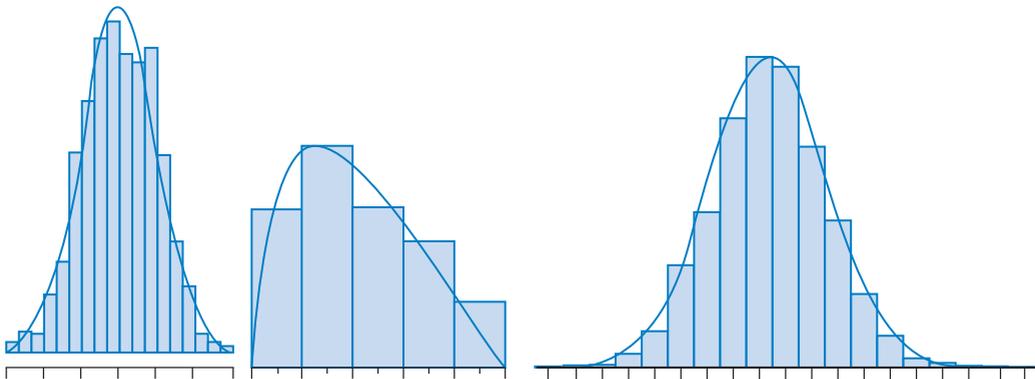
Symmetrical distributions

The first and third curves above show **symmetrical distributions**. One half is the mirror-image of the other half. You could fold it down the middle and the 2 sides would match.

A symmetrical curve could represent the masses of all high school students in Australia.

EXAMPLE 4

Construct a smooth symmetrical curve over this histogram.
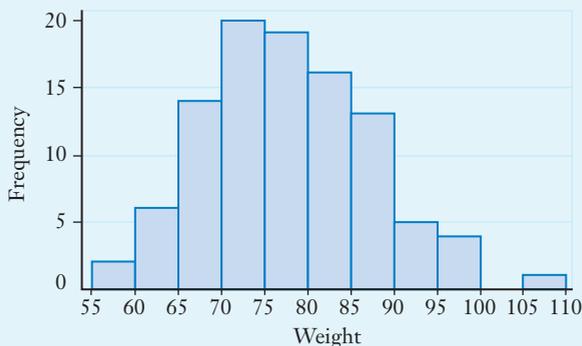
Solution

Locate the centre and use the heights of the columns to form a smooth hump for the top of the curve. Then symmetrically flatten out the curve on both sides, slightly above the horizontal axis.
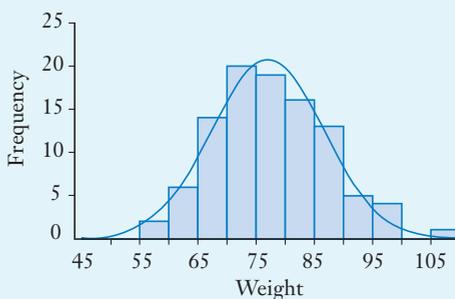
Histograms rarely have a perfect symmetrical shape. Sometimes they are pushed sideways or they have more than one peak (high point). Statisticians have names for the different types of curves and distributions.

Skewed distributions

When data is not symmetrical but pushed to one side, it said to be **skewed** (which means 'twisted'). We can identify the type of skew by looking at the 'tail' of the curve. When the tail is on the left, the data are **negatively skewed**. When the tail is on the right, the data are **positively skewed**. One way of remembering the direction of skewness is to note that on a number line, negative numbers are on the left and positive numbers are on the right.

(–) Negatively skewed distribution

(+) Positively skewed distribution
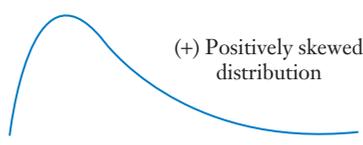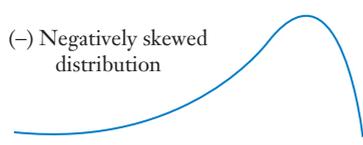
A **negatively-skewed distribution** could represent the marks scored by students on an easy test. Most students achieved high marks while comparatively few scored low marks.

A **positively-skewed distribution** could represent house prices in a small country town. There are lots of moderate prices for the houses and comparatively few high prices for bigger houses and farms.

Uniform distributions

If we roll a normal die many times, each of the possible six numbers should appear roughly the same number of times, giving a **uniform distribution**. Its graph is close to one big rectangle. Uniform means 'the same' and in a uniform distribution, the scores are evenly distributed.
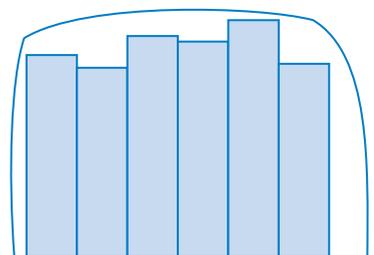
Bimodal distributions

This graph represents the amount of traffic crossing a bridge over a day. There are two peaks on the curve, corresponding to the morning and afternoon busy times. Because it has two peaks, this curve represents a **bimodal distribution**.

When there is only one peak, it's called a **unimodal** distribution.
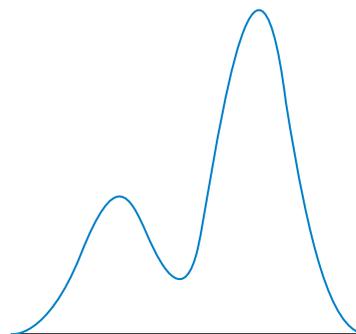
Shutterstock.com/Lunars

This graph shows the number of car owners by age who claim on their car insurance. Describe the shape of the distribution.
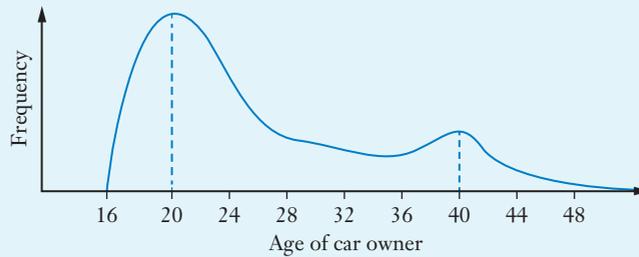
Solution

The distribution is not symmetrical so it is skewed. The tail points to the right, so it is positively skewed.

There are peaks at age 20 and 40, so the distribution is also bimodal.

The distribution is positively skewed and bimodal.

Exercise 16.04 The shape of a distribution

1 Copy each histogram.

    a   Sketch a smooth curve over each one.

    b   State whether the curve is symmetrical or not.
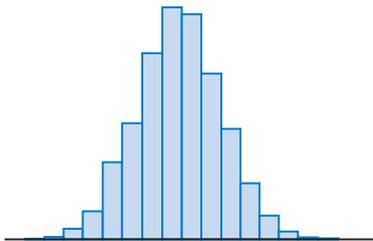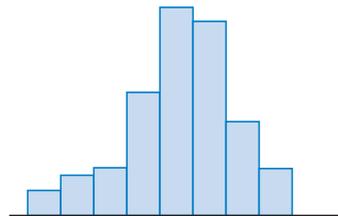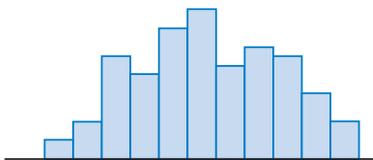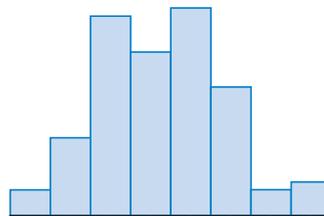
Example 4

i

ii

iii

iv

Example
5

2 What type of distribution is shown in each graph? Choose from symmetrical, positively skewed, negatively skewed and bimodal.

a Age at retirement

b Australian family income

c Number of people waiting to catch a train

d Height of trees in a forest
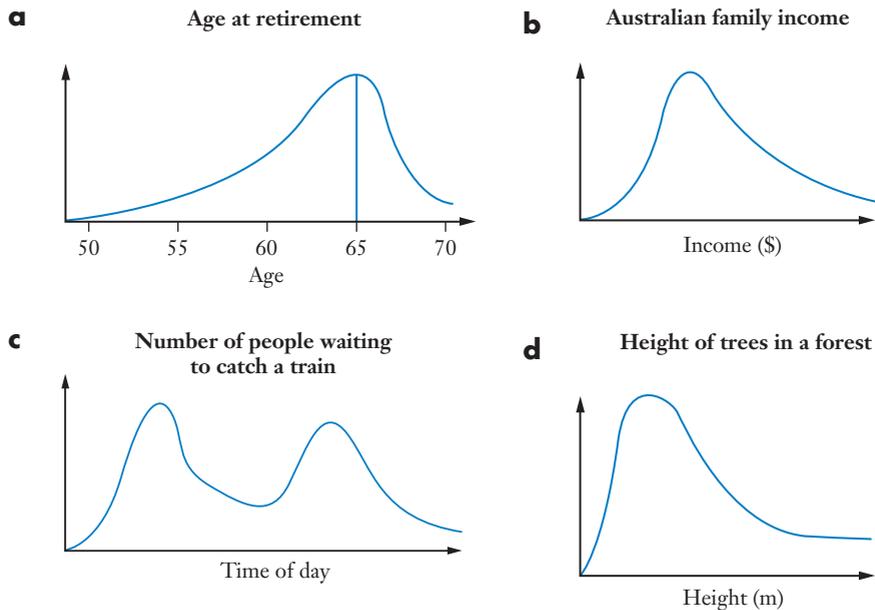
3 Which graphs in question **2** are unimodal (have one peak)?

4 Sketch a graph to represent each distribution described. Remember to label the axes.

a The age at which a person dies is negatively skewed, with a mode of 80 years.

b The percentage marks students scored on a difficult exam has a bimodal, positively skewed distribution. A small group scored 90% but the majority scored around 40%.

c A bus carrying passengers to a concert includes a large group of dancers and a small group of rugby players. The distribution of the body mass (weights) of the passengers is bimodal.

d The heights of 2000 randomly-selected girls aged 17 are distributed symmetrically.

e When a die is rolled 100 times, the numbers that come up have a uniform distribution.

f The number of minutes visitors to a museum spend looking at a display that includes a 5-minute video is bimodal. Most visitors spend less than 1 minute looking at the display, but some also watch the entire video and the display. Very few people look at the display between 1 to 5 minutes.

Shutterstock.com/Evikka

5 How can you tell that the data in this box-and-whisker plot is positively skewed?

5 7 9   19   29

6 Construct a box-and-whisker plot that shows data that are negatively skewed.

7 Construct a dot plot with scores from 1 to 8 that has a bimodal, symmetrical distribution.

8 This 'trimodal' distribution represents the number of customers at a city business at different times of the day.

   a Why is it called a trimodal distribution?

   b What type of business do you think it could be? Give a reason for your answer.
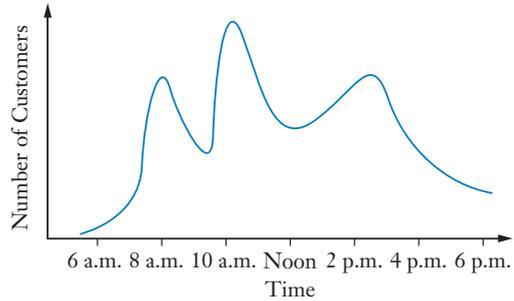
9 This stem-and-leaf plot shows the exam marks of a group of History students.

   a Describe the shape of the distribution.

   b Change four of the exam marks to make the distribution more like a symmetrical distribution. For example, you could change the 59 to 79.

Stem	Leaf
5	3 6 7 8 9
6	2 5 4
7	1 2
8	2
9	0

10 This histogram shows the amount of time customers at an appliance store had to wait for items to be brought in from the warehouse.

   a Describe the shape of the distribution.

   b Suggest a possible reason for the shape of the distribution.
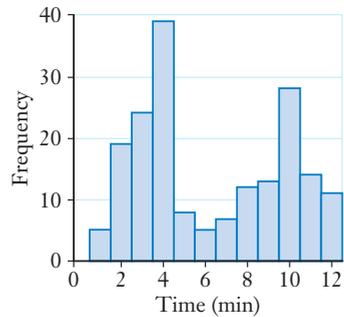
11 Sometimes, test marks in student reports are presented as a graph showing the position of the mark relative to the distribution of the marks of all students. The graph below shows Brock's test mark for mathematics compared to the rest of his class.

   a Describe the shape of the distribution.

   b Was the mathematics test easy or hard? Justify your answer.

   c Estimate the mode mark.

   d How did Brock perform in the test compared to the rest of the students?

Your child's mark is 80

Test marks from 45 to 92
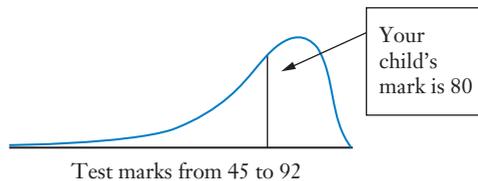
IS IT REALLY BIMODAL?

This histogram shows the number of online orders a company receives per 2-hour interval over a 24-hour period. The data appears to be bimodal.
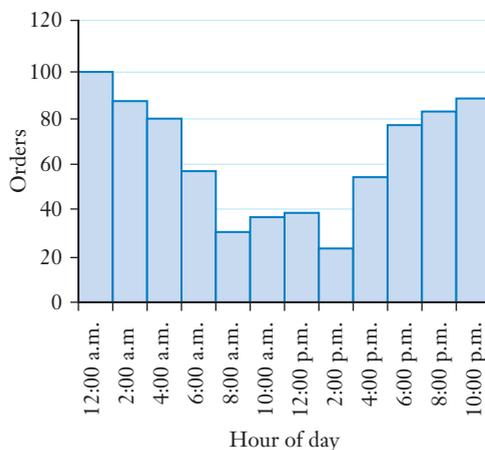
1 Construct another graph to display the same data, but start the horizontal axis at 12 p.m.

2 Describe the shape of the distribution displayed on the graph you constructed.

3 When you are displaying cyclic data, for example hourly, daily, or monthly data, describe how you can construct a graph that makes the data appear to be bimodal when it is only unimodal.

KEYWORD ACTIVITY

1 Describe a back-to-back stem plot and a double boxplot in your own words. Draw a rough sketch of what they look like.

2 What is a **five-number summary?**

3 Match the terms in the left column with their correct meanings in the right column.

a	bimodal	**A**	A rectangular distribution where every score has a similar frequency.
b	skewed	**B**	A distribution with two peaks.
c	unimodal	**C**	The scores that divide the data into four equal parts.
d	quartiles	**D**	A distribution where most scores are to the left or right of centre and there is a tail on the side that doesn't have many scores.
e	uniform	**E**	A distribution with one peak.

SOLUTION ^{TO} THE CHAPTER PROBLEM

Problem

Ziad and Adrian are arguing about which local football team is better. The number of goals scored by their favourite teams in each match over the previous season are listed here:

Eagles: 20, 10, 40, 12, 17, 20, 22, 20, 34, 19, 36, 18, 24, 12, 38, 34, 24, 36, 32, 22, 6, 7, 38, 18

Cougars: 14, 18, 24, 39, 14, 4, 4, 14, 10, 13, 28, 22, 16, 18, 18, 12, 18, 28, 21, 6, 10, 18, 36, 12

a What is the best graph to use to show this data? Construct this graph.

b Which is the better team based on this data? Justify your answer.

c What additional data might you need to know to decide which is the better team?

Solution

a For this list of scores, the best graph is a stem-and-leaf plot.

Eagles		Cougars
7 6	0	4 4 6
9 8 8 7 2 2 0	1	0 0 2 2 3 4 4 4 6 8 8 8 8 8
4 4 2 2 0 0 0	2	1 2 4 8 8
8 8 6 6 4 4 2	3	6 9
0	4	

b From the shape of the scores of each team, it looks like the Eagles scored more goals than the Cougars. Compare their medians and clusters.

The median for the Eagles is 22.

The median for the Cougars is 17.

The scores for the Cougars are clustered in the 10s.

The scores for the Eagles are spread evenly across the 10s, 20s and 30s.

Based on this data, the better team is the Eagles.

c You would need to know how many games each team won. It would also help to know how many points were scored in total, and how many goals were scored *against* each team.

Comparing data

Exercise 16.01

1 The following are the Mathematics test results for Manuel's class.

6   4   2   10   16   12   14   12   6

11   9   10   12   13   18   4   10   14

a   What is the five-number summary for this data?

b   Draw the boxplot for this data.

Exercise 16.01

2 This boxplot summarises the number of hours worked in one week by each employee of Café Coffee.
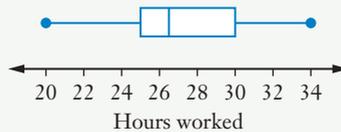
a   What is the median for this data?

b   Find the range.

c   How many employees worked between 30 and 34 hours, if there are 36 employees altogether?

Exercise 16.02

3 The scores of two cricket teams in one season of the local competition are listed below:

The Bulls: 83   125   89   113   109   90   127   159   98   140   114   137

The Tigers: 130   144   104   72   139   133   109   97   138   147   126   139

a   Draw a back-to-back ordered stem-and-leaf plot for this data.

b   How many matches did each team play in one season?

c   Find the median for each team.

d   Are there any outliers in either set of data? If so, state the outliers.

e   Which team is the better team? Justify your answer.

Exercise 16.03

4 These are the five-number summaries for the quiz results of 11Blue and 11Magenta:

11 Blue: 0   4   7   9   10

11 Magenta: 1   5   7   8   10

a   Draw a double boxplot for these five-number summaries.

b   What is the median for each class?

c   What is the interquartile range for each class?

d   Shane in 11Blue scored 9 and Adele in 11Magenta scored 9. Who has performed better in relation to their own class? Justify your answer.

5 What type of distribution is shown in each graph? Choose from symmetrical, positively skewed, negatively skewed, uniform and bimodal.

a

Goals scored

Frequency

Number of goals

b

Cars on motor way

Number of cars

Time of day

c

Heights of year 12 students

Number of students

Height
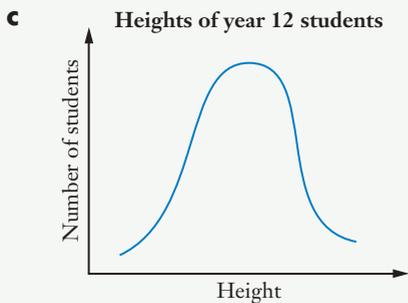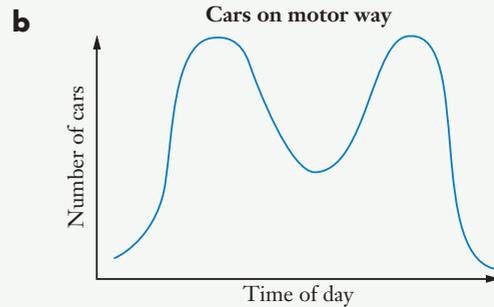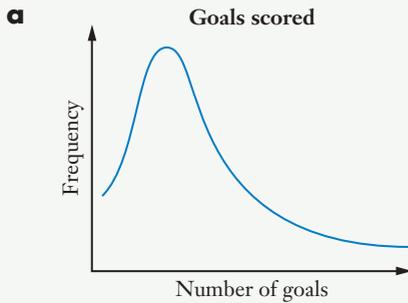
6 Sketch a graph for each distribution described below. Remember to label the axes.

   a The percentage marks students scored on an easy assessment task – the results are negatively skewed with most scoring between 80 and 90 percent.

   b The masses of all Year 11 students in Australia are distributed symmetrically.

   c When a card is chosen randomly from a deck of cards 500 times, the suit of the card (diamonds, hearts, clubs, spades) has a uniform distribution.

Practice set 4

●●●●

Section A   Multiple-choice questions

For each question, select the correct answer **A, B, C** or **D**.

1 The favourite party food of a group of 3-year-old children was recorded.
What is the only statistical measure that can be found for this data?

A mean **B** median **C** mode **D** range

2 Simplify 32 : 48.

A 4 : 6 **B** 10 : 16 **C** 3 : 4 **D** 2 : 3

3 Describe the shape of the data in this graph.
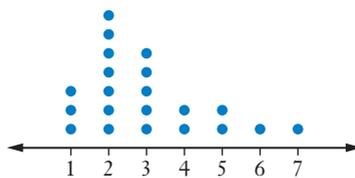
A symmetric **B** bimodal

C negatively skewed **D** positively skewed

4 A map has a scale of 1 : 5000. Which of the following distances in kilometres is
represented by 64 mm on the map?

A 0.32 km **B** 3.2 km **C** 32 km **D** 320 km

5 Alison and Elena buy a length of material and divide it between them in the
ratio 2 : 3. Alison has 3.6 m. What length of material does Elena have?

A 9 m **B** 5.4 m **C** 2.4 m **D** 1.8 m

6 Calculate the median for this data.

10   3   5   8   4   2   10

A 5 **B** 6 **C** 8 **D** 10

7 A street map has a scale of 1 : 200 000. What distance on the map represents
9.6 km?

A 0.48 cm **B** 4.8 cm **C** 48 cm **D** 480 cm

8 Calculate the interquartile range for the data in question **6**.

A 3 **B** 5 **C** 7 **D** 10

9 0.5 m^3 of cement is added to 0.375 m^3 of metal. What is the ratio of cement to metal?

    A $4 : 3$ **B** $7 : 8$ **C** $3 : 4$ **D** $3 : 16$

10 A boat travels 24 km in 90 minutes. What is its average speed?

    A   12 km/h   **B**   16 km/h   **C**   18 km/h   **D**   36 km/h

Section B   Short-answer questions

1 For their new bathroom, Ann and Chris need 4 green tiles for every 3 white tiles. They buy 100 green tiles. How many white tiles do they need to buy?

2 Draw a graph that shows:

    a   a symmetrical distribution

    b   a negatively skewed distribution

    c   a bimodal distribution

    d   a positively skewed distribution

3 Paul and Nicole drove from Perth to Broome, a distance of 2370 km, at an average speed of 71 km/h. How long did the trip take them? Answer in hours and minutes.

4 This data shows the maximum temperature over 10 days in Karratha:

                23   14   20   21   9   20   16   19   18   17

For this data find:

    a   the mean   **b**   the mode   **c**   the median   **d**   the range

5 Jemma likes to use a paint colour called Spring Green. She makes the colour by mixing blue and yellow paint in the ratio 5 : 3. How much blue paint does Jemma use to make a 4 litre can of Spring Green? Give your answer in millilitres.

6 Use the street map of Manly in Chapter 15 on page 402 to find:

    a   the feature is at J6

    b   the position coordinates of Manly Wharf

7 **a** Fish

b Frog

Scale 1 : 10

Scale 1 : 4

i Measure the length of each object to the nearest millimetre.

ii Use the scale to work out the actual length of the object in centimetres.

8 The ages of children at a play centre are shown in the frequency table. Find, correct to 2 decimal places:

a the mean

b the standard deviation

Ages in years	Frequency
5	3
6	4
7	5
8	2
9	2

9 Year 11 students completed 2 tests for their assessment, both marked out of 50.

Test 1:

48	19	17	45	39	27	40	41	30	23
38	32	30	27	31	34	36	20	25	22
40	41	30	46	27	34	31	23	8	38

Test 2:

39	30	20	47	35	35	27	36	34	44
11	11	47	31	28	32	3	38	7	28
29	21	32	46	19	50	31	49	17	23

a Draw a back-to-back stem-and-leaf plot for this data.

b Find the range for each test.

c Are there any outliers in either test? If so, state the outliers.

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10 The formula $D = \dfrac{V}{1000}(210 + 97R)$ can be used to calculate a car's stopping distance where V is the speed in km/h and R is the road surface index. Manu is driving at 80 km/h on a wet asphalt road with road surface index 1.6. What distance will he travel after he applies the brakes?

11 Melina measured the height, in centimetres, of the 23 students in her class:

170	165	159	167	183	174	185	174
168	152	161	163	163	176	186	169
170	149	169	172	186	151	173	

a Find the median of these scores.

b Find the upper and lower quartiles of these scores.

c Calculate the interquartile range for this data.

12 Using your answers to question **11** to:

a state the five-number summary for this data.

b draw a boxplot for this data.

13 Draw:

a a dot plot with scores clustered around 23 to 25.

b a histogram with 2 clusters and one gap

c a stem-and-leaf plot with scores clustered in the 20s and 2 gaps

14 For the 2 sets of test results in question **9**:

a find the five-number summary of each set

b draw a double boxplot

15
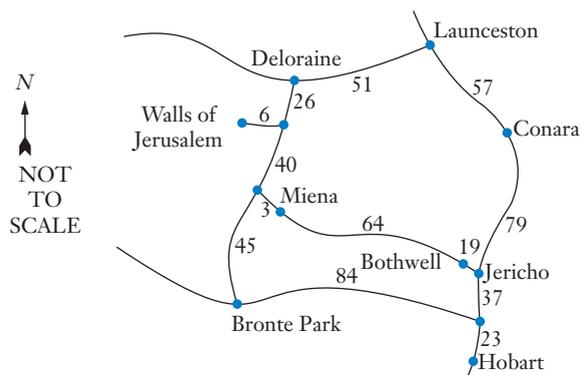
a Jenna drove from Hobart to Bronte Park and then returned to Hobart. How far did she travel altogether?

b Ashvin lives in Launceston and drives to and from Conara each day for work. How many kilometres does he travel in one working week of 5 days?

c Charlotte plans to drive from Hobart to Deloraine to visit the Liffey Falls. She is unsure which is the best route to take: via Bronte Park, via Bothwell and Miena or via Launceston.

    i Which route is the shortest? Justify your answer with calculations.

    ii What other factors could influence her decision?

16 Darryl and Christine are building a house on a new block of land. To answer the questions below, you will need to measure the scale drawing below. Give all answers in metres.
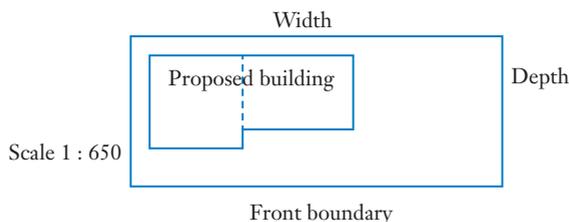
a What is the width of the block of land?

b What is the depth of the block of land?

c How far is the building from the left boundary of the land?

d How wide is the proposed building?

e How far is the building from the right boundary?

f How far is the building from the front boundary?

g What is the area of the block of land (in m^2)?

ANSWERS

Chapter 1

Exercise 1.01

1 a 14   **b** 16   **c** 20   **d** 33

2 a 16   **b** 18   **c** 20   **d** 28

   e 45   **f** 17

3 Any combination of two scores that add to 13, e.g. double 6 + 1 or 7 + 6.

4 6 ways: 4 + 3, 6 + 1, 5 + 2, 5 + double 1, 3 + double 2, 1 + double 3

5 a 23

   b Double 10 + 3 or double 9 + 5 or double 8 + 7 or double 7 + 9

6 Four throws (4×25)

7 3 + double 8

8 To make it harder to get high scores. If the players want to get high scores, they need to place accurate throws.

Exercise 1.02

1 a 46   **b** 90

2 180 ($3 \times$ triple 20)

3 Many answers are possible, e.g. 20 + 10 + 7 or 13 + 17 + 7

4 151   **5** Rebecca

6 16 or double 8   **7** Still 86

8 104

9 a double 17

   b double 10 + double 7

   c 10 + 10 + double 7

10 160

11 a 4   **b** Renata on turn 2

   c 58 on turn 3   **d** 2

   e 2 throws for combined 10, then double 7

   f 29 is an odd number (no number on the board doubles to make 29)

   g Teacher to check.

Exercise 1.03

1 a $\frac{3}{5}$ **b** $\frac{3}{4}$ **c** $\frac{31}{100}$ **d** $\frac{2}{25}$

   e $\frac{3}{10}$ **f** $\frac{17}{20}$ **g** $\frac{99}{100}$ **h** $\frac{3}{100}$

   i $1\frac{3}{5}$ **j** $1\frac{7}{20}$ **k** $\frac{1}{4}$ **l** $2\frac{1}{2}$

2 C

3 a 0.18   **b** 0.82   **c** 0.02   **d** 0.5

   e 1.2   **f** 0.511   **g** 0.79   **h** 0.125

   i 0.163   **j** 0.04   **k** 0.187   **l** 0.0525

4 a 17%   **b** 70%   **c** 26%

   d 55%   **e** 62.5%   **f** 96%

   g 160%   **h** $66\frac{2}{3}\%$ **i** 125%

   j 140%   **k** 67.5%   **l** 6.25%

   m 295%   **n** $44\frac{4}{9}\%$ **o** $333\frac{1}{3}\%$

   p 80%   **q** $116\frac{2}{3}\%$ **r** $63\frac{7}{11}\%$

5 a 38%   **b** 55%   **c** 96%   **d** 62.5%

   e 8%   **f** 5.4%   **g** 60%   **h** 0.3%

   i 190%   **j** 40.5%   **k** 126%   **l** 11.4%

6 a $\frac{13}{20}$, 65%   **b** $\frac{3}{5}$, 60%

   c $\frac{1}{5}$, 0.2   **d** $\frac{21}{25}$, 0.84

   e 0.5, 50%   **f** 0.125, 12.5%

   g $\frac{9}{25}$, 0.36   **h** 0.625, 62.5%

   i $0.\dot{3}$, $33\frac{1}{3}\%$ **j** $\frac{2}{3}$, $0.\dot{6}$

7 a 24   **b** 7   **c** 4

   d 10   **e** 42   **f** 10

   g 750 m   **h** 8 h   **i** 400 mL

   j 250 kg   **k** 10 months   **l** 35 min

Exercise 1.04

1 a False, $4 + 2 \times 3 = 10$ **b** True
  c True   **d** True
  e False, $2 \times 4^2 = 2 \times 16 = 32$
  f False, $48 \div 4 \times 3 = 12 \times 3 = 36$
  g False, $20 - 5 + 8 = 23$
  h True   **i** True

2 a 3   **b** 3   **c** 22   **d** 36
  e 75   **f** 1   **g** 12   **h** 10
  i 2   **j** 14   **k** 40   **l** 140
  m 150   **n** 26   **o** 30

3 a $(4 + 7) \times 5 = 55$ **b** $60 \div (5 + 7) = 5$
  c $(3 \times 2)^2 = 36$ **d** $(6 + 8) \times (9 - 5) = 56$
  e $(3 \times 4 + 5) \times 2 = 34$ **f** $(28 - 4 \times 5) \times 2 = 16$

4 When she pressed the ▬ key in the middle, the calculator added 3 and 6 first, before multiplying by 5.

5 a The expression represents the sum of the points for 4 red balls, 2 brown balls, 1 pink ball and 2 black balls.
  b 17 points

6 a Do the $\times$ first
  b Explain the order of operations
  c $(48 - 8) \times 3$

Exercise 1.05

1 $6870   **2** $39 000   **3** $84
4 a $920   **b** $47 840
5 $7.20   **6** 4.5
7 a 9h 45 min   **b** 113 h 45 min
8 12 minutes   **9** Rockets by 2
10 Neither team is in front. The score is 110 each.
11 $1060.50

Exercise 1.06

1 B   **2** B   **3** C   **4** B   **5** B
6 a 1600 m   **b** 4
7 $26
8 a $34   **b** Yes   **c** Yes
9 a Paige knits approximately 2 rows per minute.
  b approximately 25 minutes

Exercise 1.07

1 a 16.1   **b** 29.8   **c** 14.6
  d 13.3   **e** 104.6   **f** 195.2
2 124.73
3 Many answers are possible, e.g. 16.27 or 16.32
4 Teacher to check.
5 a Mia: wave 1, 4.9; wave 2, 7.3; wave 3, 8.5; wave 4, 7.6
    Elissa: wave 1, 7.0; wave 2, 7.8; wave 3, 5.2; wave 4, 8.2
  b Mia: $7.6 + 8.5 = 16.1$; Elissa: $7.8 + 8.2 = 16.0$
  c Mia
6 3.9 m   **7** 538.5 km
8 a 8745 m   **b** 8.7 km
9 a 79.3 is close to 80 and 155.8c is close to $1.50
  b $120   **c** $123.55   **d** $3.55
10 a Closer to $150 because $1.35 is closer to $1 than $2.
  b $207.63
  c If she uses the same amount of LPG each month, her budget allowance isn't enough.
11 $16.21
12 a $2.85   **b** $3.55   **c** $2.95
13 $2.40
14 No. His purchases added to $2.56, which rounds to $2.55. The rounding should happen only at the end.
15 19 bags
16 Smallest $4.23, largest $4.27
17 5 bags   **18** 6 boxes
19 a 467 mL   **b** 64 m   **c** 484 g
  d 50 cm   **e** 18 minutes   **f** 329 days
20 a 333.3 mL   **b** 618.8 g   **c** 443.8 kg
  d 22.4 min   **e** 17.6 km   **f** 38.3 s

Exercise 1.08

1 a 1600 envelopes   **b** 3 boxes
  c 200, 400, 600, 800   **d** 5 boxes
2 a 1400 mm is not a multiple of 300 mm.
  b 1500 mm   **c** 2400 mm
  d 1.2 m
3 600 m

4 a 20 cm of pink, 40 cm of white

b Pink $4.40, white $8.80, total cost $13.20

5 Posts: 8 of 2.7 m and 1 of 2.1 m. Top rails: 8 of 2.4 m.

Exercise 1.09

1 a 24 cents   **b** 24 cm

2 a 90c   **b** 90 cm

3 a 2 h 30 min   **b** 3 h 48 min

     c 1 h 24 min   **d** 2 h 54 min

4 a 12   **b** 6   **c** 4 years 6 months

5 2 years 3 months

6 a 9   **b** 5 years 9 months

7 a 6 months 15 days   **b** 8 months 27 days

     c 3 months 7 days   **d** 5 months 9 days

8 a 3   **b** 18 overs and 3 balls

     c Teacher to discuss.

Exercise 1.10

1 $1452   **2** $158.33

3 1050 ml milk, 450 ml cream, $1\frac{1}{2}$ pinches of starter culture

4 a $455.80   **b** $23 701.60

5 a 30   **b** $606.30   **c** $30.315

     d $212.21   **e** $818.51

6 a $37 892.40   **b** $640.70

     c $160.18   **d** $480.52

7 75 g carrot, 50 g parsnip, 30 g celeriac, 110 g potatoes, 1 egg, 50 g apples

8 a $9617   **b** $24 441.50   **c** $63 097

9 $1 098 097

10 a 137   **b** $649.50   **c** $59

Keyword activity

1 Double   **2** Triple

3 Bullseye   **4** Twelve

5 BIDMAS   **6** Five

7 Indices   **8** Brackets

9 Hundred   **10** Darts

11 Divide

Test yourself 1

1 a 9   **b** 13   **c** 22   **d** 23

2 a 34   **b** 84

3 a 32.5%   **b** 0.1865   **c** 105%   **d** $\frac{7}{20}$

4 $30.60

5 a 18   **b** 14   **c** 4

6 a 174.8   **b** 19.9   **c** 151.3

7 a $30   **b** $24 to $25   **c** $94 to $95

8 a $96   **b** No, it's too small.

9 $334   **10** $10.60

11 a 16   **b** 16.8

12 a 28 kg   **b** 135 m   **c** 5 mm

13 0.286   **14** 15

15 2100 mm   **16** 3 h 12 min

17 8 years 3 months

18 a $632.50   **b** $32 890

19 700 g butter, 420 g caster sugar, 1190 g flour, 7 teaspoons baking powder

Chapter 2

Exercise 2.01

1 a $33   **b** 84 kg

     c 252 cm   **d** $307.50

     e 216 marks   **f** 595 000 people

     g 152.29 kg   **h** 5 m

     i 294 students   **j** $312.70

     k 12 L   **l** 113.6 ha

2 a 96 cm   **b** 84 hours

     c 219 days   **d** 3900 mL

     e 23c   **f** 98 days

     g 1350 m   **h** 600 kg

3 258 students   **4** $412.50

5 a $0.81   **b** $2062.50

6 3.72 hours

7 782 seedlings   **8** $52.40

9 1275 people   **10** 11 700 seats

11 24.31 kg   **12** 337.5 MB

Exercise 2.02

1 a 80% **b** 55%
c 80% **d** 88.75%
2 a 87.5% **b** No
3 41.8%
4 a 8.3% **b** 18.75% **c** 12.5%
d 37.5% **e** 52% **f** 11.4%
g 25% **h** 21.4% **i** 13.7%
j 13.9% **k** 21.4% **l** 6.4%
5 75% **6** 17.6%
7 49.4% **8** 55.9%
9 52.5% **10** 38.1%
11 a 34.8% **b** 47.8%
12 a English 60%, Mathematics 54.3%,
Science 64%
b Science

Exercise 2.03

1 a 152 kg **b** $2650
c 157.5 m **d** 13.3 L
2 $9 **3** $682
4 $35.37 **5** $234
6 $20 790
7 a $94 080 **b** $158 080
8 24 hectares **9** $2041.20
10 $184 **11** $563.33
12 a $516.25 **b** $567.88
c Teacher to check.

Exercise 2.04

1 a $64.50 **b** 1440 L
c 105.05 kg **d** 714 students
e 7.2 hours **f** 3 weeks
2 $247.50 **3** 31 141
4 $679.15 **5** 1438
6 a $427.50 **b** $877.50
7 813 students
8 a $39.57 **b** $1939.13
9 $172.01 **10** $27 993
11 $1032
12 a i $670 **ii** $549.40
b $494.46

Exercise 2.05

1 a 28.6% **b** 29.6% **c** 83.1% **d** 55.8%
2 a 18.6% **b** 40.2% **c** 12% **d** 15.4%
3 87.5% **4** 45.5%
5 a Profit, $15 **b** 10%
6 a Loss, $500 **b** 11.8%
c Keiran might be happy as he used the car for
a year.
7 $272.25
8 a $585 **b** $23 985 **c** $21 100
d Loss **e** 12%
9 a $315 **b** $324 **c** Profit **d** 2.9%
10 45.8%

Exercise 2.06

1 80% **2** 38 385
3 a 19.7% **b** 22.4 g
4 $8625 **5** $11 200 **6** 7.6%
7 $703.80 **8** 69.02 g **9** $754.40
10 $350 175 **11** 13.5% **12** $691.25
13 a 0.83% **b** 4:55:30
14 164.5%
15 $4500 **16** 22%
17 30.8% **18** $41 850

Test yourself 2

1 a $32 **b** 210 mL **c** 11.25 ha
d 60 cm **e** 3600 g **f** 81 mins
2 a 273 people **b** $945
c 16 questions
3 a 85% **b** 25% **c** 10%
d 75% **e** 25% **f** 15%
4 a 3.5% **b** 93% **c** 36.1%
5 a $367.50 **b** 93 kg
c 18 000 people
6 a $1478.05 **b** $2310
7 a $54 **b** 63.75 m **c** 6 weeks
8 a $45 **b** 69 006 people
9 a 20% profit **b** 40% profit
c 26.3% loss **d** 9.5% loss
10 a 70.6% **b** 114.3%

11 **a** 117 females

　　 b **i** 30.5%　　　　　　 **ii** 2 g

　　 c $16

Chapter 3

Exercise 3.01

1 240 cm

2 **a** 20 cm　　　 **b** 120 cm　　　 **c** 6 cm

　　 d 63 cm　　　 **e** 73.5 cm　　 **f** 550 cm

3 **a** 140 cm　　　　　 **b** Teacher to discuss.

4 705 cm

5 **a** length = 2820 cm, width = 940 cm,
　　　 height = 1410 cm

　　 b length = 28.2 m, width = 9.4 m,
　　　 height = 14.1 m

6 14.4 m

Exercise 3.02

1 **a** 1000, ×　　 **b** 10, ÷　　　 **c** 100, ÷

　　 d 1000, ÷　　 **e** 100, ×　　 **f** 1000, ÷

　　 g 10, ×

2 **a** 30　　 **b** 500　　 **c** 0.4　　 **d** 2000

　　 e 3　　 **f** 2　　　 **g** 0.5　　 **h** 0.25

　　 i 0.6　 **j** 600　　 **k** 4.5　　 **l** 800

　　 m 0.8　 **n** 9000　 **o** 0.09　 **p** 6500

3 **a** 640　　　　　　 **b** 64 000

4 **a** 850　　　　　　 **b** 0.85

5 **a** 45 000　　　　 **b** 4.8

　　 c 1 300 000　　 **d** 0.4175

6 6　　　　　　　 **7** 76

8 **a** 3900　　 **b** 3.9　　　　 **c** 90

9 21　　　　　　 **10** 160

11 **a** 3340 m　　　　 **b** 3.34 km

12 **a** 3096 m　　　　 **b** 3.10 km

13 $120.60

14 **a** 148.2　　 **b** 38.1　　　 **c** 1005.8

　　 d 609.6　　 **e** 7.3　　　 **f** 11.3

15 109.7　　　　　 **16** 8 furlongs

17 16.5

18 1673 km, 2655 km, 644 km, 3379 km, 877 km,
　　 331 km, 1392 km.

19 3.66

20 Modern pools are 29.2 cm shorter than old pools.

21 8

Exercise 3.03

1 **a** 24 m　　　 **b** 20 m　　　 **c** 34 m

2 30 m

3 **a** 14.9 cm　　　 **b** 17 cm

4 Any 2 lengths that add to 18 m, such as 12 m by
　 6 m, or 9 cm by 9 cm

5 **a** Regular pentagon, 25 m

　　 b Regular hexagon, 24 cm

　　 c Regular octagon, 24 mm

6 6 m

7 **a** 8.4 cm　　　 **b** 7.5 m

8 **a** 21 m　　　　 **b** $189

9 **a** 11.27 m　　　 **b** 56.35 m

　　 c Two 25 m rolls and 1 10 metre roll

Exercise 3.04

1 **a** About 20 cm^2　　 **b** About 28 cm^2

2 About 32 cm^2

3 **a** About 14 m^2　　 **b** About $910

4 About 12 cm^2

5 Teacher to discuss.

Exercise 3.05

1 **a** 450 m^2　　　　 **b** 5005 m^2

　　 c 264 m^2　　　　 **d** 435 m^2

2 68 m^2

3 **a** 324 m^2　　　　 **b** 72 m

4 200 m^2　　　　　 **5** 3 m

6 Any two lengths that multiply to 24 cm^2,
　 e.g. 6 cm × 4 cm, or 8 cm × 3 cm.

7 **a** Any pair of numbers that multiply to give 36,
　　　 for example 4 × 9, 3 × 12, 6 × 6.

　　 b Teacher to check.

　　 c 24 cm

8 **a** perimeter　 **b** 42 m　　　 **c** $924

9 **a** area　　　　 **b** 11.7　　　 **c** 3

10 **a** Teacher to discuss.　 **b** 8.5 cm^2

11 a A and C 2.16 m², B and D, 2.7 m²

   b A and C, 6.6 m, B and D, 7.8 m

   c 28.8 m

   d Many answers possible, for example

     Beds B and D can be constructed from 4 3m-lengths and 2 3.6m-lengths each cut in half.

     Beds A and C can be made from 1 3.6m-length cut into 4 90cm lengths and 3 3.2m-lengths cut into 2.4m and 60cm lengths. Three 2.4m-lengths are for sides and the 3 60 cm pieces make the remaining 2.4 m side.

   e 39

   f 3

Exercise 3.06

1 a 1400 m²   **b** $133 000

   c 33 m²   **d** $858

   e No, the area of the backyard is 1000 m² and one bag will cover only 150² m.

2 a 2 bedrooms   **b** 7 doors

   c 4 m × 3.5 m   **d** South

3 a 15 m   **b** 14 m

4 a 15 m   **b** 3 lengths

5 a 48 m²   **b** 14 L   **c** 4 tins

   d One 10 L tin and one 4 L tin, for $174.

6 a In bedroom 1, the 3.6 m wide carpet will be just bigger than 3.5 m. He will need the other dimension of the room for the length. This is 4 m. In bedroom 2, the 3.6 m width will fit the 3 m across with a bit to spare. It will need to be 4 m long.

   b $1440

7 a Rectangles **b** 135 m² **c** $1755

8 a 14 cm

   b It will depend on how the rail is attached to the wall. The longer rail will give more space to hang towels.

9 $540 (100 tiles)

10 The bed will fit in the bedrooms, but there won't be much spare space for a wardrobe or set of drawers in bedroom 2.

11 a 14.625 m² **b** 16.0875 m² **c** 14

Exercise 3.07

1 a 35 cm² **b** 55 cm² **c** 60 cm²

   d 80 cm² **e** 192 cm² **f** 63 cm²

2 a 21 m and 20 m   **b** 210 m²

3 a 119.7 mm² **b** 84 cm² **c** 56 cm²

4 7.14 cm² and 5.4 cm²

5 2.9 m²

6 Approximately 36 cm²

7 Many answers are possible, e.g.
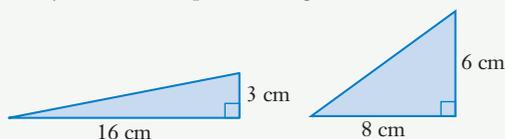
Exercise 3.08

1 a hectares   **b** square metres

   c square centimetres **d** square metres

   e square centimetres **f** square millimetres

   g square kilometres **h** square millimetres

   i square kilometres

2 a 790   **b** 1.5   **c** 6.9

   d 76   **e** 86.5   **f** 120 000

   g 320 000 **h** 45 000 **i** 750 000

   j 1.9

3 6.5 m², 114 000 cm², 25 050 000 mm²

4 54 cm², 990 mm², 0.000 032 m²

5 a 352.1   **b** 3.521

6 a 6800 m²   **b** 3200 m²

7 Soccer field. It is 1750 m² smaller than 1 ha. A rugby field is 3000 m² smaller than 1 ha.

8 a 24 000 000   **b** 24

   c Many answers possible, e.g. 6 km by 4 km.

9 a 900 cm² **b** 11.11 **c** 280 **d** 294

10 10.95

11 106 million square nautical miles

Keyword activity

1 metric   **2** length   **3** kilometres

4 thousandth **5** perimeter **6** area

Test yourself 3

1 4

2 a 50 **b** 300 **c** 3.6
  d 4200 **e** 0.08

3 a 1372 m **b** 1.372 km **c** 2040 m^2

4 36 m **5** 58 cm^2

6 a 33 m^2 **b** 36 m^2

7 2 **8** 30.25 m^2 **9** 2.4 L

10 a 30 m^2 **b** 24 m^2 **c** 24 m^2

11 a 60 000 **b** 7.6 **c** 580 **d** 5000

Practice set 1

Section A

1 D **2** A **3** C **4** D **5** A
6 B **7** B **8** C **9** B **10** D

Section B

1 a $16 **b** $24 **c** $30

2 a 640 **b** 24 **c** 15 800 **d** 9.8

3 a 5 kg **b** $112 500
  c 192 minutes **d** 6480 mL

4 a 79 **b** $\frac{1}{5}$ **c** 29 **d** −2

5 a 92% **b** 3% **c** 15% **d** 25%

6 a 85 m **b** 17 kg **c** $10

7 a 560 cm^2 **b** 6400 mm^2 **c** 49.5 cm^2

8 23.31%

9 a 8.6 m **b** 58 tiles **c** 4 boxes

10 a 900 mm **b** 2400 mm

11 $7858.50 **12** $24 592

13 180 g butter, 6 tablespoons sugar, 6 eggs,
  6 tablespoons self-raising flour, 2466 g or
  6 cans pie apple, $1\frac{1}{2}$ cups coconut

14 a 9 m
  b 1 × 3 m length, 2 × 3.3 m length
  c 17 shovel loads

15 $8991

Chapter 4

Exercise 4.01

1 a 6 **b** 18 **c** 3.6
  d 0.24 **e** 0.39 **f** 7.56

2 a 10 **b** 140 **c** 15
  d 107.5 **e** 235 **f** 15

3 16 **4** 18

5 a 1.25 **b** 5.75 **c** 0.875 **d** 1.5

6 a 75 **b** 300 **c** 6.75 **d** 36.75

7 a 6 **b** 8 **c** 1.92 **d** 2.2

8

a	8	6	14	4.5	9	6.25	$3\frac{1}{2}$
b	3	5	12	3	7.5	0	2
$a + b$	11	11	26	7.5	16.5	6.25	5.5
$a - b$	5	1	2	1.5	1.5	6.25	1.5
$2a + 3b$	25	27	64	19	40.5	12.5	13
$5(a + 4b)$	100	130	310	82.5	195	31.25	57.5
$\frac{2(3a-b)}{5}$	8.4	5.2	12	4.2	7.8	7.5	3.4
$a^2 + b$	67	41	208	23.25	88.5	39.0625	14.25

9 a 13.5 **b** 12 **c** 16
  d 40 **e** 4 **f** 1.15

10 Teacher to discuss.

Exercise 4.02

1 3 mL **2** 904.8 cm^3 **3** 177°C

4 a 285 km **b** 71.25 km

5 280 cm or 2.8 m

6 a Young's rule: 10.3 mL; Clark's rule: 7.5 mL
  b Clark's rule because it's based on weight and
    Isabella is under weight for her age.

7 a 0.06 **b** $8119.60

8 51% **9** 4140 m^3

10 82 km/h **11** 0.0979

12 a 1.5 hours
  b Will's BAC = 0.06, Kate's BAC = 0.75,
    Kate's BAC is higher by 0.015
  c The female formula has a smaller
    denominator, which makes Kate's overall
    value higher.

Exercise 4.03

1 a

x	1	2	4	7	10
y	18	16	12	6	0

b

x	1	2	3	5	11
y	5	7	9	13	25

c

x	4	2	5	7	3
y	7	1	10	16	4

d

x	1	2	3	6	9
y	$\frac{1}{2}$	1	$1\frac{1}{2}$	3	$4\frac{1}{2}$

2 a F **b** B **c** A
d C **e** E **f** D

3 Other answers possible.
  a $y = x + 1$ **b** $y = \dfrac{x}{10}$
  c $y = 4x$ **d** $y = x^2$
  e $x + y = 10$ **f** $xy = 24$ or $y = \dfrac{24}{x}$
  g $x + y = 7$ or $y = 7 - x$

4 Other answers possible.

x	1	2	3	4	5
y	0	1	2	3	4

Keyword activity

1 FORMULA
2 EVALUATE
3 EQUATION
4 DENOMINATOR
5 PRONUMERAL

Test yourself 4

1 a 30 **b** 66 **c** 6 **d** 4
2 21.8
3 a 460 km **b** 28.75 km
4 $985.60 **5** 21.7
6 a

x	0	2	4	7	12
y	4	10	16	25	40

b

x	1	3	4	6	12
y	11	9	8	6	0

c

x	0	3	9	15	12
y	0	1	3	5	4

d

x	2	5	9	11	13
y	14	11	7	5	3

Chapter 5

Exercise 5.01

1 a 5 cars **b** 35
  c 6 a.m.–8 a.m. **d** Teacher to check.
2 a 13 **b** Friday **c** 48
  d Teacher to check.
3 a 500 000 people or half a million
  b Sydney, 5 100 000
  c Darwin, 100 000
  d The scale means we can only estimate to the
    nearest 100 000 but the actual population is
    more exact than that.
  e Adelaide **f** Teacher to check.
4 a 2% **b** NSW
  c Victoria and Northern Territory
  d No, it only tells you the percentage increase,
    not the actual numbers.
  e 512
5 a Peanut butter **b** Biscuits
  c Cereal **d** 28%
  e Peanut butter **f** Biscuits
  g 14 g **h** Cereal and biscuits
6 a Motor vehicle thefts in the country town are
    decreasing over these 6 years.
  b 2015 **c** 2017, 55
  d Teacher to check.
7 a 10.5% **b** 1990 and 1991
  c 1994 and 1995 **d** $20 400
  e i $8640 **ii** $11 760
8 a 15 kWh **b** 23 kWh
  c Monday, Tuesday, Wednesday in the first
    week, Friday in the second week
9 a 20°C **b** 212°F
  c 32°F **d** 38°C
10 a €9 **b** $83 **c** $58
  d Yes, since €25 ≈ $42 **e** €132

11 a 420 kJ   **b** 170 cal

  c 2100 kJ   **d** about 2100 cal

12 a $120   **b** $200   **c** $280   **d** $40

  e To cover his business costs, e.g. tools.

13 a $24   **b** $48   **c** $60

  d $60   **e** $12

14 a Rugby league   **b** Motor racing

  c Aussie rules and soccer

  d 840   **e** Teacher to check.

15 a Editing

  b Editing, Printing, Binding, Royalty, Transport and Promotion

  c $9.75

16 a Visiting friends

  b 40 people

  c No, on Monday evening there would be more people travelling for work and fewer people travelling for leisure or visiting friends.

Exercise 5.02

1 a 120   **b** People aged over 30

  c Muffins   **d** 36   **e** 80%

2 a **i** 5900   **ii** 16 100   **iii** 11 000

    iv 11 000   **v** 22 000

  b 22 000   **c** $\dfrac{59}{220}$ **d** 73.18%

  e 21.82%

3 a **i** 120   **ii** 95   **iii** 108   **iv** 215

  b 215   **c** 64

  d 50.23%   **e** 35.8%

  f More hamburgers, since a large proportion of men prefer them to chicken wraps.

4 a **i** 83   **ii** 187   **iii** 110

    iv 185   **v** 160

  b 24.06%   **c** 59.46%

  d Teacher to check.

5 a **i** 3630   **ii** 9130   **iii** 8920

    iv 3840   **v** 12 760

  b 71.55%   **c** 28.81%   **d** Teacher to check.

6 a **i** 80   **ii** 10   **iii** 75

    iv 45   **v** 120

  b 120   **c** 95

  d 79.2%   **e** 18.8%

Exercise 5.03

1 a $120   **b** about $23 more

  c about $90   **d** Teacher to check.

2 a 3   **b** about $1750

  c These are for winter, when extra electricity is used for heating and cooking.

  d Teacher to check.

3 a 15 months   **b** approximately 181 MJ

  c June to August, heating in winter, others answers possible.

  d Teacher to check.

4 a 2.05%   **b** 2.30%   **c** $550

  d Money is locked in for the 24 months, you cannot withdraw any of it.

5 a August   **b** January and February

  c January and February, March and December, May and November, or July and September

  d 7   **e** July, August, September

  f Teacher to check.

6 a 33°C   **b** June, July, August

  c A lot of rain from November to March, little rain from April to October.

7 a June, July, August, September

  b about 10°C

  c about 30 mm

  d Teacher to check.

8 Northern hemisphere, because the warmest temperatures are in the middle of the year.

9 a 1% of donations   **b–d** Teacher to check.

  e 9180 L

Exercise 5.04

1

Make of car

2

3 **a** 7% **b** other
   c 31% **d** 548

4 **a** 73°, 93°, 43°, 77°, 27°, 47°

   b

5 **a** **i** 70 cm **ii** 140 cm
   b **i** 3 years **ii** 11 years
   c 0 and 1 year
   d about 2 years 10 months
   e fairly flat

6

7

Stem	Leaf
3	7 7 8 8
4	1 3 4 4 5 5 6 6 8 9 9
5	1 1 1 2 2 3 3 4 4 5 5 5 8
6	0 2 3 6 6 7
7	0
8	
9	0

8 **a**

Test marks	Frequency
6–20	7
21–35	12
36–50	16
51–65	10
66–80	14
Total	59

   b 59 **c** 36–50 **d** 19

9 Water level of a canal

Exercise 5.06

1 **a** **i** 6 kg **ii** 9.5 kg
   b **i** 8 months **ii** 11 months
   c 6 and 7 months
   d approximately 6 months
   e Teacher to check.

2 **a** 8%
   b 40 to 50 years of age
   c 7%
   d More likely to die from cancer and heart disease.
   e True
   f Between 25 and 60.
   g Between 18 and 42.

3 **a** A Melbourne, B Sydney, C Brisbane, D Adelaide, E Perth, F Darwin, G Canberra, H Hobart
   b Jan 28°, Feb 27°, March 24.5°, April 19.5°, May 15°, June 12°, July 11°, Aug 13°, Sept 16°, Oct 19°, Nov 23°, Dec 26°.

c March and December

d B June, C July, D May, E June, September

e F

f G, 15° in December

g 33°, F, November

h 0°, G, July

4 a April 22, 24°C **b** 15°C

c 9°C **d** 1 unit = 1°C

e 16°C **f** April 20, April 21

g 16 April **h** 5

5 a i Time, 4 hours

ii Temperature, 0.2°C

b 39.7°C

c Midnight Thursday

d 40.4°C

e 12 hours **f** 2000 (8 p.m.) Saturday

6

Angelinas's temperature
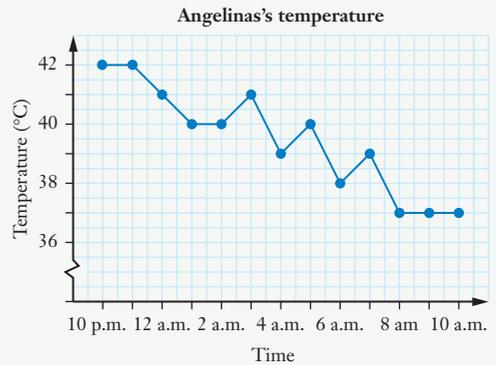
7 a

Week		Start	1	2	3	4	5	6	7	8	9	10
Jacob	Weight loss (kg)		4	7	5.5	12	2.5	5	6.5	8.5	3	4
	Actual weight (kg)	183	179	172	166.5	154.5	152	147	140.5	132	129	125
Evan	Weight loss (kg)		2.5	4.5	1.1	3.9	6.4	3	4.6	5	5	2
	Actual weight (kg)	137	134.5	130	128.9	125	118.6	115.6	111	106	101	99

b
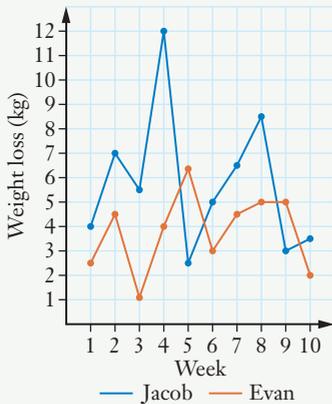
c
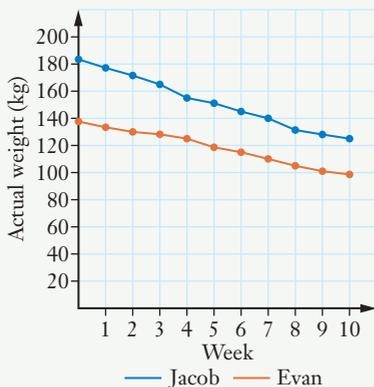
d Teacher to check.

e i 58 kg **ii** 38 kg

f Jacob 31.7%, Evan 27.7%

Exercise 5.07

1 a Green 31.5c, Octas 33c, System Two 32.5c

b 1c **c** the first graph

d The scale on the second graph starts at zero; the scale on the first graph only goes from 30 to 33.

e Green company, to make their calls seem cheap.

2 a Brisbane **b** Darwin

c 144c **d** about 14c

e David only used from 135c to 155c and this makes the gaps look bigger.

3 Small: graph the actual population; Big: graph the increase in the population.

4 a 120c **b** $80

c The cost of petrol is in *cents*, the cost per barrel is in *dollars*: vertical scale is different for each graph

d The two graphs move up and down in a similar fashion: this suggests the two things are related.

5 a Australia's average weekly wages are *much* greater than in Malvolia.

b No vertical scale, using a 3D symbol instead of a column.

c a column

d

6 Teacher to check.

Test yourself 5

1 a 40   **b** 6 a.m. to 8 a.m.

2 a 2 000 000   **b** 2 700 000

3 a 13%   **b** approximately 1.6%

4 a 36 euros   **b** $100

5 a Motor racing   **b** 595

6 a

	High-speed internet	No high-speed internet	Total
City	105	38	143
Country	89	42	131
	194	80	274

b 131

c 73%

d 29%

7 a $120

b approximately $52

8 a approximately 32MJ

b December to February

c No heating in the summer months and possibly less cooking.

9 a 3.15%

b $1375

10 categorical, pie graph, change, time, it keeps the detail of the data, histogram

11

12

Chapter 6

Exercise 6.01

1 a words/min   **b** beats/min

c c/min   **d** $/kg

e $/h   **f** c/L

g persons/year   **h** c/kL

i persons/km^2

2 a 17 sheep/h   **b** $4.30/kg

c 26 students/teacher   **d** 34 points/game

e 91 words/min   **f** 8.5 articles/h

g 4.8 cars/day   **h** 630 boxes/h

i 37 m/s   **j** 920 bottles/h

k 1324 revolutions/min   **l** $35/h

m 56 km/h   **n** $2.75/kg

o 4.75 runs/over   **p** 8.1 km/L

q $10.50/h   **r** 42 kg/ha

3 $16/kg

4 a Can travel 100 km in one hour at this speed

b 150 cars will pass in an hour at this rate

c 10.3 L will be used over a distance of 100 km

d for each hectare of land, there are 60 sheep

5 80 kg/person   **6** 1800 ha/year

7 139 c/L   **8** 182.5

Exercise 6.02

1 a 14 800 kJ   **b** 22%

2 a 8000 kJ   **b** 2400 kJ

3 a 5000 kJ   **b** 1000 kJ

4 a 2100   **b** 86   **c** 286

   d 6   **e** 586   **f** 2571

5 a 2310 kJ   **b** 46 cal

6 a boys   **b** 2 to 3 years   **c** 3350 kJ

   d 4 to 8 years   **e** 56 000 kJ

   f No, 1100 kJ too many.

   g increase

7 a 2000 kJ   **b** 2 hours

   c   **i** 10 500 kJ   **ii** 14 000 kJ

     iii no (activities expend 14 000 kJ)

     iv Eat more or exercise less.

Exercise 6.03

1 a 2659 kJ   **b** 1463.5 kJ

   c 5691 kJ   **d** 725 kJ

2 a Breakfast 4491 kJ, lunch 4335 kJ, dinner 7783 kJ, daily total = 16 609 kJ.

   b Unless he is very, very active, he will put on weight.

3 Teacher to check.

4 a 3450 kJ   **b** 115 minutes

5 a 690 kJ   **b** 765 kJ   **c** 1020 kJ

   d 3975 kJ   **e** 1920 kJ   **f** 8050 kJ

6 a 306 kJ   **b** 888 kJ   **c** 1152 kJ

   d 14 754.6 kJ   **e** 76 kg

Exercise 6.04

1 a $130.59   **b** $164.86   **c** $92.63

2 a Simpsung, uses a smaller amount of electricity annually

   b $52.49, $109.91   **c** $57.42

   d 7.5 years   **e** Teacher to discuss

3 $163.71

4 a 11 500 kWh   **b** 7500 kWh

   c $525   **d** $1124

5

	Power rating (W)	kWh per day	Daily cost (cents)	Monthly cost ($)
a	800	19.2	653	195.90
b	2400	3.6	122	36.60
c	900	0.45	15	4.50
d	1100	1.1	37	11.10
e	100	0.6	20	6.00
f	380	0.19	6	1.80
g	1500	1.5	51	15.30
h	1500	0.375	13	3.90
i	1900	1.9	65	19.50
j	650	0.325	11	3.30
k	950	0.2375	8	2.40
l	40	0.2	7	2.10
m	1400	0.7	24	7.20
n	550	3.3	112	33.60
o	950	0.7125	24	7.20

6–8 Teacher to check.

Exercise 6.05

1 117 beats/min

2 a 126   **b** 90   **c** 148

   d 153   **e** 156   **f** 156

3 4920

4 a 168   **b** 552

5 a 25–38   **b** 3–4 years

   c Yes, her pulse is only 57 beats/min and it should be 70–110 beats/min.

6 a 149 beats/min   **b** 44–45 days

   c Teacher to check

7 Premature. His pulse is 156 beats/min.

Keyword activity

1 d   **2** h   **3** f   **4** b   **5** g

6 a   **7** c   **8** e

Test yourself 6

1 a 1050   **b** 1370

2 a 500 kJ   **b** 175 minutes = 2h 55 min

3 a 1100

   b Many answers possible, teacher to check

4 4790 kJ   **5** 3600 kJ

6 a $3.50/kg **b** 110 km/h
c $14.10/h **d** 5.2 runs/over
7 0.5 kWh **8** 8.4 c
9 66 beats/min **10** $71.18
11 4860

Chapter 7

Exercise 7.01

1 a 3000 **b** 12 000 **c** 1.5 **d** 2.4
e 850 000 **f** 0.9 **g** 2500 **h** 0.5
2 a 10 000 **b** 10
3 a 4 **b** 54 **c** 2160
4 a 135 g **b** 135 000 **c** 270 mg
5 20
6 Teacher to discuss answers with the class.
7 360 mg
8 a 11
b Yes, its mass is less than 12 pounds.
9 Sum of the dimensions = 40.4 inches, mass = 52.8 pounds. The bag is small enough but it is too heavy.
10 a 1350 kg **b** 10.8 t
11 1600 g
12 It weighs 32.15 troy ounces and is worth approximately $42 790.

Exercise 7.02

1 a No **b** 150c, 160c
c potatoes, blue peas, onion, tomatoes, green peas
d 2 **e** 13.5 g **f** 5
2 a Thailand **b** yes **c** 14.0 g
d 0.4 g **e** no
3 a 1830 kJ **b** 170 mg **c** 68.6%
d peanuts, tree nuts, sesame seeds, egg, milk
4 a 12 **b** 30 mL **c** 360 mL
d 3276 kJ **e** 2.4 g
f There is the same quantity of both.
g 85% **h** 3.6 g **i** 1.2 g
5 a 220 mg **b** 0.6 mg **c** 1.2 g

Exercise 7.03

1 a m^3 **b** cm^3 **c** cm^3
d mm^3 **e** m^3 **f** m^3
g cm^3 **h** m^3 **i** mm^3
j cm^3 **k** mm^3 **l** cm^3
2 a E **b** G **c** F **d** C
e A **f** B **g** D
3 a 5 000 000 **b** 1 600 000
c 0.006 **d** 4
e 0.16 **f** 0.25
g 180 000 **h** 120
i 4 000 000 000 **j** 0.0096
4 4210 mm^3, 42 cm^3, 0.0042 m^3
5 0.6 m^3, 65 000 cm^3, 7 000 000 mm^3
6 0.306 m^3
7 2 520 000 mm^3
8 200 000 cm^3

Investigation: Volume of a rectangular prism

1 a 10 cm^3 **b** 20 cm^3 **c** 8 cm^3
2 a 3 cm **b** 1 cm **c** 3 cm **d** 9 cm^3
e 2 cm **f** 2 cm **g** 3 cm **h** 12 cm^3
i 3 cm **j** 2 cm **k** 2 cm **l** 12 cm^3
m 3 cm **n** 2 cm **o** 5 cm **p** 30 cm^3
3 Multiply the dimensions together to get the volume.
4 350 cm^3 **5** 216 m^3

Exercise 7.04

1 a 111 cm^3 **b** 2.5 m^3
c 256 m^3 **d** 486.42 cm^3
2 a 1 071 000 cm^3 **b** 91.125 cm^3
c 21 952 cm^3 **d** 258.06 cm^3
3 a 84 cm^3 **b** 240 cm^3
4 a 16 065 cm^3 **b** 1 285 299 cm^3
5 a 42 875 cm^3 **b** 471 625 cm^3
c approximately 330 books
6 a 648 cm^3 **b** 3420 cm^3
c 1068.375 cm^3 **d** 1026 cm^3
e 794.75 cm^3

7 a 126 pavers **b** 4 500 000 mm^3
  c 567 000 000 mm^3 **d** 13
  e \$737.10
8 200 m^3
9 Volume = 420 m^3 so Nazneen requires a large air-conditioner.
10 510 cm^3

Exercise 7.05

1 a 85.5 cm^2 **b** 2223 cm^3 **c** 101 cm^3
2 a 1725 cm^3 **b** 1050 cm^3
  c 675 cm^3 **d** 39%
3 795 cm^3 **4** 198 cm^3
5 Volume is approximately 70 cm^3 and it holds approximately 28 g of coffee beans.
6 532.5 cm^3

Exercise 7.06

1 a mL **b** kL **c** L
  d mL **e** L **f** kL
2 a D **b** G **c** J **d** H **e** I
  f A **g** F **h** E **i** C **j** B
3 a 8 mL **b** 1500 mL **c** 425 mL
4 a 2 L **b** 3.5 L **c** 0.25 L
5 a 5000 mL **b** 5
6 2000 **7** 4000
8 1.5 L **9** 1000 cm^3
10 1250 cm^3 **11** 9 L
12 504 L
13 a 0.2 mL **b** 12 mL
  c 2160 mL **d** 17.28 L
14 a rectangular prism **b** 2.042 m^3
  c 2042 L **d** 19 minutes
15 a 10 143 cm^3 **b** 10 L **c** 5 kg
16 795 L
17 a 297 L **b** 39 mL

Keyword activity

1 H **2** D **3** I **4** E
5 F **6** B **7** A **8** G
9 C

Test yourself 7

1 a 5000 **b** 0.2 **c** 1400
  d 3500 **e** 7.5
2 a 498 **b** 220
  c Several answers possible, examples
  $16.7 \times 0.5 = 8.35$ and $16.7 + 8.35 = 25.05$
  or $25.05 \div 16.7 = 1.5$, $1\frac{1}{2}$ times bigger, thus increased by half or 50%.
  d $1.4 \div 7 = 0.2$, 2
  e 1.19
  f $3.85 \times 70 = 269.5$
3 a 5000 **b** 2 000 000 **c** 0.5
  d 250 000 **e** 0.024 **f** 36
4 a 11.16 cm^3 **b** 64 m^3
  c 153 cm^3 **d** 48 cm^3
5 a 1500 cm^3 **b** 1.5 L
6 a 24 **b** 6000 cm^3
7 700

Chapter 8

Exercise 8.01

1 a \$1330 **b** \$2660 **c** \$69 160
2 a \$6875 **b** \$3173.08 **c** \$1586.54
3 a \$67 600
  b A month is usually longer than 4 weeks
  c \$5633.33 **d** \$37.14 **e** \$0
4 a \$249.76 **b** 4.5 hours
5 a \$879.23 **b** \$1170.43
6 \$15.68 **7** \$4160
8 a \$178 **b** 11
  c Teacher to discuss
9 a Job 3, the salary **b** Teacher to discuss

Exercise 8.02

1 a \$25.80 **b** \$34.40 **c** \$21.54 **d** \$28.72
  e \$36.90 **f** \$49.20 **g** \$46.88 **h** \$62.50
2 \$123 **3** \$122.40 **4** \$272.50
5 a 2 **b** \$1060.20
6 a **i** \$19 **ii** \$28.50 **iii** \$38
  iv \$399 **v** \$114 **vi** \$228
  b \$741

7 a $18 **b** $81

8 $105

9 a $135.20 **b** 7:30 a.m. **c** 1 hour

  d 3:30 p.m. **e** $101.40 **f** 11 a.m.

Exercise 8.03

1 a $962.15 **b** $2290.88

2 $611.25 **3** $1002

4 $1113.30 **5** $721.21

6 $576.25

7 a i 8 **ii** 7 **iii** 4

  iv 5 **v** $12.32 **vi** $18.48

  vii $18.48 **viii** $24.39 **ix** $98.56

  x $129.36 **xi** $73.92 **xii** $121.95

  b $423.79

Exercise 8.04

1 a $61.25 **b** $221.20

  c $581.88 **d** $1206.63

2 a $486.50 **b** $2655.50

3 $3492.10

4 a $60 644.40 **b** $4664.95 **c** $816.37

5 $6536.62 **6** $5963 **7** $376

8 a $363.69 **b** $5420.89

9 $448

10 a $78.75 **b** Teacher to check

Exercise 8.05

1 a $2250 **b** $40 **c** $6000

  d $12 500 **e** $6570 **f** $570

2 $117.25 **3** $4603.50

4 $554.40 **5** $10 600

6 a $18 **b** $61 **c** $159.50

7 a $18 **b** $61 **c** $214

8 $2235

9 More than $8.35; $8.50 or $9 would be suitable

10 $88 **11** $412 700

12 a $20 440 **b** $43 400

13 a $16.80 **b** $62.40 **c** 417

14 $2875

15 Melissa $17 675.29, publisher $41 242.35

16 a $204 **b** $945.20 **c** $2363

Exercise 8.06

1 $82 **2** $398

3 $112.80 **4** $2376.27

5 a $20 745.40 **b** $204.20

6 a $745.30 **b** $658.80

7 Age pension $769 155.40, annual phone allowance $4850.40

8 The pension received ($5235.10) is the correct amount (not $3614.25) and Rose has not been overpaid.

Exercise 8.07

1 a $5800 **b** $111.54

2 a

Income		Expenses	
Office	$620	Rent	$280
Club	$215	Food	$60
		Mobile phone	$20
		Travel	$60
		Total fixed expenses	$420
		Entertainment	$60
		Savings	$315
		Clothes	$40
Total income	$835	Total expenses	$835

Others answers possible for entertainment, savings, clothes.

b

Income		Expenses	
Office	$620	Rent	$280
Club	$215	Food	$60
		Mobile phone	$20
		Car	$175
		Total fixed expenses	$535
		Entertainment	$50
		Savings	$210
		Clothes	$40
Total income	$835	Total expenses	$835

3 a $312 **b** $41 080 **c** $16 224

4 a Income = $420, Expenses = $300

  b $1440 **c** Teacher to check

5 a $158 **b** $223

  c Approx. 113 weeks **d** Teacher to check

Keyword activity

1 J   **2** F   **3** G   **4** I
5 K   **6** L   **7** A   **8** C
9 E   **10** H   **11** D   **12** B

Test yourself 8

1 a $656.25   **b** $1312.50   **c** $34 125
2 a $8000   **b** $3692.30
3 a $30.36   **b** $283.36
4 $21   **5** $115.85
6 $875   **7** $6227.50
8 $40 500   **9** $782
10 $21 015.80
11 She should budget. If she saves $80 per fortnight into a special account she will have a little more than she needed this year to pay these expenses.

Practice set 2

Section A

1 C   **2** A   **3** A   **4** B   **5** D
6 C   **7** B   **8** C   **9** A   **10** D

Section B

1 a 7   **b** −5   **c** 20   **d** −34
2 1386 cm^3
3 a 2011   **b** Inner city
    c 2011   **d** 150
4 156 beats/min
5 a 50 g   **b** 12 000 g   **c** 12 kg
6 a

Age group	Exercise regularly	No exercise	Total
Under 40	60	50	110
40 and over	65	25	90
Total	125	75	200

   b 37.5%
   c 52%
7 a

x	0	2	3	5
y	1	5	7	11

   b

x	−1	0	2	3
y	8	6	2	0

8 a 15   **b** 5   **c** 182
9 a 3718.75 cm^3 **b** 384
10 a $x + y = 8$ **b** $y = 9x$
11 a 1405 kJ   **b** 42.15 minutes
12 $10 150
13
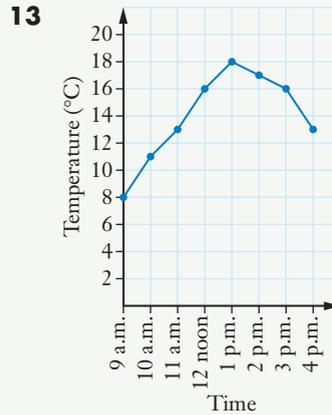
14 a 14.4 kWh   **b** 748.8 kWh   **c** $254.59
15 Volume of tank = 80 m^3 = 80 000 L. Tank will meet their requirements.
16 a $4192.31   **b** $1172.50
17 a $3880   **b** $679   **c** $4559
18 $8991

Chapter 9

Exercise 9.01

1 a N   **b** C   **c** N   **d** N
   e N   **f** C   **g** N   **h** N
2 a C   **b** C   **c** N   **d** N
   e C   **f** N   **g** N   **h** C
3 Teacher to check.

Exercise 9.02

1 a

Method of travel	Tally	Frequency
W	Ⲕⲧ Ⲕⲧ Ⲕⲧ Ⲕⲧ Ⲕⲧ I	26
R	Ⲕⲧ Ⲕⲧ Ⲕⲧ Ⲕⲧ III	23
B	Ⲕⲧ Ⲕⲧ II	12
C	Ⲕⲧ Ⲕⲧ	10
T	Ⲕⲧ IIII	9
Total		**80**

   b Walk   **c** Train

2 a

Age	Tally	Frequency
B	IIII IIII	9
P	IIII IIII	10
I	IIII IIII II	12
O	IIII IIII IIII	14
Total		**45**

b Children older than 8 years.

c 20%

3 a

Make of car	Tally	Frequency
H	IIII IIII	9
F	IIII II	7
T	IIII I	6
M	III	3
S	III	3
O	II	2
Total		**30**

b Holden

c 10%

4
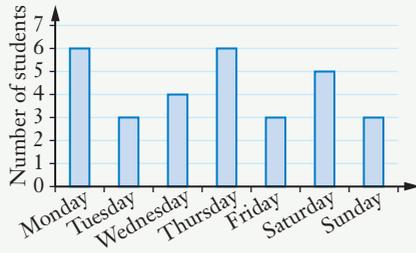
5
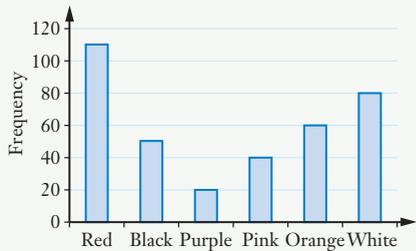
Exercise 9.03

1 a

Number of hamburgers	Tally	Frequency
17	IIII	5
18	IIII	4
19	IIII II	7
20	IIII	4
21	I	1
22		0
23	I	1
24	I	1
25	I	1
26	I	1
27	III	3
28	III	3
Total		**31**

b 16

c 23%

2 a

Number of siblings	Tally	Frequency
0	IIII	5
1	IIII IIII	10
2	IIII III	8
3	IIII IIII	9
4	IIII	5
Total		**37**

b 37

c 5

d 23

e 27%

3 a

Age	Tally	Frequency
31–40	IIII IIII	9
41–50	IIII III	8
51–60	IIII I	6
61–70	IIII	4
71–80	IIII III	8
81–90	IIII	5
Total		**40**

b 31–40

c 17

d 32.5%

4
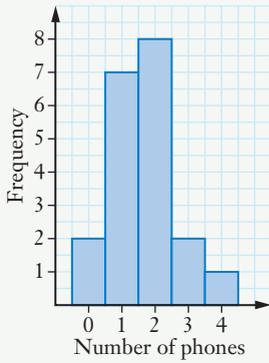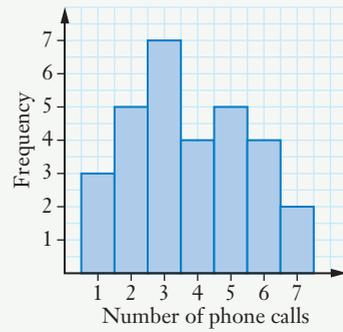
5 a
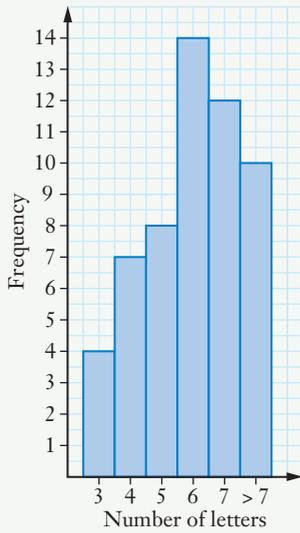
b 11 days

c 6 letters

6 a

Number of phone calls	Tally	Frequency
1	III	3
2	₩I	5
3	₩I II	7
4	IIII	4
5	₩I	5
6	IIII	4
7	II	2
Total		**30**

b

c 5 days

d 3 phone calls

7 a

Heights	Tally	Frequency
150–154	II	2
155–159	IIII	4
160–164	III	3
165–169	₩I	5
170–174	₩I	5
175–179	IIII	4
180–184	II	2
Total		**25**

b 25

c
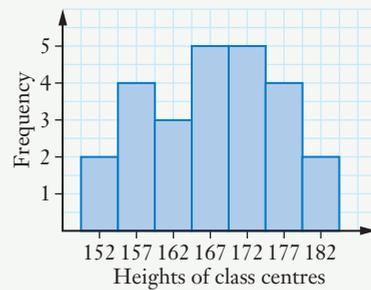
d 11 students

e 165–169 and 170–174

Exercise 9.04

1 a
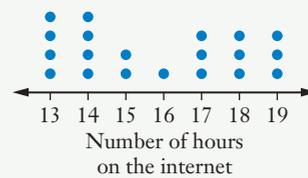
b 20   **c** 4   **d** 9

2 a
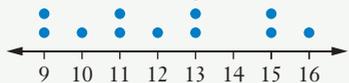
b 3   **c** 25%   **d** 5

3 a
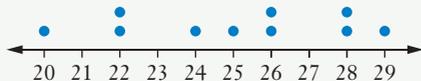
b 12   **c** $28   **d** 5

4 a

Stem	Leaf
7	6
8	1 6 8
9	5 7 8
10	1 5 5
11	2 2 4 7
12	4

b 53%

5 a

Stem	Leaf
1	1 2 2 3 3 4 6 7 7 9
2	0 0 0 2 3 3 4 5 5 5 6 7
3	0 1 3 3 3 4 5 9
4	1 2 8 8
5	5 5

b 8   **c** 22%

6 a

Stem	Leaf
0	0 0 5 8 9
1	1 4 5 6 7
2	1 2 4 5 6 7 9
3	1 3 5
4	2

b 42 hours   **c** 5   **d** 11

e 21   **f** 52%

7 a stem-and-leaf plot   **b** dot plot

c histogram   **d** stem-and-leaf plot

e dot plot   **f** dot plot

g histogram or stem-and-leaf plot

h histogram   **i** dot plot   **j** histogram

Exercise 9.05

1 a 28   **b** 1   **c** 12   **d** 94

2 0, 2, 16

3 a 31 45 45 45 49 49 50 50 52 52 55 55 56 58 58
59 59 60 60 75

b 31, 75

4 a 30, 47, 48, 48, 49, 54, 59, 59, 63, 64, 68, 68,
68, 80

b 30, 80

5 a

Stem	Leaf
2	5
16	1 5 7 7 9 9
17	0 0 1 3 5 6 6 9
18	0 0 2 2 4 5 6
19	7 8
23	0

b 25 cm – definitely a wrongly recorded measurement, no Year 11 student would be this short.

c 230 cm – probably a wrongly recorded measurement, a Year 11 student is unlikely to be this tall.

6 a $1 800 000

b Reasonable – this could be paid for a particularly large/luxurious house.

7 a $245 000

b Reasonable – this could be the salary of the CEO or overall business manager.

8 a 16

b 10 cm, 11 cm, 15 cm, 40 cm

c All are likely to be wrongly recorded measurements – too small (10, 11, 15) or too large (40) for a foot measurement.

9 a $35 000

b Reasonable – often a business only makes a small profit in the first year.

Keyword activity

categorical data	C
numerical data	F
frequency table	A
histogram	E
dot plot	B
stem-and-leaf plot	G
outlier	D

Test yourself 9

1 a C   **b** N   **c** N
  d C   **e** N   **f** C

2 a

Colour	Tally	Frequency
Blue	Ⅼℋ Ⅼℋ IIII	14
Green	Ⅼℋ Ⅼℋ II	12
Red	Ⅼℋ III	8
Purple	Ⅼℋ Ⅼℋ	10
Yellow	Ⅼℋ IIII	9
Magenta	Ⅼℋ II	7
Total		**60**

b Blue   **c** 20%

d
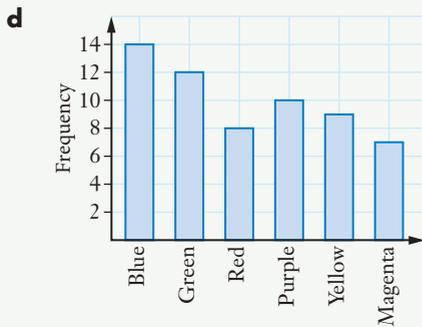
3 a

Temperature	Tally	Frequency
15	II	2
16		0
17	I	1
18	II	2
19	III	3
20	III	3
21	Ⅼℋ I	6
22	IIII	4
Total		**21**

b 21 days   **c** 8 days

d
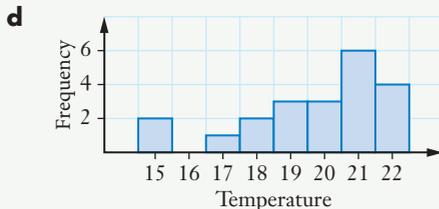
4 a
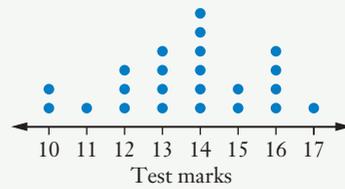
b 23   **c** 7

5 a

Stem	Leaf
2	5 6 8 8 9 9
3	2 3 3 5 5 6 9
4	1 7 8
5	0 0 2 5 6

b 21   **c** 56   **d** 42.9%

6 a 19   **b** 7   **c** 43.9   **d** 76

7 a 56   89   93   98   99   100   100   101
     104   125

b 56 and 125   **c** Teacher to check.

Chapter 10

Exercise 10.01

1 a 360 min   **b** 130 weeks
  c 8 min   **d** 10 years
  e 42 days   **f** 12 fortnights
  g 60 months   **h** 42 days
  i 126 days   **j** $6\frac{1}{2}$ years

2 195 min   **3** 15 weeks

4 $1520   **5** 180

6 a $67 020   **b** $1288.85

7 a 3 h 32 min   **b** 9 min 21 s
  c 5 min 30 s   **d** 2 h 15 min
  e 6 h 49 min   **f** 12 min 47 s

8 a 1400 s   **b** 23 min 20 s
  c 5:24 a.m.

9 26 h 45 min

10 10 h 50 min

11 a Teacher to check.   **b** 3 h 26 min

Exercise 10.02

1 a 1144   **b** 1835
  c 0251   **d** 2154

2 a 8:45 a.m.   **b** 1:20 p.m.
  c 11:31 p.m.   **d** 10:45 a.m.

3 a 11:23 a.m.　　**b** 5:54 p.m.
　c 1:16 p.m.
4 a 5:20 a.m.　　**b** 10:05 a.m.
　c 2:45 a.m.
5 a 3:15 p.m.　　**b** 8:31 p.m.
　c 11:55 p.m.
6 a　　　**b**

　c

7 a 7:15 a.m.　　**b** 5:30 p.m.
　c 9:50 p.m.　　**d** 11:20 a.m.
　e 0500　　**f** 1410
　g 1718
8 a 2030　　**b** 2205
9 5:30 p.m.
10 a 8 hours　　**b** 3 hours 35 minutes
　c 0305

Exercise 10.03

1 a 5 h 45 min　　**b** 5 h 44 min
　c 2 h 20 min　　**d** 3 h 53 min
2 a 3 h　　**b** 10 h
　c 5 h 15 min　　**d** 8 h 10 min
3 9 h 30 min
4 6 h 25 min
5 a 8:00 p.m.　　**b** 7:43 p.m.
　c 1:17 p.m.　　**d** 2:24 a.m.
6 a 2:15 p.m.　　**b** 2:35 a.m.
　c 11:25 a.m.　　**d** 7:50 a.m.
7 3:15 p.m.　　**8** 7:45 p.m.
9 a 3 years 8 months　　**b** 4 years 1 month
　c Teacher to check.
10 1 year 4 months　　**11** August 2014
12–13 Teacher to check.

Exercise 10.04

1

	NT	
AWST	ACST	AEST
$-1\frac{1}{2}$	0	$+\frac{1}{2}$
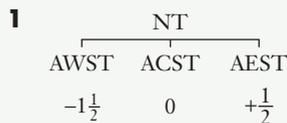
2 a ahead　　**b** ahead　　**c** same
　d ahead　　**e** behind　　**f** ahead
　g ahead　　**h** same　　**i** ahead
　j behind
3 a 11 a.m.　　**b** 9 a.m.　　**c** 10:30 a.m.
　d 11 a.m.　　**e** 11 a.m.　　**f** 9 a.m.
4 a 11 p.m.　　**b** 10:30 p.m.　　**c** 9 p.m.
　d 10:30 p.m.　　**e** 11 p.m.　　**f** 11 p.m.
5 1:45 p.m.
6 a 5:30 p.m.　　**b** 7 p.m.
7 8:30 p.m.　　**8** 10 p.m.
9 a–c Teacher to check.　**d** 3:30 p.m.
10 Teacher to check.
11 WA (Perth)
12 Perth, Adelaide (on Summer time)

Exercise 10.05

1 7:50 a.m.　　**2** 5:15 p.m.　　**3** 8:10 a.m.
4 a 4:52 p.m.　　**b** 5:08 p.m.　　**c** 5:22 p.m.
5 5:22 p.m.　　**6** 8:45 a.m.
7 a 47 min longer　　**b** Teacher to check.
8 a, b Teacher to check.
9 20 h 30 min
10 4, 9:45 p.m., 5:15 a.m. (next day), 8:20 a.m., 11:45 a.m.
11 a 6 h 25 min　　**b** 11 h
12 a approximately Bulgunnia Turnoff
　b Teacher to check.
13 a 25 h 25 min　　**b** Longer
　c Teacher to check.
14 44 min
15 a 11:02 a.m.　　**b** 34 min
　c 58 min　　**d** Teacher to check.
16 grey is a.m. times, white is p.m. times
17 a 2 buses, Bus 1 can do the 10:30 a.m. departure and so on.
　b 1 p.m., first bus after 11:42 a.m. is 12:05 p.m.
　c Teacher to check.　**d** Teacher to check.

Exercise 10.06

1 **a** 3:50 a.m. **b** 3:43 a.m. **c** 3:52 a.m.
2 **a** 4:15 a.m. **b** 4:37 a.m. **c** 4:05 a.m.
3 **a** 12 h 49 min **b** 0.62 m
4 **a** 5:48 a.m., 6:16 p.m. **b** 12 h 28 min
5 Mon 14, Wed 23, Thu 24, Sat 26
6 **a** Sat Oct 26 **b** It is getting earlier.
7 **a** Between 3 a.m. and 9 a.m. or between 3:30 p.m. and 9 p.m.
  b Between 4:30 a.m. and 10 a.m. or between 5 p.m. and 10 p.m.
8 2:01 p.m.
9 **a** 12 h 39 min **b** They are increasing.
10 Teacher to check.

Keyword activity

12-hour time – D
24-hour time – B
timeline – C
time zone – E
timetable – A

Test yourself 10

1 **a** 12 **b** 49 **c** 54 **d** 8
2 **a** 1877 seconds **b** 4 days
3 **a** **i** 0417 **ii** 1525 **iii** 1000
  b **i** 6:15 a.m. **ii** 4:40 p.m. **iii** 11 p.m.
4 **a** 6 hours, 10 minutes
  b **i** 7 hours **ii** 2 hours, 35 minutes
  iii 0113
5 **a** 4 hours, 25 minutes **b** 11:25 a.m.
6 **a** 4 hours, 50 minutes **b** 10:40 p.m.
  c March 2015
7 **a** Teacher to check. **b** 1:30 p.m.
  c 2:45 p.m.
8 **a** 8:50 a.m. **b** 8:27 a.m. **c** 5:01 p.m.
9 **a** 8 hours **b** 8:20 a.m.
  c Teacher to check.
10 **a** 49 minutes **b** 11:15 a.m.
11 **a** 2:35 a.m. **b** 12 hours, 37 minutes
  c 12 hours 16 minutes **d** 0.24 m

Chapter 11

Exercise 11.01

1 **a** $15 **b** 44 000 people **c** 1.05 kg
  d 810 letters **e** 750 m² **f** 48 L
  g 60 066 **h** 6 mins **i** $21.08
  j 60 people
2 **a** 7 days **b** 21 days
3 25 299 cars
4 **a** $29 **b** $2.44
5 **a** $9 **b** $234
6 113 students 7 $39.10 8 $1084.65
9 287 passengers
10 **a** 324 000 km **b** 314 160 km
11 **a** 360 **b** 196
12 O+ 9 934 000 A+ 7 698 850 B+ 1 986 800
   AB+ 496 700 O– 2 235 150 A– 1 738 450
   B– 496 700 AB– 248 350

Exercise 11.02

1 **a** 85% **b** 85% **c** 40% **d** 75%
2 **a** English 53.75%, Maths 81.18%, Design 58.46%, Science 65%, Business Studies 84.29%, Health 75.56%
  b Business Studies, Maths, Health, Science, Design, English
3 Tiago 54.5%, Luke 62.2%, Luke is more successful.
4 Muesli bars 31.4%, Jam 49%, Jam has the higher percentage of sugar.
5 **a** Colombia 8.78%, Iran 7.07%
  b Colombia
  c Teacher to check.
6 **a** 5% **b** 37.5% **c** 1.25% **d** 25%
7 **a** Monday 28.6%, Wednesday 35%, Saturday 30%
  b Wednesday **c** 31.25%
8 A 25%, B 26.7%, B has the highest percentage of alcohol.
9 **a** Clarkson 120.6, Bailden 126.3
  b Bailden
10 Victoria 4.8%, Western Australia 2.75%, Victoria has the higher rate of stamp duty.

Exercise 11.03

1 **a** $720   **b** $60   **c** $130.20
   d $109.20   **e** $1029   **f** $412.25
   g $34.88   **h** $2056.20

2 **a** $864   **b** $3264

3 **a** $202.50   **b** $1702.50

4 **a** $72   **b** $3.96   **c** $45.83
   d $312.94   **e** $442.74   **f** $17.55

5 $501.88   **6** 0.39%

7 **a** 0.7%   **b** 0.1615%   **c** 4.2%
   d 0.0230%   **e** 0.3231%   **f** 2.1%

8 **a** $84   **b** $101.77   **c** $126
   d $31.07   **e** $155.08   **f** $189

9 **a** $6.69   **b** $371.69

Exercise 11.04

1 **a** $18 000   **b** $48 000   **c** $800

2 **a** $261   **b** $1761   **c** $73.38

3 **a** $3610
   b **i** $4455   **ii** $58 455   **iii** $2435.63
   c **i** $150.94   **ii** Yes, she will have $5900.94.

4 $18 750

5 **a** $18 687.50   **b** $668 687.50
   c $93 687.50

6 **a** $8795   **b** $6295   **c** $1397.49
   d $7692.49   **e** $213.68

7 **a** $1620   **b** 4 years

8 5 years

9 **a** $1200   **b** 10%

10 **a** 8.5%   **b** 6.9%   **c** 5.6%   **d** 7.2%

Exercise 11.05

1 **a** $108   **b** $612
   c $30.60   **d** $581.40
   e No, 20% off gives a price of $576.

2 **a** $53 199.30   **b** $50 539.33
   c No, 35% gives a price of $49 399.35.

3 **a** 1160   **b** 348   **c** 17.4%

4 **a** $262.20   **b** 24%

5 **a** $1552.50   **b** $747.50   **c** 32.5%

6 **a** $554.80   **b** 24%

7 **a** $34.63   **b** 17.5%

8 **a** $640   **b** $704

9 **a** $704   **b** Neither, they are the same.

10 2786 people   **11** $336.08   **12** 2517

Exercise 11.06

1 **a** $620.50   **b** $3029.50

2 **a** $10 400   **b** $26 400   **c** $440

3 **a** $273   **b** $300.30
   c Teacher to check.
   d $268.13 so probably $269.

4 192 m^2

5 27%

6 **a** $2700   **b** $2430
   c No, 20% off gives a value of $2400.

7 **a** $6650   **b** $332.50

8 54.8%

9 **a** $57   **b** $60.90

10 **a** $399.90   **b** $3599.10   **c** $4030
   d $4429.90   **e** $430.90   **f** $215.45
   g 5.99%

11 3.49%

Test yourself 11

1 **a** $414.72   **b** 105 students

2 **a** **i** Megan 74.19%, Jasmine 68.75%
     ii Megan
   b **i** Storm 77%, Raiders 79%
     ii Raiders

3 **a** $714
   b **i** $3100.50   **ii** $16 100.50

4 **a** $127.50   **b** $229.69

5 **a** 1.0417%   **b** 0.2404%   **c** 6.25%

6 **a** $364.60   **b** $286.08   **c** $437.50

7 **a** $982.80   **b** $7282.80   **c** $202.30

8 **a** $31 122   **b** $29 565.90

9 **a** $1871.28   **b** $727.72   **c** 28%

10 54.0%

11 **a** $614   **b** $2456   **c** $1964.80

Chapter 12

Exercise 12.01

1 **a** 50 km/h   **b** 25 words/min
   c 50 L/h   **d** $17.50/kg
   e 7.27 m/s   **f** $26/h
   g 250 g/L   **h** 600 revs/min
2 18 L/m^2 3 1350 L/h
4 **a** 40 L/container   **b** 4 L/day
   c $5\frac{1}{3}$ g/cm^3 **d** $3.20/DVD
   e 35 mm/day   **f** 14.5 km/L
   g $11.40/m   **h** 256 vibrations/s
   i 40 sheep/ha   **j** $1.58/L
5 9 m^2/L   6 $120/day
7 **a** $8.50/kg   **b** $12.48/kg   **c** $2.45/kg
   d 55c/roll   **e** $2.45/bottle

Exercise 12.02

1 **a** 5.6 m/s   **b** 13.9 m/s
   c 22.2 m/s   **d** 30.6 m/s
2 **a** 4.8 km/h   **b** 1.3 m/s
3 **a** 45 km/h   **b** 144 km/h   **c** 3.5 km/h
4 40 kg/ha   5 1.8 L/h
6 **a** 1.2 g/mm   **b** 1.2 t/km
   c the same   **d** 12 g/cm
7 **a** 3500 L/h   **b** 58.3 L/min   **c** 1.0 L/s
8 **a** $2.80/L   **b** 0.28c/mL
9 **a** 10.4 m/s   **b** 37.44 km/h
10 garden pots (76 mL/m^2)

Exercise 12.03

1 **a** $2.30   **b** $2.20   **c** $2.25
2 **a** 50 mL: 72c/10 mL; 80 mL: 70c/10 mL
   b 80 mL
3 **a** 40c and 35c
   b box containing 6 eggs
   c 3 boxes containing 6 eggs
4 350 g, as it's the cheapest per 100 g
5 **a** 1 kg   **b** 1 kg for $3.50

6 **a** $145, $140, $139, $142
   b one 2.5 g packet and one 5 g packet
7 Teacher to discuss
8 The 1 L bottle is the better value. The 750 mL bottle is the equivalent of $11.93 per L.

Exercise 12.04

1 **a** 112   **b** 196   **c** 336
2 $248
3 **a** 3 h   **b** 1.5 h
   c 4.8 h or 4 h 48 min
4 6.25 kg
5 **a** 720 kg   **b** 15 trees
6 **a** 5460 km
   b **i** 2.0 h   **ii** 3.1 h   **iii** 4.1 h   **iv** 15.2 h
7 **a** 960   **b** 270   **c** 25 m^2 **d** 95 m^2
8 768 kg
9 **a** 750 mL   **b** 1500 mL   **c** 1.5 L
   d 36 L   **e** 40 min   **f** 40 h
10 **a** $8000   **b** 35 weeks   **c** 3 weeks
11 **a** 18 h   **b** 35 h   **c** 24 h
12 **a** 21.6 m   **b** $270   **c** 18 m
   d 10 windows
13 **a** 504 L   **b** $1134   **c** $2232   **d** 15 h

Exercise 12.05

1 **a** 50.15 L   **b** $80.24
2 13.9 L/100 km   3 820 km
4 9.5 L/100 km
5 **a** 10.1 L/100 km   **b** 8.8 L/100 km
   c 8.5 L/100 km   **d** 7.3 L/100 km
   e 7.8 L/100 km
6 800 km
7 **a** 7.15 L   **b** $10.73
8 **a** 47 L   **b** $82.25
9 **a** They both use 1.8 L to complete the job.
   b Use whichever mower he wants. However, with the ride-on, there will be less noise pollution.
10 **a** 0.4 L/h   **b** 3.2 L
   c 7.5 h

Keyword activity

Crossword:

- 1 Down: CONVERT
- 2 Down: SPEED
- 3 Down: UNIT PRICING
- 4 Across: COMPARISON
- 5 Across: RATE
- 6 Across: TIME
- 7 Down: PER
- 8 Across: FUEL CONSUMPTION

Test yourself 12

1 $64/h **2** 20.8 m/s

3 108 000 km/h

4 a i $1.33 **ii** $1.07 **iii** $1.30

 b 750 mL

5 $2310 **6** $106

7 Choose $36.50/h. It pays $60 more per week.

8 a White car 8.5 L/100 km, Red car 9.1 L/100 km

 b White car

Practice set 3

Section A

1 C **2** A **3** C **4** D **5** A

6 B **7** C **8** D **9** D **10** B

Section B

1 7, 9

2 a 28 days **b** 7 years

 c 4.5 days **d** 11 fortnights

3 a

Number on die

 b 9 **c** 45%

4 a $78.75 **b** $3578.75

5 a 75 m/min **b** 4.5 km/h

6 a 9:30 p.m.

 b 0:15 a.m. or 15 minutes after midnight

7 a $3680 **b** $4048 **c** $2833.60

8 a

Waiting time	Tally	Frequency
1–5	II	2
6–10	IIII IIII IIII IIII	20
11–15	IIII IIII IIII III	18
16–20		0
21–25	II	2
Total		42

 b 18 **c** 4.8%

9 3024 mL

10 a 8:09 a.m.

 b 7:18 a.m., 7:48 a.m., 8:18 a.m.

 c 5:39 p.m.

11 a 675 km **b** $64.95

12 a

Sport	Tally	Frequency
Ice skating	IIII III	8
Speed skating	IIII IIII II	12
Ice Hockey	IIII IIII IIII III	18
Bobsled	IIII IIII IIII	15
Downhill events	IIII II	7
Total		60

 b

 c Ice Hockey

13 a $6 760 **b** $32 760 **c** $546

14 a i 3:30 p.m. **ii** 2 p.m.

 b i 12 noon **ii** 10 a.m.

15 a English 77.5%, Mathematics Methods 54.12%, Engineering Studies 87.69%, Physics 72.5%, Geography 67.14%, Visual Arts 68.89%

b i Mathematics, lowest result

ii What subjects are required for career choice, were there contributing factors to poor test result, other answers possible.

16 56.7L/day

Chapter 13

Exercise 13.01

1 a 9 **b** 8 **c** 8

2 a 2 **b** 45, 54 **c** no mode

d green **e** spade

3 a 16 **b** 37.5 **c** 72.9 **d** 50.5

4 a 8 **b** 13 **c** 11 **d** 12

e Teacher to check.

5 a 14 **b** 14

c 13.8, January, February, December, Teacher to check.

6 a 4 **b** 1, 3, 4, 7 **c** 4.3

7 Teacher to check.

8 a mode = 1, median = 3, mean = 5

b mean, it is the highest

c mode, it is the smallest

d Teacher to check.

9 a 4

b

Number of texts (score)	Frequency	Score × frequency
0	8	0
1	4	4
2	10	20
3	10	30
4	15	60
5	3	15
Total	50	129

c 2.58

10 a 50 **b** 6

c

Score	Frequency	Score × frequency
1	2	2
2	5	10
3	10	30
4	6	24
5	11	55
6	13	78
7	3	21
Totals	50	220

d 4.4

e Teacher to check.

Exercise 13.02

1 a Binns – 16.4, Thomson – 25.3

b the last age

c The much larger 91 makes the mean higher.

2 a $696 0500

b $767 273

c Median – it is more typical of most prices.

d $1 800 000

e $664 000, much closer to the median.

3 a Mark – 43.9, Steve – 45.4

b Steve

c Mark – 45, Steve – 37

d Mark

e Teacher to check.

4 a $154 000 **b** $70 500

c Median, 10 out of 12 scores are close to the median.

d Mean, its higher

e $275 000, $890 000 **f** $68 300

5 a Mean = $63 400, Median = $71 000

b Median, 4 out of 5 years are close to this value.

c Wanting to minimise tax paid.

d $32 000

e Mean = $71 250, Median = $71 500

6 a 204 deliveries

b This doctor could be a specialist in difficult pregnancies and deliveries.

c Mean = 30.65, median = 21.5

d Mean = 21.5, median = 21

e The outlier has a big effect on the mean, but only a very small effect on the median.

7 a $355 000 **b** $431 125

c Median – it is lower. **d** Mean – it is higher.

e $835 000, $1 700 000 **f** $397 568

Exercise 13.03

1 a range = 11

b $Q_1 = 18, Q_2 = 19, Q_3 = 25$

c 7

2 a range = 7

   b $Q_1 = 29, Q_2 = 31, Q_3 = 31$

   c 2

3 a range = 31

   b $Q_1 = 159.5, Q_2 = 169, Q_3 = 174.5$

   c 15

4 a range = 6

   b $Q_1 = 4, Q_2 = 5.5, Q_3 = 8$

   c 4

5 a Inner City

    i 43

    ii $Q_1 = 20, Q_2 = 25.5, Q_3 = 33$

    iii 13

   Coastal

    i 38

    ii $Q_1 = 52, Q_2 = 60, Q_3 = 64.5$

    iii 12.5

   b Coastal is much higher but the interquartile ranges are much the same.

6 a

0.00	0.00	0.02	0.04	0.05	0.07
0.09	0.09	0.12	0.15	0.18	0.20

   b Mean = 0.08, modes = 0.00 and 0.09, median = 0.08, range = 0.20

   c 3   **d** $Q_1 = 0.03, Q_3 = 0.135$

   e 0.105   **f** $\dfrac{5}{6}$

Exercise 13.04

1 a $30 000   **b** $44 000

   c 2009, 2011   **d** $36 000 to $64 000

   e 2010

2 a $30 000   **b** 78th percentile

   c $10 000   **d** Median

   e 9%

3 a 60%   **b** 90   **c** 66 or 67

   d 3rd and 4th decile

   e Easy, since the median score is 64% and more students scored at the higher end.

4 a 6   **b** October

   c August   **d** 5 times

   e Poor, as the below average months are very poor. Other answers possible.

5 a 25%   **b** 95%

   c 188 cm   **d** 5 years

   e i 178 cm or 179 cm   **ii** 182 cm

Exercise 13.05

1 The number of hours is evenly spread over a small range.

2 The scores are clustered in the 40s and 50s and tightly packed. There is a gap at the top.

3 The test results are tightly packed with a gap at the bottom.

4 a clustered, spread out

   b gaps, more dense, less dense

   c more dense, spread out

   d spread out, gaps

   e clustered, spread out, tightly packed

   f tightly packed, gaps

   Other answers are possible.

Exercise 13.06

1 a Mean = 20.78, $\sigma = 3.05$

   b Mean = 48.27, $\sigma = 21.34$

   c Mean = 14.55, $\sigma = 14.55$

   d Mean = 55.27, $\sigma = 21.34$

2 a Mean = $497.60

   b $\sigma = 103.6$

   c Teacher to check.

3 a $469.60   **b** $\sigma = 67.43$

   c Teacher to check.

   d Quite difficult as the mean is higher than $420. Other answers possible.

4 a $\bar{x} = 6.6$ **b** $\sigma = 1.0$

5 a $\bar{x} = 2.58$ **b** $\sigma = 1.52$

6 a $\bar{x} = 4.4$ **b** $\sigma = 1.61$

7 a Port Paradise: $\sigma = 2.17$, Palm Tree Cove: $\sigma = 4.46$

   b Port Paradise as the temperatures are more consistent (smaller standard deviation)

8 a Brad: Mean = 8.3, $\sigma = 2.0$, Aryn: Mean = 4.5, $\sigma = 1.7$, Kim: Mean = 6.5, $\sigma = 2.6$

   b Aryn as he has the lowest standard deviation

   c Brad as he has the highest mean and a fairly low standard deviation

9 a 70, 71, 73, 73, 74, 75, 75, 75, 75, 75, 7,
76, 77, 77, 77

b Mean = 74.6, σ = 2.03

c Paul is a consistent player as his scores show a
small standard deviation

10 a You would expect a large standard deviation
as the data is spread from 127 to 157

b σ = 10.08   **c** Teacher to check.

11 a

46	98	102	102	110	146
168	183	194	208	210	305

b Mean = 156, median = 157, mode = 102,
range = 259

c 99   **d** 66.9

e Teacher to check.

Keyword activity

1 mode   **2** average   **3** number

4 median   **5** odd   **6** order

7 outlier   **8** Quartiles   **9** 10

10 percentiles   **11** spread   **12** range

13 interquartile range

14 standard deviation

Test yourself 13

1 a i no mode   **ii** 913   **iii** 830

b i $40   **ii** $37   **iii** $35.82

c i 12°C, 20°C, 23°C, 25°C

ii 20°C   **iii** 19°C

d i no mode   **ii** 125.5 mm   **iii** 128 mm

2 a 61%

b 56%, 58%, 59%, 61%, 62%

c 62.3%

d Modes not useful. Mean or median are a
good reflection of the data.

3 a 830   **b** 300   **c** 962.5

d It lowers the mean.

4 a 59, 202, 227

b Mean = 116.9 mm, median = 124

c Raised the mean.

d Little effect – the medians are close together.

e Either median is good as most scores are
close to them.

5 a i 826   **ii** 554, 1064.5   **iii** 510.5

b i $12   **ii** $32, $40   **iii** $8

c i 14°C   **ii** 14°C, 23.5°C   **iii** 9.5°C

d i 168 mm   **ii** 89 mm, 150.5 mm

iii 61.5 mm

6 a computer fraud, rainfall, student income
(no outliers)

b temperatures (outliers)

7 a 30%   **b** 79

c 8th and 9th decile

8 a 6

b September, November, March and June.

c about 210 mm

9 The data are quite spread out and clustered
between 15 and 21 and between 23 and 25. It is
most tightly-packed at 15 to 18.

10 σ = 5.05

11 a $\bar{x}$ = 1.91   **b** σ = 1.50

12 a Deevine: $\bar{x}$ = 50.08, σ = 24.36;
Clatchey: $\bar{x}$ = 55, σ = 34.27

b Deevine, as the rainfall is more consistent
there (smaller standard deviation).

Chapter 14

Exercise 14.01

1 a 5 : 7   **b** 3 : 5   **c** 7 : 9

d 7 : 13   **e** 5 : 3

2 a

b 1 : 4

3 Teacher to check.

4 Fewer students for each teacher

5 a 8 : 13   **b** 3 : 8   **c** 13 : 1   **d** 1 : 25

6 a 39 : 23   **b** 23 : 100

c 38 : 100 or 19 : 50   **d** 23 : 28

7 a 13 : 25   **b** 17 : 100   **c** 5 : 12

d 150 : 1   **e** 500 : 43   **f** 350 : 83

g 3000 : 1421   **h** 27 : 40   **i** 59 : 180

j 180 : 7   **k** 9 : 49   **l** 7700 : 17

8 a 1 : 25   **b** 1 : 2   **c** 1 : 4

d 11 : 9   **e** 1 : 1   **f** 2 : 1

Exercise 14.02

1 a 4 : 3 **b** 3 : 4 **c** 3 : 2 **d** 2 : 1
  e 3 : 2 **f** 3 : 1 **g** 3 : 2 **h** 6 : 1
  i 5 : 1 **j** 8 : 7 **k** 7 : 13 **l** 4 : 1
  m 2 : 3 : 1 **n** 2 : 1 : 6 **o** 3 : 5 : 10 **p** 3 : 2 : 4
2 a 1 : 2 **b** 2 : 3 **c** 1 : 3 **d** 4 : 1
  e 2 : 3 **f** 1 : 2 **g** 5 : 3 **h** 3 : 1
3 a 3 : 20 **b** 1 : 20 **c** 3 : 1
  d 1 : 8 **e** 3 : 1 : 20
4 a 8 : 3 **b** 7 : 3 **c** 1 : 4
  d 6 : 1 **e** 16 : 7 : 1
5 a 5 : 8 **b** 1 : 13 **c** 1 : 2
  d 3 : 16 **e** 8 : 5 : 3
6 heavy-duty cleaning
7 a $1
  b i 3 : 2 **ii** 3 : 1 **iii** 2 : 1 **iv** 1 : 3
8 a 27 : 29 **b** 19 : 27 **c** 29 : 75
  d 29 : 19 **e** 27 : 29 : 19
9 a 3 : 25 **b** 4 : 5 **c** 1 : 4
  d 8 : 3 **e** 2 : 5 **f** 12 : 7
10 a black to red **b** purple to yellow
  c green to grey **d** green to all
  e green to red to black
  f yellow to purple to grey
11 a 4 : 3 **b** 4 : 3 **c** 29 : 36

Exercise 14.03

1 a 9 : 5 **b** $\dfrac{5}{14}$

2 a 6 : 2 **b** 3 : 1 **c** $\dfrac{3}{4}$

3 The ratios of red : yellow in the mixtures are
20 : 40 and 4 : 8. The ratios are equivalent.
They both simplify to 1 : 2.
4 a 5 : 2000 **b** 1 : 400
5 It looks more green than blue. Possibly Lara got
the ratio around the wrong way. Maybe she made
a 1 : 4 ratio instead of 4 : 1.
6 a 3 : 2 **b** 1 : 2 **c** 3 : 1 **d** 1 : 1
7 72 mL
8 a 5 mL **b** 10 mL **c** 15 mL **d** 20 mL
9 a $\dfrac{1}{4}$ **b** 2 cm **c** 3 : 1
  d i 2.5 cm **ii** 6.7 cm
10 a 10 **b** 9

11 a zinc 25 g, nickel 5 g
  b copper 112 g, zinc 40 g
  c 160 g
12 a 5 cups **b** 18 cups
13 a 2000 mL **b** 2 L **c** 150 mL
  d 25 mL **e** general perennial weeds

Exercise 14.04

1 56 mL blue, 4 mL black
2 18 mL red, 6 mL yellow
3 8 mL red, 2 mL yellow, 2 mL white
4 20 mL red, 80 mL yellow, 40 mL white
5 400 mL **6** $4200
7 Cement 30 kg, sand 60 kg, gravel 90 kg
8 a Toby $840, Vinson $1260
  b Toby $1750, Vinson $350
9 399 boys
10 silver beads 20, porcelain balls 15, crystal eyedrops 10
11 160 mL
12 a 2 g **b** gold 315 g, copper 84 g
13 a 150 mL **b** 400 mL **c** 200 mL

Exercise 14.05

1 a 1.5 cm **b** 3 cm **c** 4.5 cm
  d 7.5 cm **e** 9 cm **f** 3.5 cm
  g 3 cm
2 a 1.25 cm **b** 2.5 cm **c** 3.75 cm
  d 6.25 cm **e** 7.5 cm **f** 2.5 cm
  g 1.9 cm

3

Man

Woman
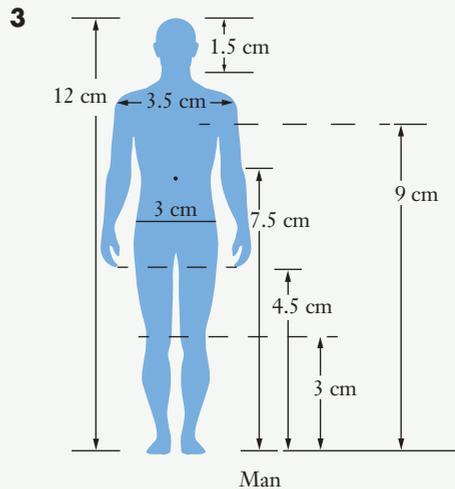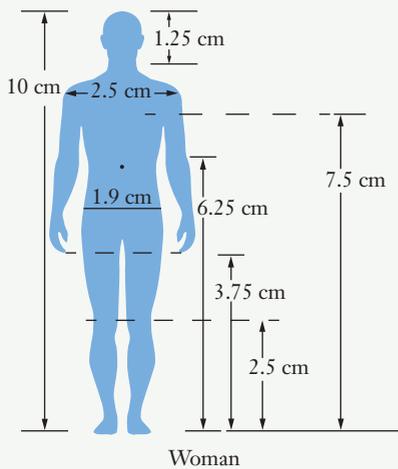
Exercise 14.06

1 a 11.4 m, 1 : 200   **b** 27 m, 1 : 500

   c 4.5 m. 1 : 150   **d** 20 mm or 2 cm, 2 : 1

   e 16.2 m, 1 : 300   **f** 208 cm or 2.08 m, 1 : 40

2 1100 m = 1.1 km

3 25 m

4 Length 4 m, width 2.5 m

5 a 13.5 cm   **b** 6.9 m

   c 16 cm   **d** 62.4 cm

6 4 m   **7** 6.4 km

Test yourself 14

1 a 1 : 3   **b** 75%

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

3 250 mL   **4** 3 mL

5 a Manal $64, Eddie $16

   b 24 km, 48 km

6 12 mL blue, 8 mL green and 4 mL white

7 48 mm

8 a 30 cm   **b** 0.8 cm or 8 mm

Chapter 15

Exercise 15.01

1 a $T = 5$ **b** $D = 240$

2 a 180 km   **b** 4 h

3 80 km/h   **4** 275 km   **5** 8 km

6 a 0.15   **b** 9 min

7 7.5 min

8 a 2000 m = 2 km

   b 30 is minutes not hours.

   c 4 km/h

9 a 279 m   **b** 4.5 s

10 a 5400 m   **b** $11\frac{1}{9}$ s

11 a 750 km   **b** 10 h

    c 76 km/h   **d** 5 a.m. Tuesday

12 a 16.7 m/s, 25 m/s

13 40 320 km/h

14 Teacher to check. The distance will be in the order of 100 km.

15 a 8 km   **b** 4 km   **c** 1 hour

    d 4 km/h   **e** 2 hours   **f** 6 km/h

    g The second hour is uphill. In the first hour, his speed was 8 km/h and in the second hour his speed was only 4 km/h.

16 a i 2 p.m.   **ii** 11 a.m.

    b 12:45 p.m.   **c** 48 km   **d** 4.5 h

    e i 16 km/h **ii** 6.4 km/h   **iii** 9.6 km/h

     iv 9.6 km/h

17 a 240 km

    b Sam, steeper graph, ending journey earlier.

    c 120 km   **d** 180 km

    e 10 a.m., 160 km

    f after 9:15 a.m., graph is steeper

    g 40 km/h   **h** B

18

Graph	Person	Distance from school
A	Luke	10 km
B	Peta	8 km
C	Wayne	4 km
D	Shelby	2 km

19 Teacher to check.

Exercise 15.02

1 32.3 m

2 a 20.2 m   **b** 1.7 m   **c** slow down

3 a Yes, he could stop in 16.8 m.

   b Yes, he would take 18.3 m to stop.

4 a 51.0 m   **b** 24.0 m

5 He should leave about 31 m since he needs that distance to stop.

6 Agree. Teacher to check reasoning.

7 a 79.2 km/h   **b** 16 km/h

8–9 Teacher to check.

Exercise 15.03

1 a Helensvale Primary
  b churches
  c Helensvale Plaza
  d

2 a H14   **b** A6   **c** J9 or J10
3 a West   **b** North   **c** South   **d** East
4 a 250 m   **b** 3.5 km   **c** 2.5 km   **d** 3 km
5 Doyalson Place
6 Walk north along Discovery Drive for approximately 500 m. Turn right into Ashford Rd. Quirindi Ct is the third street on the right.
7 Turn right at the next set of traffic lights into Discovery Drive. Follow Discovery Drive for approximately 3 km until you get to the roundabout at Helensvale High School. Turn left into Helensvale Rd. Follow Helensvale Rd to the motorway on ramp.
8 Drive north on Kingston and take the first right into Habana St. Take the first left into Milaroo Drive. Follow Milaroo Drive to the intersection with the Gold Coast Highway.
9 a East   **b** 450 m
10 a Walk north-west along Port Hacking Rd, then follow the road around to the right. Turn down Blamey Ave, the first on the left. Keep walking until you reach Mirral Rd.
  b 500 m   **c** $7\frac{1}{2}$ minutes

Exercise 15.04

1 a 30 m   **b** 116 m   **c** 190 m
2 a 1 : 10 000   **b** 1 km   **c** 580 m
  d 1 km   **e** 11:20 a.m.
3 a 790 m   **b** Approximately 13 minutes.
4 a 200 km   **b** 36 km/h
  c The average speed is low. The road is probably not sealed and rough in places.
5 a 20 m   **b** 60 m and 114 m
  c $4872
6 a Even numbers from 156 to 190 and 175, 177, 181.
  b 129 m   **c** 307 m
  d around 21 m
  e It will flood during 1-in-50 floods.

7 a 11.6 km   **b** 2 h 54 min
  c South west of North Era

Exercise 15.05

1 a *ABCD*, *AFD*, *AED*
  b 27 km, 25 km, 24 km
  c *AED*
2 a *A* to *B* via the curve is 17 km, *ADB* 16 km, *ACB* 17 km
  b 15 km   **c** *ABCD*
3 a *ADC*, *ABC*, *ABDC*, *ADBC*
  b *ADBC*
4 a via the hotel
  b 6 km   **c** 7 km
5 The shortest routes involve going directly to Southside, then taking the appropriate road to the fire.
6 Head north-west along East Esplanade for 200 m and turn right into Belgrave St. Drive for 400 m and turn left onto Raglan St. Manly Oval is on your left when you turn in.

Exercise 15.06

1 155 km   **2** 120 km   **3** 98 km
4 a 3664   **b** 64 km/h
5 a 80 km   **b** 1 h 4 min   **c** 1:40 p.m.
  d i 141 km/h
    ii His average speed was 141 km/h, but at some times he was travelling faster and other times slower.
6 a 456 km   **b** 13 h 6 min
7 a Mittagong   **b** 170 km
  c 1 h 53 min   **d** 37 km/h
8 $182
9 a 2:30 p.m.   **b** $18 each   **c** $11 each
10 10:59 a.m.

Exercise 15.07

1 a 7:30 a.m.   **b** 45 min   **c** 6 hours
  d 93 km/h   **e** 3:17 a.m.   **f** 18 min
  g 10:20 a.m.   **h** 26 hours 50 min
  i $861

j $11, Many answers possible, for example, they wanted to see more of the countryside; or, the airline might charge more to include luggage; or, they didn't want a long stopover.

2 $170

3 **a** northwest **b** 75 km/h

4 **a** $210 **b** $20

c They need 2 caravans, but only 1 cabin.

d No, teacher to discuss.

5 **a** Moockra Tower Lookout

b Bruce

c Middle Gorge

d Teacher to check.

6 **a** 290 km **b** 5 h 16 min

7 **a** They only need 1 room, but they would need 2 rooms at the Greenwood Lodge.

b $381

8 **a** 0900. The 1345 flight lands at 1545, which only leaves 75 minutes for any delays and checking in for their flight. It may not be sufficient time and they could miss their flight home.

b 2010 or 8:10 p.m.

Keyword activity

Across

5 coordinates **8** distance

9 compass

Down

1 second **2** kilometres

3 south **4** scale

6 northwest **7** speed

10 map

Test yourself 15

1 3 hours **2** 15 km

3 20 m/s **4** 25 m/s

5 4 km/h **6** 39 m

7 Studio Village **8** 1 km

9 At the end of Cannington Pl, turn left into Lindfield Rd. Take the second street on the right (Discovery Drive), then first left and second right.

10 **a** northwest **b** Approximately 1400 m

c Approximately 1 hour

d Approximately 11:40 a.m.

11 **a** 15 (*ABDC*) **b** 17 (*ABC*)

12 18 (*ABEDC*)

13 **a** 4WD (4-wheel-drive) vehicle

b Alice Springs – Eridunda – Mt Ebenezer – Luntja Rd

c Head south on Luntja Rd, turn right at Lasseter Highway.

d 200 km **e** Curtin Springs **f** west

g Northeast

Chapter 16

Exercise 16.01

1 **a** 17, 18, 19, 25, 28

b

2 **a** 25, 29, 31, 31, 32

b

3

4 **a** 6, 13, 21, 24, 41

b
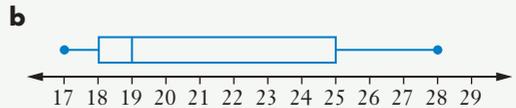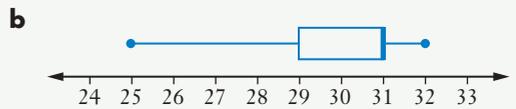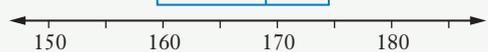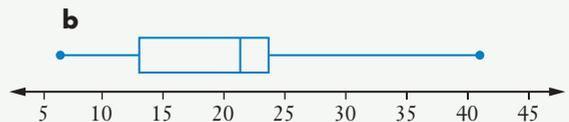
5 **a** 22 **b** 35

c **i** 15 **ii** 45

d 18

6 **a** 76, 88, 101, 112, 124

b
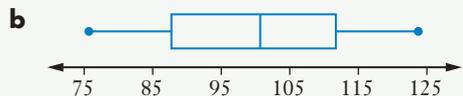
7 **a** Boys: 163, 166.5, 171.5, 179, 182
Girls: 160, 164, 168.5, 172, 177

b
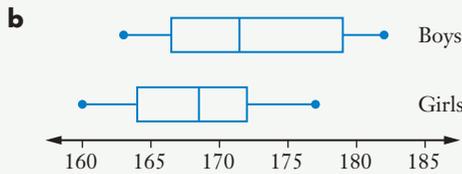
8 a 20   **b** 11   **c** 4

d 15   **e** 30

9 a Inner City: 12, 20, 25.5, 33, 55

Coastal: 36, 52, 60, 64.5, 74

b
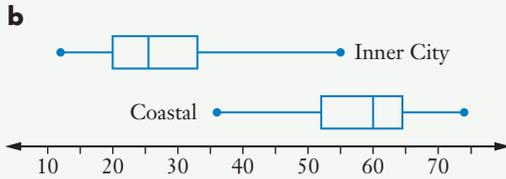
c Inner City, lower risk of theft.

Exercise 16.02

1 a

Class A		Class B
	3	5 8 9 9
	4	0 1 2 2 2 6 7
	5	1 4 6 7 9
9 7 5 2 0	6	0 1 5 5 5 6 8
9 8 6 5 1 1 1 0	7	1 2 4
9 9 9 8 5 5 4 2 1 1 0	8	8
5 5 4 3 1	9	

Key: 0|6| = 60

|3|5 = 35

b 29

c A: 81, B: 56.5

d A: 35, B: 53

e an outlier in B (88)

f A – top, B – middle

2 a

Year 11		Year 12
	0	7 8
5 5 5	1	0 2 3 3 4 5 8 9 9
9 5 3 3 2 2 0	2	0 0 1 2 2 3 4 4 6
9 1 0 0 0 0 0	3	
4 2 1	4	

Key: 5|1| = 15

|1|0 = 10

b 11: 29.5, 12: 19

c 11: 29, 12: 19

d No outliers

e Clustered in the 20s

f medians are very different

g number of students in each year

3 a

Male		Female
	15	0 2 7 9
8 7 5 0	16	0 2 3 4 4 5 6 6 6 7 8
8 8 8 5 2 0 0	17	1 3 3 6 7 8
4 4 3 3 1 1 1 1 0 0	18	5 5
1 0 0	19	
0	20	

Key: 0|6| = 160

|15|0 = 150

b 25

c 23

d Males: 160, 171, 180, 183.5, 200;

Females: 150, 162, 166, 173, 185

e 200 is an outlier in the male group

f Male median is higher than the female median.

g Teacher to check.

4 a

Townsville		Kiama
	20	3 7
	21	0 8
	22	1 3 5 5
	23	0
	24	5 7 9
	25	0 4 5 6 6 9
	26	4 7
	27	0 6 9
	28	
5 3	29	6
	30	
9 9 8 7 7 2 2 0 0 0	31	
8 7 7 5 3 3 2 1 1	32	5 6
7 6 4 4 1	33	0
3 2	34	
	35	
	36	3

Key: 0|29| = 293

|20|3 = 203

b 28

c Townsville: 32.15°, Kiama: 25.45°

d Townsville: 5°, Kiama: 16°

e Townsville: 29.3°, 29.5°; Kiama: 36.3°, 33.0°, 32.6°, 32.5°

f Townsville temperatures are close together, Kiama temperatures are widely spread out.

g Teacher to check.

h Teacher to check.

5 a 25

b Langley Lynx: 49, Blakely Bears: 50

c Langley Lynx: 66, Blakely Bears: 70

d Langley Lynx: 43, 51.5, 66, 75.5, 92

Blakely Bears: 44, 57, 70, 87, 94

e
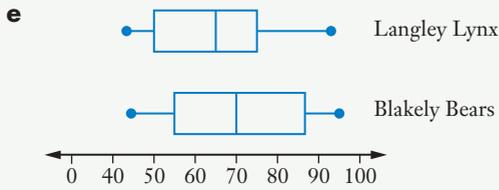
f Teacher to check.

g Blakely Bears

Exercise 16.03

1 a
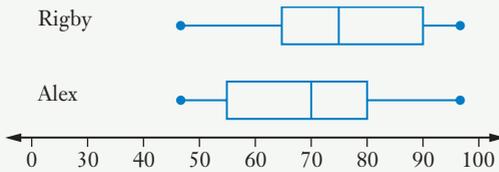
b i 75   **ii** 69

c i 48   **ii** 50

d Alex – his mark is 16% above the median, while Rigby's is only 10% above the median.

e Rigby's class – more than 50% of the scores are above the median for Alex's class.

f No, we don't have any scores or the numbers of students in each class.

2 a Chatphone: 3, 7, 7.5, 9 1;

Oztel: 5, 7, 9, 10, 11

b
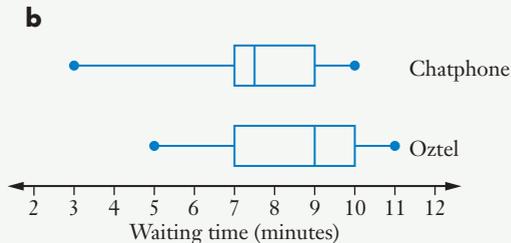
c i 7.5   **ii** 9

d i 7   **ii** 9

e i 2   **ii** 3

f Yes, Chatphone's median is 1.5 minutes less than Oztel and 75% of Chatphone's calls wait less than 50% of Oztel calls.

g Teacher to check.

3 a Middleton: 60, 67.5, 72.5, 82.5, 90;

Blakewell: 58, 68, 72, 75, 82

b
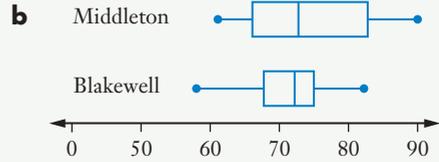
c i 72.5 km/h   **ii** 72 km/h

d i 72, 75, 85   **ii** 68, 70, 72, 73, 75

e i 74.2 km/h   **ii** 71.5 km/h

f i 15 km/h   **ii** 7 km/h

g No, the mean in Blakewell is lower and 25% of the sample in Middleton were faster than the entire Blakewell sample.

4 a 60   **b** 61   **c** soft drink

d Coffee   **e** Teacher to check.

5 a 52%   **b** 15–24

c Yes, higher frequency in each age group.

6 a 20°   **b** February

c Teacher to check.

d Yes, higher frequency in each age group.

d 14–

e Teacher to check.

Exercise 16.04

1 a

b

c

d
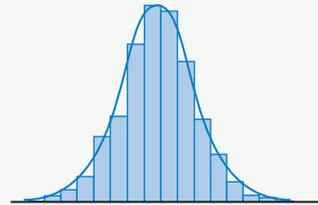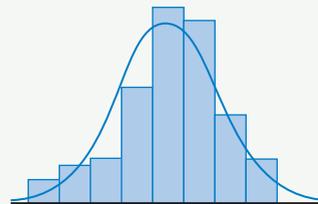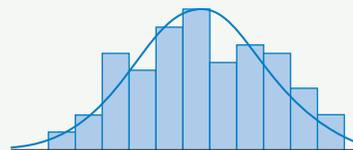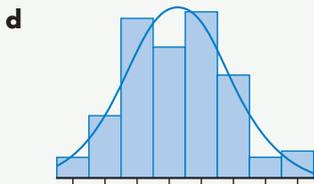
2 a unimodal, negatively skewed
b unimodal, positively skewed
c bimodal
d unimodal, positively skewed.
3 **a**, **b** and **d**
4 Many answers are possible. Teacher to discuss.

a

80
Age

b

40%   90%
Marks

c

Body mass

d

Height of 17-year-old girls

e

16

1 2 3 4 5 6
Number on a die

f

1   5
Time in minutes
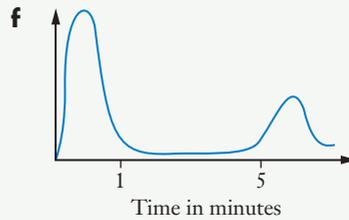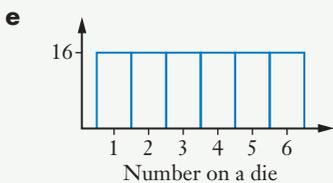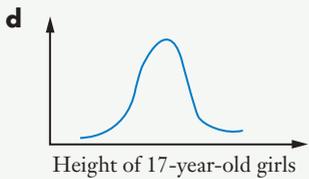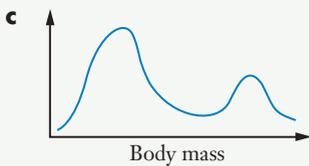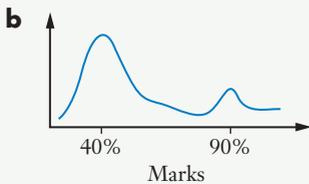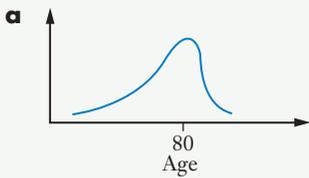
5 The tail extends on the right to 29, and half of the data lies from 5 to 9.
6 Teacher to discuss. The diagram shows an example answer.

5   10   15 17 20

7 Many answers possible. Teacher to check.
8 a Has three peaks.
b Many possible answers. It could be a coffee shop. Peak times correspond to people going to work, plus morning and afternoon tea times.
9 a Positively skewed
b Remove scores 56, 57, 58, 59. Make 2 scores in the 80s and an extra 2 scores in the 70s.
10 a bimodal
b Many possible reasons, including the three given below.
- There are two warehouse employees and one works faster than the other.
- The information is from two different times, for example, weekdays and weekends. The weekend employees are only part-time and can't locate items as quickly as the full-time employees.
- Some items are more difficult to access than others.
11 a Negatively skewed.
b Easy, most people got high marks.
c around 85
d Average to just below average, but below the mode.

Keyword activity

bimodal = A distribution with two peaks.

skewed = A distribution where most scores are to the left or right of centre and there is a tail on the side that doesn't have many scores.

unimodal = A distribution with one peak.

quartiles = The scores that divide the data into four equal parts.

uniform = A rectangular distribution where every score has a similar frequency.

Test yourself 16

1 a 2   6   10.5   13   18

b
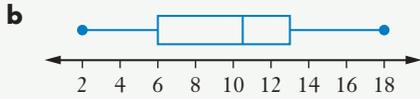
2 a Median = 26.5

b 14   **c** 9 employees

3 a

Bulls		Tigers
	7	2
9 3	8	
8 0	9	7
9	10	4 9
4 3	11	
7 5	12	6
7	13	0 3 8 9 9
0	14	4 7
9	15	

b 12

c Bulls: 113.5   Tigers:131.5

d Bulls: 159   Tigers: 72

e Tigers – higher median and scores clustered in the 130s.

4 a
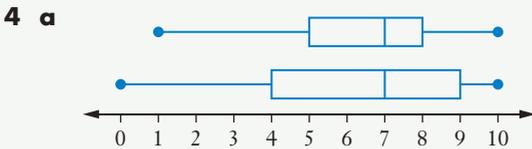
b Median is 7 for both classes.

c Blue: 5   Magenta: 3

d Adele – she is in the top 25% of her class, whereas Shane is at the 75% mark in his class.

5 a positively skewed

b bimodal

c symmetrical

6 a

b

Mass of students

c
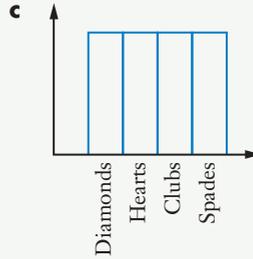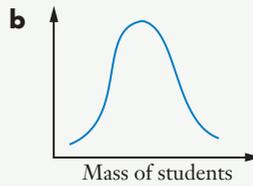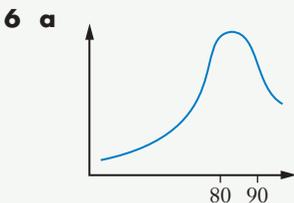
Practice set 4

Section A

1 C	**2** D	**3** D	**4** A	**5** B
6 A	**7** B	**8** C	**9** A	**10** B

Section B

1 75 white tiles

2 Teacher to check.

3 33 h 23 min

4 a 17.7   **b** 20   **c** 18.5   **d** 14

5 2500 mL

6 a Town Square   **b** H7

7 a i 85 mm   **ii** 85 cm

b i 26 mm   **ii** 10.4 cm

8 a 6.75   **b** 1.25

9 a

Test 1	Stem	Test 2
8	0	37
9 7	1	1179
7 7 7 5 3 3 2 0	2	0137889
9 8 8 6 4 2 1 1 0 0 0	3	0 0 1 1 2 2 4 5 5
8 6 5 1 1 0 0	4	6 8 9
		4 6 7 7 9

b Test 1: 40, Test 2: 46

c Test 1: 8, Test 2: none

10 29.216 m

11 a 169 cm

b $Q_L = 163$ cm, $Q_U = 174$ cm

c 11

12 a 149, 163, 169, 174, 186

b

Heights of Year 11 students (cm)

145 150 155 160 165 170 175 180 185 190
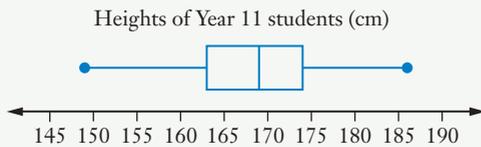
13 Teacher to check.

14 a Test 1: 8, 25, 31, 39, 48

Test 2: 3, 21, 30.5, 36, 49

b

Test 2

Test 1

0 5 10 15 20 25 30 35 40 45 50
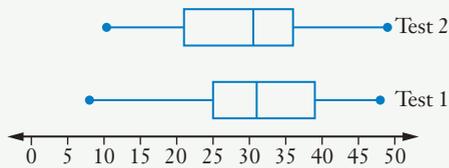
15 a 114 km   **b** 342 km

c **i** Via Bothwell and Miena is the
shortest – 212 km, via Bronte Park is
218 km and via Launceston is 247 km

  ii quality of roads, other things to see and
do, other answers possible

16 a 31.85 m   **b** 13 m

c 1.3 m   **d** 17.55 m

e 13 m   **f** 3.25 m

g 414.05 m^2

GLOSSARY AND INDEX

12-hour time: a.m. or p.m. time, for example, 2:35 p.m. (p. 261)

24-hour time: Time expressed as a 4-digit number with the first two digits representing the hour (from 00 to 23) and the last two digits representing the minutes, for example, 1435 representing 2:35 p.m. (p. 261)

allowance, government: Money paid by the government to support individuals for specific purposes (for example, to support the aged, unemployed, disabled, students). (p. 219)

allowance, worker's: Money paid to a worker for job-related expenses (for example, travel, special clothing, working in isolated or dangerous areas). (p. 210)

annual: Per year. (p. 14)

annual leave loading: Extra pay given to a worker during annual leave, usually 17.5% of 4 weeks' pay. (p. 213)

area: The amount of surface occupied by a flat shape, measured in square units. (p. 72)

Australian Central Standard Time (ACST): The timezone for central Australia: the Northern Territory and South Australia. (p. 266)

Australian Eastern Standard Time (AEST): The timezone for eastern Australia: Queensland, NSW, the ACT, Victoria and Tasmania. (p. 266)

Australian Western Standard Time (AWST): The timezone for Western Australia. (p. 266)

back-to-back stem-and-leaf plot: Two stem-and-leaf plots in the same diagram. (p. 434)

Allfit		Superfit
7 6 5 5 5 2	1	1 3 6 6 9
7 3 2 2 1 1 0 0	2	0 0 1 2 2 3 7 7
9 4 2	3	1 2 4 4 5 8
3 3	4	6
1	5	

base (of a prism): One of the parallel end faces of a prism. (p. 183)
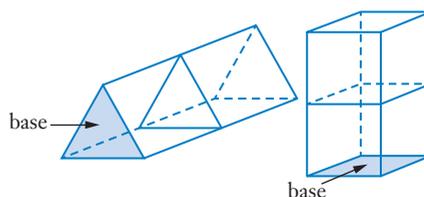
BIDMAS: *See* **order of operations**.

bimodal distribution: A statistical distribution with two peaks. (p. 444)

Number of people waiting to catch a train

Time of day
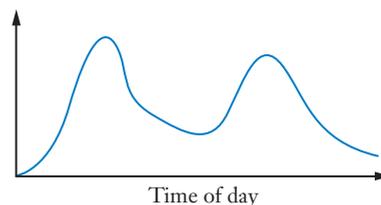
bonus: Extra pay for doing good work, meeting targets or deadlines. (p. 210)

boxplot: A diagram that displays the quartiles of a set of data as a box and the extremes as whiskers. (p. 432)
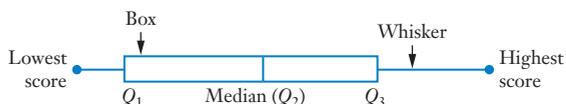
budget: A plan for managing money. (p. 223)

calories (Cal): An imperial (before metric) measure of the energy contained in food. (p. 148)

capacity: Amount of liquid or gas that can be held by a container, usually measured in millilitres (mL) or litres (L). (p. 192)

categorical data: Information represented as a category rather than a number, for example the makes of cars or the colours of eyes. (p. 238) Differs from **numerical data**.

centi-: One-hundredth $\left(\dfrac{1}{100}\right)$. (p. 344)

class interval: In statistics, when there are many data scores, they may be grouped into class intervals. For example, ages of people may be grouped into class intervals of 1–10, 11–20, 21–30, and so on. (p. 245)

climate graph: A graph that shows the 12-month pattern of rainfall and temperature of a city by showing a column graph of rainfall and line graphs of maximum and minimum temperatures. (p. 125)

cluster: A group of data scores that are bunched or close together. (p. 348)

clustered column graph: A column graph with two or more columns stuck together for each category on the horizontal axis. (p. 114)

Percentage of protein, fat and carbohydrates
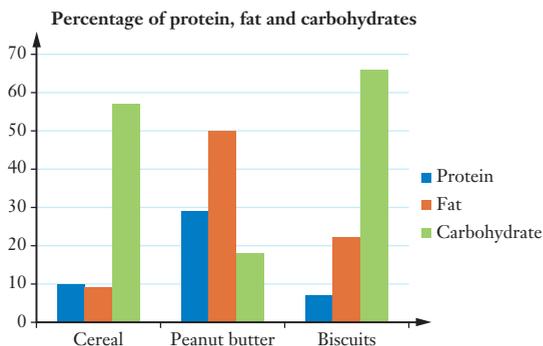
column graph: A graph consisting of columns of equal width. (p. 113)

commission: The earnings of a sales person or agent; usually a percentage of the value of items sold. (p. 215)
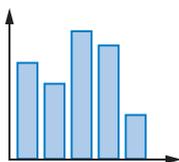
conversion graph: A graph that is used to convert between different units, such as between metric and imperial units of measurement, or between currencies in foreign currency exchange. (p. 116)

coordinates: A pair of values and/or letters for describing a location on a map, for example, D4. (p. 402)

cost price: The price it costs a shop to buy a product from the factory or wholesaler. (p. 49)

cubic metre (m^3): A unit of volume equal to the volume of a cube of length 1 m (the size of two washing machines). $1 \text{ m}^3 = 1\ 000\ 000 \text{ cm}^3$. (p. 179)

data: Statistical information. (p. 238)

deciles: Values that divide a data set into 10 equal parts when the scores are arranged in order. (p. 343). *See also* **percentiles** and **quartiles**.

decrease: To make smaller. (p. 46)

**discount:** Money deducted from the usual marked price. (p. 46)

distance-time graph: A line graph that describes a journey, by comparing distance on the vertical axis with time on the horizontal axis. The slope or steepness of the graph measures speed. (p. 392)

Monique's cycling trip
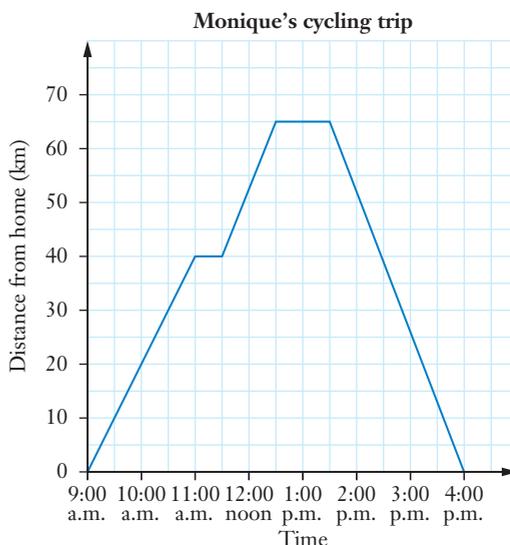
dot plot: A graph that uses dots to show frequencies of data scores. (p. 246). *See also* **stem-and-leaf plot**.
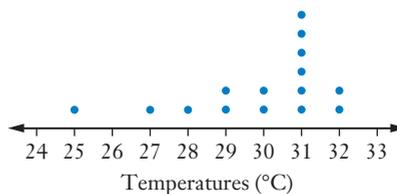
double boxplot: Two boxplots shown on the same scale. (p. 439)
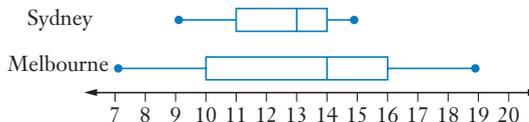
double time: A rate of overtime pay that is 2 times the normal hourly rate. (p. 207)

estimate: To make an educated guess for a numerical answer. (p. 17)

evaluate: To find the value of a numerical or algebraic expression. (p. 98)

expense: The cost of spending. (p. 223)

five-number summary: These five values for a set of data: the lowest score, the lower quartile, Q_1, the median, Q_2, the upper quartile, Q_3, and the highest score. These are used to construct a **box-and-whisker plot**. (p. 432)

flat-rate interest: See simple interest.

formula: A rule written as an algebraic equation, using variables. For example, the formula for the area of a triangle is $A = \frac{1}{2}\, bh$. (p. 99)

fortnight: Two weeks. (p. 30)

frequency: The number of times a score or group of scores occurs in a data set. (p. 242)

frequency histogram:
A column graph in which the height of each column represents the frequency of a single score or group of scores. There is no space between the columns. (p. 130, 242)
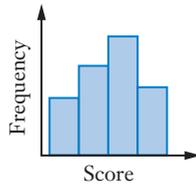
frequency polygon: A line graph formed by joining the midpoints of the tops of the columns of a frequency histogram. (p. 130)
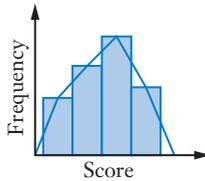
frequency table: A table that lists the frequency of each item in a data set. (p. 239)

fuel consumption: The rate at which a vehicle uses fuel, measured in litres/100 km. (p. 319)

gross pay: Your pay before the tax is taken out. *See* also **net pay**.

GST: Goods and services tax. (p. 32)

heart rate: *See* **pulse**.

hectare: A large unit for measuring area, equal to 10 000 square metres. (p. 85)

histogram: *See* **frequency histogram**.

holiday loading: *See* **annual leave loading**.

income: Money that is earned or gained (usually regularly). (p. 223)

increase: To make bigger. (p. 44)

interest: Money earned on an investment, or money paid to a financial institution for borrowing. (p. 291)

interest rate: The percentage of the investment or loan on which interest is calculated. (p. 291)

interquartile range (IQR): The difference between the upper quartile and lower quartile of a data set ($Q_3 - Q_1$). It is a measure of the spread of the data. (p. 339)

kilo-: One thousand.

kilogram: 1000 grams. (p. 170)

kilojoules (kJ): An measure of the energy contained in food. (p. 148)

kilometre: 1000 metres. (p. 64)

kilowatt (kW): A unit of electrical power equal to 1000 watts. (p. 156)

kilowatt hour (kWh): A unit of electrical energy equivalent to that used by one kilowatt of power in one hour. (p. 156)

line graph: A graph made of lines, often used to represent data that changes over time (p. 115)

litre: A unit for measuring capacity, equal to 1000 mL. The size of a tall carton of milk. (p. 192)

loss: The amount of money lost by a shop on an item; loss = cost price − selling price. (p. 49)

map scale: *See* scale.

mass: A measure of size or weight in units such as grams, kilograms or tonnes. (p. 170)

mean: The average of a set of numerical data, calculated by adding all the scores and dividing by the number of scores. (p. 332)

measure of central tendency: A statistical value, such as the **mean**, **median** or **mode**, that describes the centre or average of a set of data. (p. 332)

measure of spread: A statistical value, such as the **range** or **interquartile range**, that describes the spread of a set of data. (p. 339)

median: The middle score of a set of numerical data, or the average of the two middle scores when scores are arranged in order. (p. 332)

mega-: One million.

metric system: A measurement system based on powers of 10. (p. 64)

milli-: One-thousandth $\left(\dfrac{1}{1000}\right)$.

mode: The most common score(s) in a set of data. (p. 332)

net pay: Your pay after the tax has been taken out. *See* also **gross pay.**

numerical data: Data that involves numbers, such as heights or the number of cars owned. (p. 238)

order of operations: The order in which you calculate an expression with two or more operations: brackets, indices (powers), multiply and divide from left to right, add and subtract from left to right. This can be remembered using the initials BIDMAS. (p. 12)

outlier: An extreme (high or low) score in a data set that is very different from the other scores. It affects the mean but not the mode or median. (pp. 250, 336)

overtime: Woking beyond normal hours, paid at a higher rate. (p. 207)

**per annum (p.a.):** Per year. (p. 291)

percentiles: Values that divide a data set into 100 equal parts when the scores are arranged in order. (p. 343). *See also* **deciles** and **quartiles**.

perimeter: The distance around the outside of a shape. (p. 70)

perpendicular height: The height of a shape that is at right angles (90°) to the base. For example, h is the perpendicular height of each triangle. (p. 82)
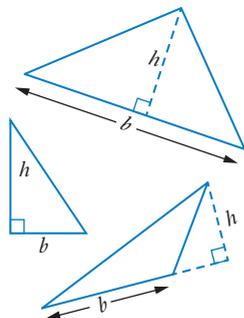
picture graph: A type of graph where pictures are used to indicate quantities. (p. 112)

Letter deliveries

= 4 letters
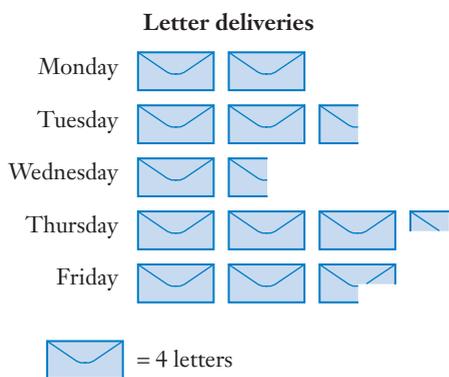
pie graph (or **sector graph**): A graph using a circle divided into parts called sectors. (p. 119)
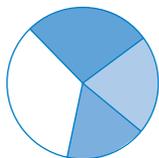
piecework: A type of work in which a worker is paid per item produced or processed, such as dressmaking or craftwork. (p. 215)

principal: The original amount of money invested or borrowed, upon which interest is calculated. (p. 291)

prism: A solid shape with flat sides that has the same shape at both ends. A triangular prism and square prism are shown below. (p. 183)
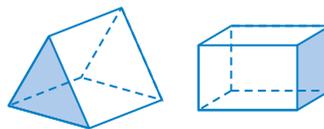
profit: The amount of money gained or made by a shop on an item; profit = selling price – cost price. (p. 49)

pronumeral: *see* **variable**.

pulse (or **heart rate**): The rate at which a heart beats, measured in beats per minute. (p. 161)

quarterly: Every three months (quarter of a year). (p. 292)

quartiles: Values that divide a set of data into four equal parts when the scores are arranged in order. The 1st quartile (Q_1) is the lower quartile, the 2nd quartile (Q_2) is the median and the 3rd quartile (Q_3) is the upper quartile. (p. 339). *See also* **deciles**, **interquartile range**, **percentiles**.

range: For a set of data, range = highest score – lowest score. (p. 339)

rate: A comparison of two quantities with different units, for example, km/h. (p. 146, 310)

ratio: A comparison of two quantities with the same units, for example, 2 : 3. (p. 366)

retainer: A fixed amount of money paid to a salesperson that does not depend on sales, paid before commission is added. (p. 216)

royalty: A payment to an author, singer or artist for each copy of their work sold, usually a percentage of the total sales amount. (p. 215)

salary: Fixed earnings quoted as a yearly amount, but paid weekly, fortnightly or monthly. (p. 202) *See also* **wage**.

scale: (on a map or diagram): The ratio of scaled length to actual length, for example, a scale of 1 : 500 means that lengths represented on the map or diagram are actually 500 times larger in real life. (p. 382)

scale drawing: A drawing of an object, usually smaller, whose lengths are in the same ratio as the actual lengths of the object. (p. 71, 382)

sector graph: *See* **pie graph**.

selling price: The price a shop sells a product for. (p. 49)

shape of a distribution: The way the data in a frequency distribution is spread, can be symmetrical, positively skewed or negatively skewed. (p. 442)

simple interest (or **flat rate interest**): Interest earned or charged only on the original amount of money (principal) invested or borrowed, different from compound interest. (p. 291)

skewed distribution: A statistical distribution where most of the data scores are either low (positively skewed) or high (negatively skewed). The tail indicates the direction of the skew. (p. 443)

(−) Negatively skewed distribution

(+) Positively skewed distribution
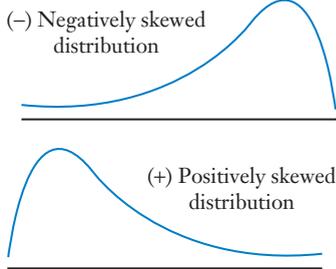
solution: The detailed answer to a problem, or the method of solving it. (p. 8)

speed: A rate that compares distance travelled with time taken. Speed is often measured in kilometres per hour (km/h) or metres per second (m/s).

$$\text{speed} = \frac{\text{distance}}{\text{time}} \text{ . (p. 390)}$$

square metre (m^2): A unit of area equal to the area of a square of length 1 m (the size of a large shower floor). $1 \text{ m}^2 = 10\ 000 \text{ cm}^2$. (p. 85)

standard deviation (symbol σ) A statistical measure of the spread of a set of scores. (p. 351)

stem-and-leaf plot: A 'number graph' that lists all the data scores, in groups. This stem-and-leaf plot shows 12 test scores, from 42 to 82. (p. 246) *See also* **dot plot**.

Stem	Leaf
4	2 5
5	0 2 8
6	6 7
7	3 5 77
8	2

step graph: A graph that has horizontal line segments, for example, parking station charges. (p. 118)
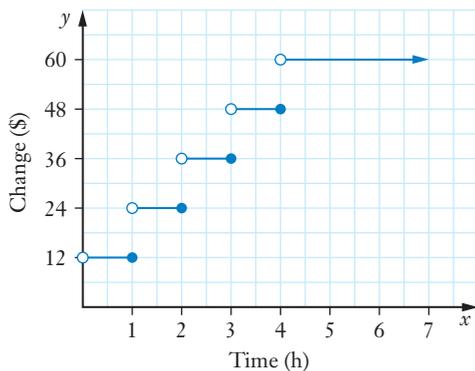
substitute: To replace a variable in an expression or formula with a number. (p. 98)

symmetrical distribution: A statistical distribution where one half is the mirror-image of the other half. You can fold it down the middle and the two sides would match. (p. 442)
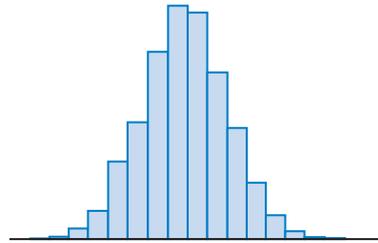
time-and-a-half: A rate of overtime pay that is 1.5 times the normal hourly rate. (p. 207)

timetable: A table displaying a schedule of events, for example, the times trains arrive. (p. 268)

time zone: A vertical zone where all locations have the same time of day, for example, central Australia (Northern Territory and South Australia) uses the Australian Central Standard Time zone (ACST). (p. 266)

tonne: A unit of mass equal to 1000 kilograms. (p. 170)

triangular prism: A solid shape with a constant, triangular cross-section. (p. 183). *See* **prism**.

two-way table: A table that show two characteristics of a set of data. (p. 120)

	Right-footed	Left-footed	Total
Right-handed	50	10	60
Left-handed	12	8	20
Total	62	18	80

uniform distribution: The shape of a statistical distribution where each value has the same or similar frequency. Its graph is close to one big rectangle as the scores are evenly distributed. (p. 444)
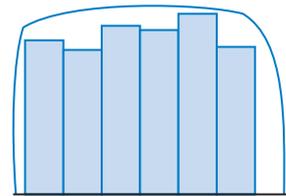
unimodal: A set of scores with only one peak. (p. 444). *See also* **bimodal**.

unit price: In supermarket pricing, the price of one unit such as 100 g or 1 L. (p. 313)

variable (or **pronumeral**): A letter or symbol such as x that stands in place of a number. (p. 98)

volume: The amount of space occupied by a solid, measured in cubic units. (p. 179)

wage: An amount paid for work as a rate in dollars per hour. (p. 202)