

Maths Progress

International 11–14

Confidence • Fluency • Problem-solving • Progression

7

Workbook



Pearson

Maths Progress

International 11–14

Confidence • Fluency • Problem-solving • Progression

7

Workbook



Pearson

Published by Pearson Education Limited, 80 Strand, London, WC2R 0RL.

www.pearsonschoolsandfecolleges.co.uk

Text © Pearson Education Limited 2020

Project managed and edited by Just Content Ltd

Typeset by PDQ Digital Media Solutions Ltd

Original illustrations © Pearson Education Limited 2020

Cover illustration by Robert Samuel Hanson

The rights of Greg Byrd, Keith Gallick, Sophie Goldie, Catherine Murphy, Su Nicholson, Amy O'Brien and Diane Oliver to be identified as authors of this work have been asserted by them in accordance with the Copyright, Designs and Patents Act 1988.

First published 2020

23 22 21 20

10 9 8 7 6 5 4 3 2 1

British Library Cataloguing in Publication Data

A catalogue record for this book is available from the British Library.

ISBN 978 1 292 32716 7

Copyright notice

All rights reserved. No part of this publication may be reproduced in any form or by any means (including photocopying or storing it in any medium by electronic means and whether or not transiently or incidentally to some other use of this publication) without the written permission of the copyright owner, except in accordance with the provisions of the Copyright, Designs and Patents Act 1988 or under the terms of a licence issued by the Copyright Licensing Agency, 5th Floor, Shackleton House, Hay's Galleria, 4 Battle Bridge Lane, London SE1 2HX (www.cla.co.uk). Applications for the copyright owner's written permission should be addressed to the publisher.

Printed in Italy by L.E.G.O. SpA

Acknowledgements

The publisher would like to thank Diane Oliver for her input and advice.

Note from the publisher

Pearson has robust editorial processes, including answer and fact checks, to ensure the accuracy of the content in this publication, and every effort is made to ensure this publication is free of errors. We are, however, only human, and occasionally errors do occur. Pearson is not liable for any misunderstandings that arise as a result of errors in this publication, but it is our priority to ensure that the content is accurate. If you spot an error, please do contact us at resourcescorrections@pearson.com so we can make sure it is corrected.

Contents

1	Analysing and displaying data	1
2	Number	11
3	Equations, functions and formulae	22
4	Fractions	32
5	Angles and shapes	42
6	Decimals and percentages	51
7	Ratio and proportion	63
8	Measure and shapes	73
9	Sequences and graphs	82
10	Transformations	94
11	Probability	103
	Progression charts	110



Welcome to Maths Progress International Workbooks

Confidence • Fluency • Problem-solving • Progression

Starting a new course is exciting! We believe you will have fun with maths, while at the same time nurturing your confidence and raising your achievement. Here's how:

Start by **Mastering** fundamental knowledge and skills over a series of lessons.

Guided questions and partially worked solutions help you structure your answers.

Your teacher has online access to **Answers**.

A **confidence checker** at the end of every lesson helps you keep track of your strengths and weaknesses and suggests which questions from **Strengthen** you should try.

4.3 Master Fractions, decimals and percentages

1 Complete this table of equivalent fractions, decimals and percentages.

Fraction	$\frac{1}{5}$	$\frac{2}{5}$	$\frac{3}{5}$	$\frac{4}{5}$	$\frac{5}{5}$
Decimal	0.2	0.3	0.5	0.75	
Percentage	20%		60%		

2 Complete this table:

Mixed number	$1\frac{1}{2}$		$1\frac{1}{4}$
Decimal	1.4		1.7
Percentage		175%	150%

3 Write these fractions as decimals.

a $\frac{1}{2}$ b $\frac{3}{4}$ c $\frac{2}{5}$ d $\frac{1}{10}$

4 Last season, the Year 7 hockey team drew 7 out of their 20 matches.

a What fraction of their games did they draw?
b Write your answer to part a as a decimal.
c What percentage of their games did they draw?

5 Modelling / STEM Some groups of chicken eggs were hatched in incubators at different temperatures. The table shows the incubator temperature, the number of eggs in each group and the number of eggs that hatched successfully.

Incubator	A	B	C	D
Temperature (°C)	25.5	27.0	27.5	28.0
Number incubated	200	150	250	300
Number hatched	154	128	220	288

a What fraction of each group hatched successfully?
b Gerry says, 'The best temperature to hatch chicken eggs is 28.0°C'. Is Gerry correct? Explain.

6 Use the fact that $\frac{1}{5} = 0.2$ to write these fractions as decimals.

a $\frac{2}{5}$ b $\frac{3}{5}$ c $\frac{4}{5}$

Check Tick each box as you confidence in this topic improves.

Need extra help? Go to page 27 and tick the boxes next to Qs 6 and 7. Then try them once you've finished 4.1-4.5.

Equivalent fractions, decimals and percentages have the same value. You can convert a fraction to a decimal by dividing the numerator by the denominator.

When a positive mixed number is greater than 1, its decimal equivalent is greater than 1, and its percentage equivalent is greater than 100%. For example, $1\frac{1}{2} = 1.4 = 140\%$.

Worked example

Literacy hint An egg incubator is a box of heated air to keep eggs at the right temperature for hatching.

QR codes give you direct access to worked example videos via your phone or tablet, providing plenty of support for tricky questions.

As well as hints that help you with specific questions, you'll find **Literacy hints** (to explain some unfamiliar terms) and **Strategy hints** (to help with working out).

Choose only the topics in **Strengthen** that you need a bit more practice with. You'll find more hints here to lead you through specific questions.

1 Strengthen

Averages and range

1 Chan recorded the number of types of birds visiting a bird table each hour one Saturday morning: 6, 2, 2, 0, 4

a Work out

Extend helps you to apply the maths you know to some different situations.

9 Extend

1 Two of the corners of a square are at the points $(-3, 1)$ and $(1, 1)$.

a Write down possible coordinates for the other two corners.
b Write down two other possible coordinates for the four corners.

Put the two points first.

When you have finished the whole unit, a **Unit test** helps you see how much progress you are making. Keep track of your confidence and the questions you answered correctly in the Progression charts on pages 110–113.

9 Unit test

1 Look at this sequence.

a Draw the next pattern.
b Complete the table.

Term number	1	2	3	4	5	6
Number of dots						

- 1 The data shows the number of 'football cards' some students have.

21, 56, 12, 21, 48

- a What is the range of the data?
b What is the mode of the data?

To find the range, work out largest value – smallest value.

The mode is the most common value.

The median is the middle value when the data is written in order.

- 2 Write down the median of each set of data.

a 7 9 3 11 8 11 11

b 2 8 5 9 7 1

Be careful, there are two middle values!

Worked example



Strategy hint

Try out different values.

- 3 Write down a set of five pieces of data with two modes.

- 4 Write down a set of five pieces of data with no mode.

- 5 Find the mode, range and median for this set of marks.

13 15 15 17 14 16 14 18 15 16

mode = range = median =



- 6 The data shows Alice's internet speed at 6pm for the last six days. The last piece of data is missing.

180Mb/s 215Mb/s 150Mb/s 135Mb/s 160Mb/s

The median is 155Mb/s.

What could the missing value be?

The median is in the middle, and there are 6 pieces of data, so the missing value must be smaller than the median.

Guided

Put in order: 135 160 215

A possible value is Mb/s.

- 7 **Problem-solving** Two internet companies compare their average speeds in Mb/s over a five-day period.

Company A: 200, 210, 205, 195, 200

Company B: 250, 250, 120, 200, 210

Work out the averages and range for each company:

Company A: Mode = Median = Mean = Range =

Company B: Mode = Median = Mean = Range =

Which company would you use? Explain your answer.

Company because

Check

Tick each box as your confidence in this topic improves.



Need extra help? Go to page 6 and tick the boxes next to Q1 and 2. Then try them once you've finished 1.1–1.5.



- 1 **Real / STEM** Every weekend, Ros collects rubbish from her local beach.

The table shows the numbers of plastic items collected.

Complete the sentences.

- Between 200 and 299 items were collected on weekends.
- Between 300 and 399 items were collected on weekends.
- The modal class is

The **modal class** is the one with the highest frequency.

Plastic items	Frequency
100–199	2
200–299	18
300–399	25
400–499	7

- 2 Write whether each set of data is **discrete** or **continuous**.

- The numbers of students in classrooms.
- The heights of students.
- The masses of students.
- Students' pocket money (money given by parents) amounts

Discrete data can only take particular values. For example, clothes sizes are usually only even numbers. For discrete data you can use groups like 1–10, 11–20 ...

Continuous data is measured and can take any value. For example, length, mass and capacity. For continuous data there are no gaps between the groups.

- 3 Adam measured the arm spans, s cm, of the students in his class.

120 cm, 133 cm, 135 cm, 140 cm, 129 cm,
155 cm, 140 cm, 134 cm, 137 cm, 141 cm,
145 cm, 130 cm, 139 cm, 135 cm, 142 cm

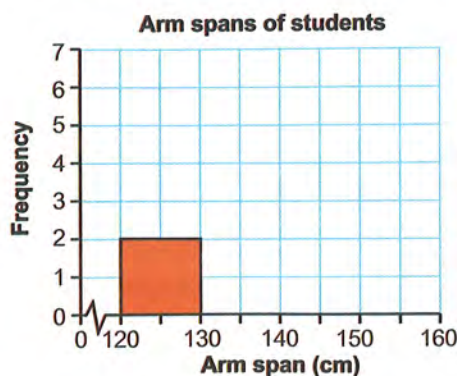
Continuous data is grouped into continuous **class intervals**. The class interval $140 \text{ cm} \leq h < 150 \text{ cm}$ includes all heights h between 140 cm and 150 cm. The $\leq$ symbol means that 140 cm is included. The $<$ symbol means that 150 cm is not included. The width of this class is 10 cm.

- Complete the grouped frequency table for the data. Make the classes have equal widths.

Arm span, s (cm)	Frequency
$120 \leq s < 130$	2
$130 \leq s < \dots\dots$	
$\dots\dots \leq s < \dots\dots$	
$\dots\dots \leq s < \dots\dots$	

- What is the modal class?

- 4 a Use your grouped frequency table from Q3 to complete the frequency diagram.



For continuous data, there are no spaces between the bars.

- How many students have an arm span of at least 140 cm?

Check

Tick each box as your **confidence** in this topic improves.



Need extra help? Go to page 6 and tick the box next to Q4. Then try it once you've finished 1.1–1.5.

- 1 Mahoud and Fahid complete record sheets for their monthly mp3 and mp4 downloads.

Mahoud: mp3 17 mp4 12
Fahid: mp3 34 mp4 8

A **two-way table** splits data into groups in rows across the table and in columns down the table. You can calculate the totals across and down.

	mp3	mp4	Total
Mahoud	17	12	
Fahid			
Total			

- a Write Mahoud's data in the top row of the two-way table.
Work out the total.
- b Write Fahid's data in the second row.
- c Work out the total of each column.
- d Add the row totals together.
Check by adding the column totals together.

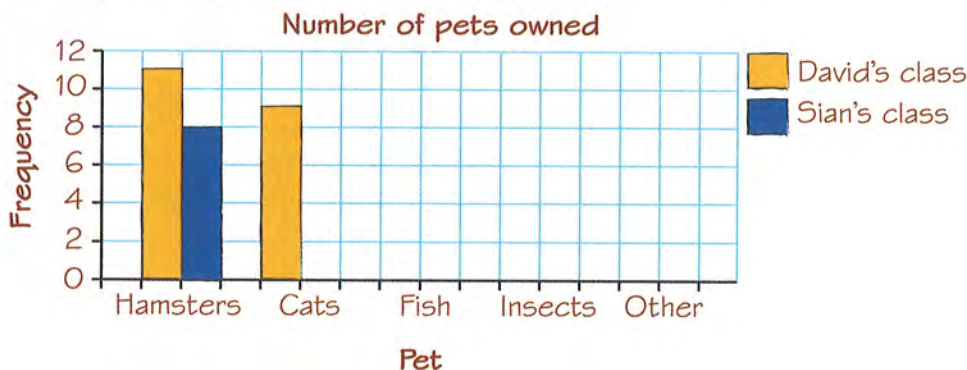
- 2 The frequency table shows the numbers of pets owned by students in David's and Sian's classes.

	Hamsters	Cats	Fish	Insects	Other
David's class	11	9	12	2	7
Sian's class	8	5	2	10	12



A **dual bar chart** compares two sets of data.

- a Complete the dual bar chart to display the data.



Worked example



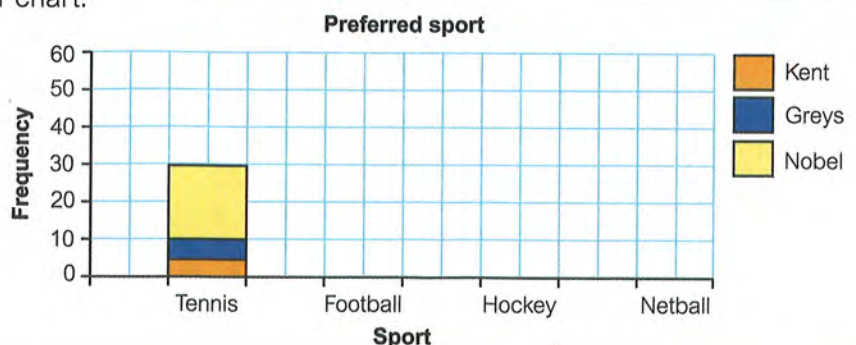
- b How many dogs are owned by pupils in Sian's class?
- c Which type of pet is most popular in David's class?
- d Whose class has the most pets?

A **compound bar chart** combines different sets of data in one bar.

- 3 Girls from three different schools were asked which sport they would prefer for their interschool charity sports competition. The two-way table shows the results.

	Tennis	Football	Hockey	Netball
Kent	5	30	10	20
Greys	5	10	10	15
Nobel	20	20	10	5

- a Complete the compound bar chart.
- b How many girls at Greys answered the questionnaire?
- c Which sport is likely to be played in the competition? Explain.



Check

Tick each box as your confidence in this topic improves.



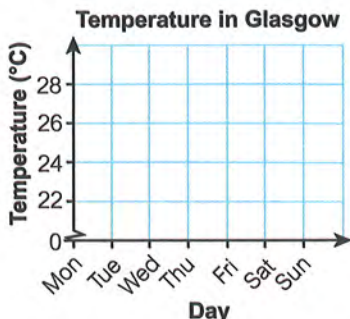
Need extra help? Go to page 6 and tick the box next to Q3. Then try it once you've finished 1.1–1.5.

- 1 **Modelling** The table shows the maximum daily temperatures in Glasgow for one week.

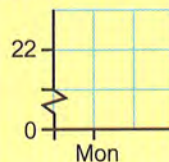
Day	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Temperature (°C)	24	25	28	28	27	27	23

When a line graph shows changes over time, put time on the horizontal axis.

- a Plot the points using crosses.
Join the points with a ruler.



The zig-zag shows there's a break in the axis scale.



Worked example



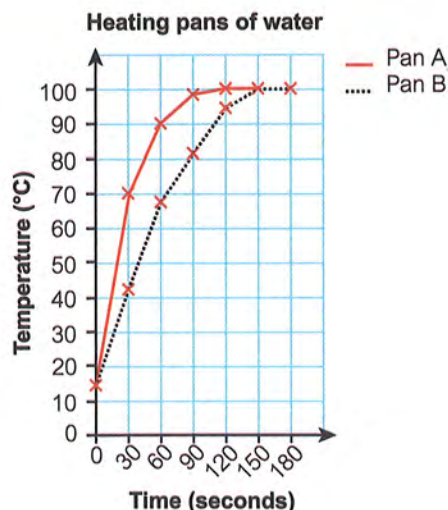
- b Dalglish says this is not a good model for predicting the temperature for the next few months. Explain why he is correct.



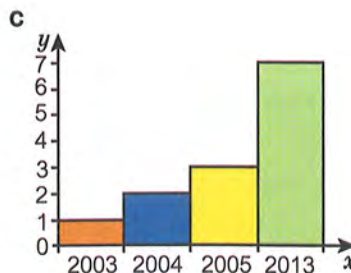
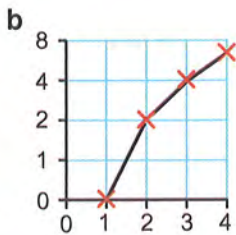
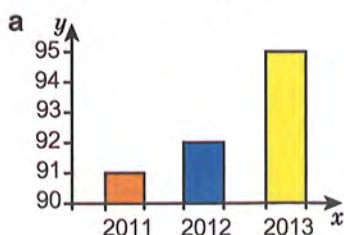
'Explain' means write a sentence:
This is not a good model because ...

- 2 Two pans of water are heated.
Pan B contains 250 ml more water than pan A.
The graph shows the recorded temperatures.

- a What was the recorded temperature in pan A after 60 seconds?
- b What was the difference in temperature between the two pans after 120 seconds?
- c Write a sentence to compare the times taken by the two pans to reach 100 °C.



- 3 **Reasoning** Explain why each of these graphs is misleading (giving the wrong idea).



- a
- b
- c

Check

Tick each box as your confidence in this topic improves.



Need extra help? Go to page 7 and tick the boxes next to Q5. Then try it once you've finished 1.1–1.5.

- 1 The data shows how many pets Pandu's friends have.

1, 1, 0, 2, 7, 2, 0, 2, 4

- a Input the data into column **A** of a spreadsheet, starting at cell **A1**.

- b Find the mode.

i Type the word **Mode** in cell **A10**.

ii In cell **A11**, type exactly `=mode(`

iii Select all of the numbers and press **Enter** to put the mode into cell **A11**.

iv Write down the mode of the data.

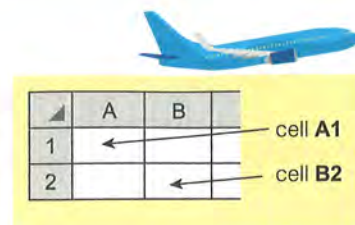
- c Complete the steps below and find the median.

i Type the word **Median** in cell **A12**.

ii In cell **A13**, type exactly `=me`

iii Select the data and press to put the median into cell **A**

iv Write down the median of the data.



- 2 Pandu collects data on how many children there are in his friends' families.

2, 3, 2, 2, 1, 2, 3, 1, 4

- a Enter the data into cells **B1–B9**.

To find the range, Pandu types **Range** in cell **B10**.

In cell **B11** he then types exactly `=B9-B5`

- b Why did Pandu use cells **B9** and **B5** to find the range?

- c What cell could Pandu have used instead of cell **B5**?

- d Follow these steps to get the mean of column B into cell **B13**.

i Type the word **Mean** in cell **B12**.

ii In cell **B13**, type exactly `=average(`

iii Select the data and press **Enter** to put the mean into cell **B13**.

iv Write down the mean of the data.

- 3 30 people are asked which type of music they like best.

- a Copy the table onto a new spreadsheet, starting at cell **A1**.

- b Draw a dual bar chart for the data by following these steps.

i Select the whole table.

ii Click the **insert** tab.

iii Click **column** and select the first dual bar chart.

iv Click **layout** and choose **options** to change your bar chart title, label the axes and turn off the legend.

- c Repeat the steps in part **b**, but this time draw a compound bar chart.

- d Which bar chart made it easier to identify the most popular type of music overall?

Type of music	Men	Women
pop	9	3
country	1	4
classical	3	3
jazz	1	0
other	2	4

Check

Tick each box as your
confidence in this
topic improves.



Need extra help? Go to page 7 and tick the box next to Q6. Then try it once you've finished 1.1–1.5.

Averages and range

- ☐ 1 Chan recorded the number of types of birds visiting a bird table each hour one Saturday morning: 6, 2, 2, 0, 4

Guided

a Work out

i the range $6 - \dots = \dots$

ii the mean. $\frac{6 + 2 + 2 + 0 + 4}{5} = \dots$

b The numbers for Sunday morning were: 3, 2, 3, 2, 2

Work out i the range $\dots$ ii the mean. $\dots$

- ☐ 2 Here is a list of numbers:

5, 5, 1, 9, 7, 8, 11

a Write the numbers in order: 1, 5, 5 $\dots$

b Circle the middle number.

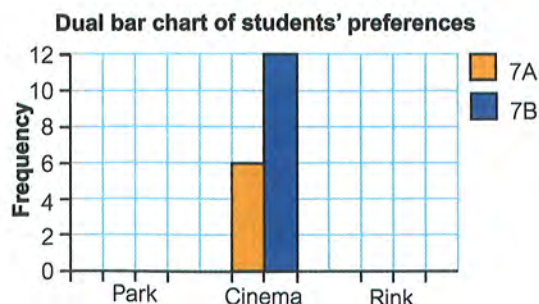
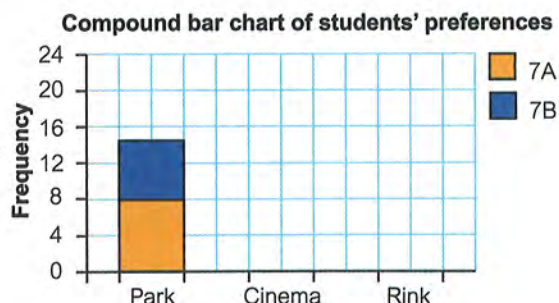
c Median = $\dots$

d Mode = $\dots$

Charts and tables

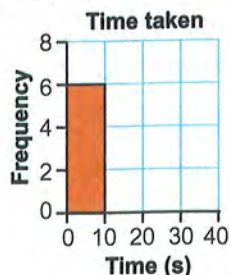
- ☐ 3 Students from classes 7A and 7B were asked if they preferred going to a theme park, the cinema or an ice skating rink. The table and the two bar charts show the same data.

	7A	7B
Park		
Cinema		
Rink	12	10



- a Use the compound bar chart to work out the number of students who chose theme park.
- b Use the dual bar chart to work out the number of students who chose the cinema.
- c Use the two-way table to complete the two bar charts.
- d What was the mode for Class 7A? $\dots$
- e What was the mode for Class 7B? $\dots$

- ☐ 4 Joe has drawn a tally chart to show the times taken by 20 students to complete a puzzle.

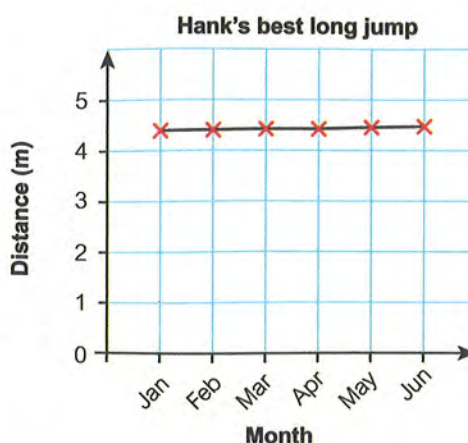
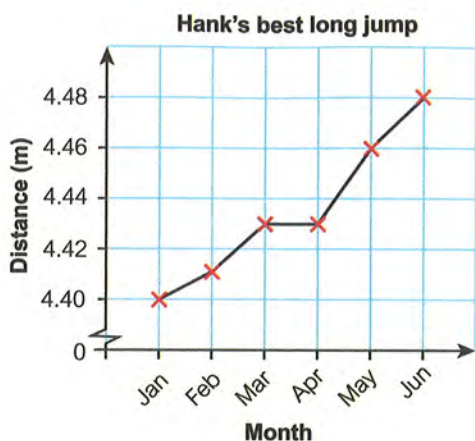


- a He must add one more tally. The time is 20 seconds. Add this data to the tally chart.
- b Complete the frequency column.
- c What is the modal class?
- d Complete the frequency diagram to show this data.

Time, t (s)	Tally	Frequency
$0 \leq t < 10$		
$10 \leq t < 20$		
$20 \leq t < 30$		
$30 \leq t < 40$		

Line graphs and spreadsheets

- ☐ 5 Hank recorded his best long jumps so far this year. He drew two graphs to show his results.



Make sure you give reasons why the first graph makes Hank look better.

Guided

Which graph makes Hank look better? Why?

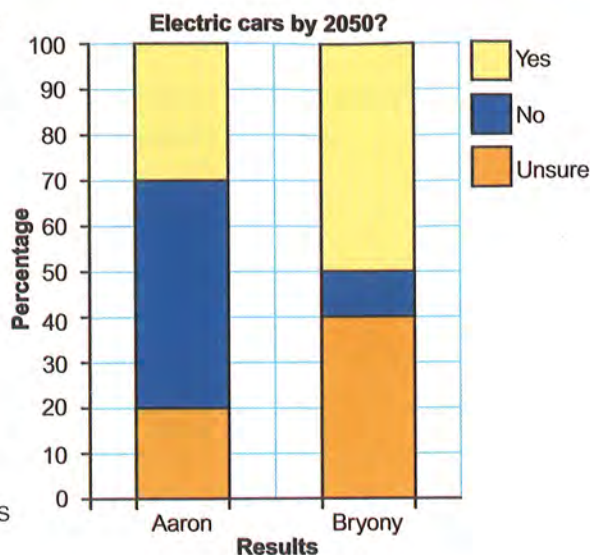
The first graph because

- ☐ 6 This spreadsheet shows the times Lai spent playing sports in one week.

	A	B
1	Day	Time (minutes)
2	Monday	30
3	Tuesday	45
4	Wednesday	60
5	Thursday	40
6	Friday	60
7		
8		
9		
10		

- a Which cell shows how much time she spent playing sports on Wednesday?
- b Input this data into a spreadsheet.
- In cell **B7** type **=sum(B2:B6)** and write down the value.
 - What does the value in **B7** tell you?
 - In cell **B8** type **=average(B2:B6)** and write down the value.
 - What does the value in **B8** tell you?

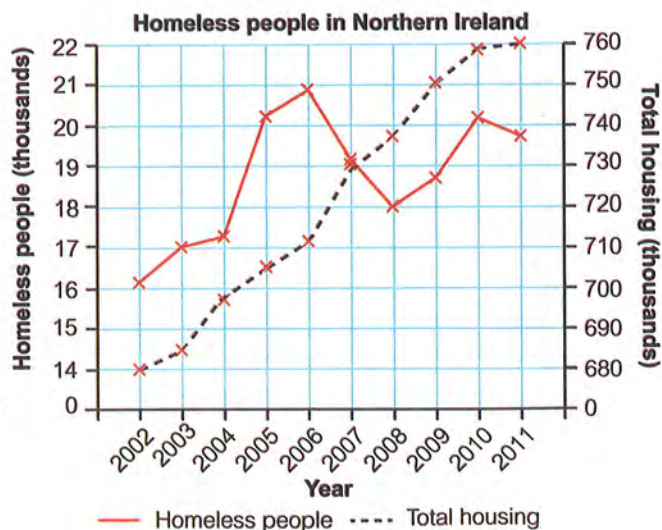
- 1 Problem-solving** Aaron and Bryony each asked a group of students the following question.
'Will all cars be electric in 2050?'
The compound bar chart shows their results.



- a** Who got the greater percentage of 'Unsure'?
.....
- b** What percentage of Aaron's replies were 'No'?
.....
- c** Aaron asked 200 students. Bryony asked 10 students.
How many of Aaron's replies were 'Unsure'?
.....
- d** Complete the two-way table to show the numbers of replies from the two surveys.

	Unsure	No	Yes
Aaron			
Bryony			

- 2 Real / Reasoning** The line graph shows the number of homeless people and the total number of houses in Northern Ireland.



- a** How many homeless people were there in 2008?
- b** How many houses were there in 2005?
- c** A newspaper wrote this with the graph: 'Before 2007 the number of homeless (people) was greater than the total number of houses available.'
Explain why the quote is wrong.

- 3 a** Here are the masses, in kg, of the first six runners to cross the line in a 100 m final.
94, 76, 83, 75, 82, 74

- i** What is their median mass?
- ii** Work out the range.
- iii** Calculate their mean mass.

- b** The table shows some statistics about the masses of the first six runners in the 1500 m final.
Write two sentences comparing the masses of the two sets of runners.

Mean	Median	Range
62.5	61	13

- 4 The table shows the masses, m kg, of a group of chimpanzees.

a Complete the table.

b How many males have a mass of at least 35 kg?

c Compare the average masses of the males and the females.

	$25 \leq m < 35$	$35 \leq m < 45$	$45 \leq m < 55$	Total
Males	7	6	3	
Females	3	7	4	
Total				

- 5 a The masses of five mice are 30 g, 29 g, 30 g, 32 g and 33 g. Use an assumed mean of 30 g to calculate the mean mass.

The assumed mean is a sensible estimate for the mean.

30 29 30 32 33

Differences from 30: 0 -1 0 +2 +3 = 4

The values are all close to 30 g, so the assumed mean is 30 g. Work out the differences from 30.

Mean of differences = $4 \div 5 = 0.8$

Mean = assumed mean + mean of differences = $30 + 0.8 = 30.8$ g

- b The masses of five rats are 162 g, 168 g, 154 g, 159 g and 161 g. Use an assumed mean to calculate the mean mass.

What would be a sensible assumed mean for this data?

- 6 **Problem-solving** Alex and six friends noted how many sit-up and press-up exercises they could each do.

Student	Alex	Cal	Ali	Gus	Ian	Pat	Ray
Sit-ups	18	15	22	19	28	25	17
Press-ups	10	4	12	9	19	14	8

Worked example



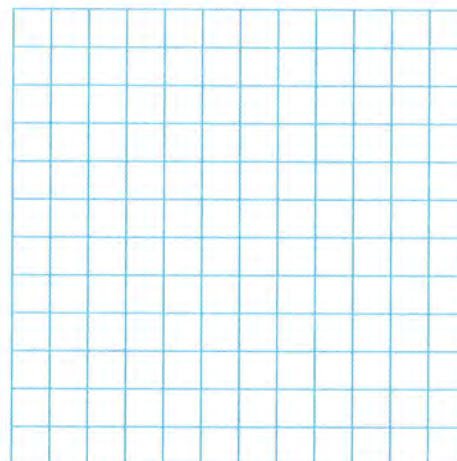
- a Draw a compound bar chart to display the data.

- b Who completed the most exercises?

- c Enter the data into a spreadsheet.

- d Use the spreadsheet to work out:

- i the mean number of sit-ups
ii the mean number of press-ups
iii the mean number of exercises.



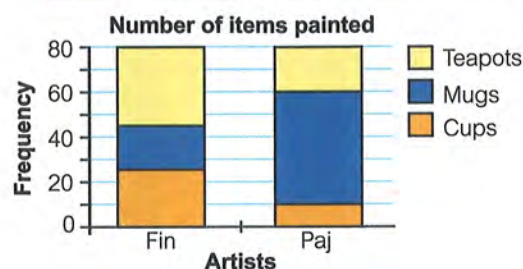
- e This table shows the number of sit-ups Alex did each week. What is the modal class for Alex's number of sit-ups?
- f Complete this sentence.
For 25% of the weeks Alex did at least sit-ups per week.

Sit-ups, s	Frequency
$100 \leq s < 120$	6
$120 \leq s < 140$	12
$140 \leq s < 160$	4
$160 \leq s < 180$	2

- 1 The table shows the numbers of items hand-painted by Fin and Paj on Monday.

	Cups	Mugs	Teapots
Fin	20	40	10
Paj	50	10	20

- a How many items did Fin paint on Monday?
- b How many mugs (big cups with handles) were painted altogether?
- c How many items were painted altogether?
- d The compound bar chart shows the numbers of items hand-painted by Fin and Paj on Friday. How many mugs were painted on both days altogether?



- 2 Betty recorded the number of 'bullseyes' she hit at archery practice each week.

7, 7, 4, 10, 6, 10, 39, 13, 9, 7

Calculate the mode, median, mean and range of this data.

- 3 The table shows the distances travelled by a lorry driver.

Distance (miles)	152	201	350	279	501	388	412	230	137	255
------------------	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Work out the mean distance travelled.

- 4 Here are the times taken, in seconds, for 15 students to send a text.

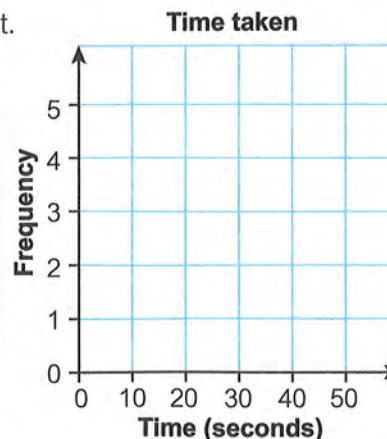
13, 22, 23, 9, 46, 30, 18, 5, 13, 29, 13, 9, 32, 26, 25

- a Complete the tally chart for the data.

- b What is the modal class?
.....

- c Complete the frequency diagram for the data.

Time, t (s)	Tally	Frequency
$0 \leq t < 10$		
$10 \leq t < 20$		
$20 \leq t < 30$		
$30 \leq t < 40$		
$40 \leq t < 50$		



- 5 The table shows the number of burgers sold each day in a restaurant.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
123	55	98	104	176	231	153

- a Input the data into a spreadsheet.
- b Use the spreadsheet to work out
- i the mean number of burgers sold
 - ii the median number of burgers sold
 - iii the range of the number of burgers sold.
- c Use the spreadsheet to display the data in a bar chart.

Guided

1 Here is a number grid.

26	27	28	29	30
31	32	33	34	35
36	37	38	39	40
41	42	43	44	45

- Shade the numbers that are divisible by 2. The first few have been done for you.
- Put a line through the numbers that are divisible by 5. The first two have been done for you.
- Circle the numbers that are divisible by 10.
- What do you notice about the numbers that are circled?

.....

2 Write down all the numbers between 30 and 40 that are

- divisible by 4
- divisible by 3
- divisible by 9

Write down the multiples of 4: 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, ...
Which are between 30 and 40?

3 There are 36 sweets in a bag.

Work out whether they can be shared equally between

- 2 people
- 3 people
- 4 people
- 5 people
- 9 people

$36 \div 2 = 18$. There is no remainder so 36 can be shared equally between 2 people.

4 Complete these statements.

- Numbers divisible by 4 can also be divided by
- Numbers divisible by 10 can also be divided by
- Numbers divisible by 9 can also be divided by

5 42 chocolates are shared equally between 9 people.

Are there any left over (remaining)? If so, how many?

Check

Tick each box as your confidence in this topic improves.



Need extra help? Go to page 17 and tick the box next to Q1. Then try it once you've finished 2.1–2.6.

1 Here is a list of numbers.

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,

15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25

Circle the prime numbers.

A **prime number** has exactly two factors: 1 and itself.

Guided

2 a Write down all the factors of

i 12 $1 \times 12 = 12$, $2 \times 6 = 12$, $3 \times 4 = 12$. Factors are 1, 2, 3, 4, 6, 12

ii 18 1×18 , $2 \times \dots$

iii 25 $\dots$

b Write down all of the prime factors of each number in part a.

i 2, 3

ii $\dots$

iii $\dots$

A **prime factor** is a factor of a number that is also a prime number.



3 **Problem-solving** Simon finds all the factors of a number. This is his list.

1, 2, 3, 4, $\dots$, $\dots$, 8, 10, 12, $\dots$, $\dots$, 20, 24, $\dots$, $\dots$, 48, $\dots$, 80, 120, 240

What are the missing numbers?

4 a Write down all the factors of 6. $\dots$

b Write down all the factors of 15. $\dots$

c Write down the common factors of 6 and 15. $\dots$

d What is the **highest common factor (HCF)** of 6 and 15? $\dots$

e Find the HCF of each of these pairs of numbers.

i 8 and 20 $\dots$

ii 9 and 27 $\dots$

The **highest common factor (HCF)** of two numbers is the largest number that is a factor of both numbers.

Worked example



5 a List the first 8 multiples of 4. $\dots$

b List the first 8 multiples of 8. $\dots$

c Write down the common multiples of 4 and 8 that are in both lists.

$\dots$

d What is the **lowest common multiple (LCM)** of 4 and 8?

$\dots$

The **lowest common multiple (LCM)** of two numbers is the smallest number that is a multiple of both numbers.

6 **STEM** The diagram shows two cogs.

The larger cog has 10 teeth and the smaller cog has 6 teeth.

The cogs start to turn with the dots next to each other.

What is the smallest number of turns each cog must make before the dots are next to each other again?



Check

Tick each box as your confidence in this topic improves.



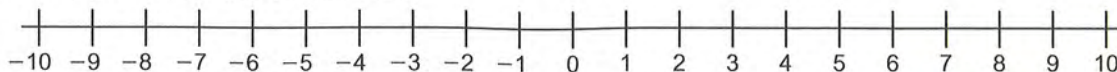
Need extra help? Go to page 17 and tick the boxes next to Q2, 3 and 4. Then try them once you've finished 2.1–2.6.

1 Write these numbers in order from smallest to largest.

-5 -7 11 -11 -1 4

.....

2 Use this number line to work out



a $9 - 11$

b $-6 + 10$

c $-4 - 5$

d $-9 + 3$

Numbers without a sign in front of them are positive. So $4 - 3$ is $+4 - +3$.

3 **Problem-solving / Reasoning** One day the temperature is -5°C . The next day it is 3°C lower.

What is the new temperature?

4 Write down the number that is

a 4 less than 6

b 4 less than 2

c 4 less than 0

d 4 less than -2

Guided

5 a Complete these patterns.

i $4 + 3 = 7$

ii $4 - 3 = 1$

$4 + 2 = 6$

$4 - 2 = 2$

$4 + 1 =$

$4 - 1 =$

$4 + 0 =$

$4 - 0 =$

$4 + -1 =$

$4 - -1 =$

$4 + -2 =$

$4 - -2 =$

b **Reasoning** Which sign, $+$ or $-$, is missing from each statement?

i $4 + -2$ is the same as 4 2.

ii $4 - -2$ is the same as 4 2.

c Complete these rules.

replace $++$ with $+$, replace $+ -$ with $-$, replace $- +$ with, replace $--$ with

6 Work out

a $9 + -4$

b $-3 + 7$

c $-15 + -2$

d $-2 - -3$



$9 + -4 = 9 - 4 =$

Check

Tick each box as your confidence in this topic improves.



Need extra help? Go to page 17 and tick the boxes next to Q5 and 6. Then try them once you've finished 2.1–2.6.

- 1 a Complete this table showing all the square numbers from 1 to 15.

1^2	2^2	3^2	4^2	5^2	6^2	7^2	8^2	9^2	10^2	11^2	12^2	13^2	14^2	15^2
1	4													

- b Use your table in part a to write down the answers to these.

i $\sqrt{9}$ ii $\sqrt{49}$ iii $\sqrt{144}$

To find the square of a number you multiply it by itself.
 $3^2 = 3 \times 3 = 9$
 3^2 means '3 squared'.

- 2 **Reasoning** A square has area 64 cm^2 .

Write down the side length of the square.

Onick says, 'The side length of the square could be 8 cm or -8 cm because the square root of 64 is 8 or -8 .'

Tammy says, 'The side length of the square can only be 8 cm.'

Who is correct? Explain your answer.



- 3 Check each of these calculations is correct by using the inverse operation.

a $19^2 = 361$
b $5.5^2 = 30.25$
c $\sqrt{24.01} = 4.9$

a Work out $\sqrt{361}$.
c Work out 4.9^2 .

Guided

- 4 a Work out an estimate for these square roots.

i $\sqrt{28}$ $\sqrt{25} = 5$, $\sqrt{36} = 6$. So $\sqrt{28}$ lies between 5 and 6.
Estimate is 5.3

ii $\sqrt{47}$
.....
iii $\sqrt{110}$
.....

Use your table from Q1 to help you.
28 is closer to 25 than 36, so estimate a bit less than 5.5.



- b Check your estimates by working out the accurate square roots on a calculator.

- 5 Work out

a 3^2
b 30^2
c 300^2
d 0.3^2

The inverse of square is **square root**.
 $3^2 = 3 \times 3 = 9$, so the square root of 9 is
 $\sqrt{9} = 3$

- 6 Work out

a $\sqrt{400}$ b $\sqrt{4} \times \sqrt{100}$
c $\sqrt{900}$ d $\sqrt{9} \times \sqrt{100}$
e $\sqrt{8100}$ f $\sqrt{3969}$



$49 \times 81 = 3969$

Check

Tick each box as your **confidence** in this topic improves.



Need extra help? Go to page 18 and tick the boxes next to Q8 and 9. Then try them once you've finished 2.1–2.6.

- 1 Complete this table showing commonly used cube numbers.

Guided

1^3	2^3	3^3	4^3	5^3	6^3	10^3
1	8				216	

To find the cube of a number, multiply it by itself and then multiply by the number again.
 $2^3 = 2 \times 2 \times 2 = 8$
 2^3 means '2 cubed' or '2 to the power 3'.
 3 is the power.

The inverse of cube is **cube root**.

$2^3 = 8$, so the cube root of 8 is $\sqrt[3]{8} = 2$.

- 2 Use your table in Q1 to write down the answers to these.

a $\sqrt[3]{8}$ b $\sqrt[3]{216}$
 c $\sqrt[3]{64}$ d $\sqrt[3]{-27}$

d $\square \times \square \times \square = 27$
 $\square \times \square \times \square = -27$

Guided

- 3 Work out

a $5^2 + 5 = 25 + 5 =$ b $2 \times 4^2 + 1 = 32 + 1$
 c $\frac{8^2}{2}$ d $\frac{\sqrt{81}}{3} + 3 \times 9$

Squares, cubes, square roots are indices or powers.

The priority of operations is

- Brackets
- Indices or Powers
- Multiplication and Division
- Addition and Subtraction

- 4 Work out

a $2^3 \times 5$ b 10×3^3
 c $\frac{5^3}{25}$ d $5 \times \sqrt[3]{1000}$
 e $\frac{50}{\sqrt[3]{125}}$ f $6^2 - 3^3$
 g $2 \times \sqrt[3]{64} + 2$ h $\frac{4^3}{\sqrt[3]{64}} - 2$



- 5 Use a calculator to work out

a $8^3 - 12$
 b $3 \times 21^2 - 323$
 c $31 \times 12^2 - 0.5 \times 12^3$
 d $5 \times \sqrt[3]{512} + 10$
 e $\frac{\sqrt[3]{2744}}{\sqrt{784}} + 4.5$



Use the $\sqrt[3]{}$ and x^y buttons on your calculator.



- 6 **STEM / Modelling** You can estimate the distance to the horizon using this flowchart.



Work out the distance to the horizon when it is seen from a height of

a 1.5 m b 10 m c 20 m

Check

Tick each box as your **confidence** in this topic improves.



Need extra help? Go to page 18 and tick the boxes next to Q10 and 11. Then try them once you've finished 2.1–2.6.

Guided

1 a Estimate the answer to each calculation.

i $51 + 6.8 \times 32 \approx 50 + 7 \times \dots = \dots$

ii $25 \times 62 - 13 \times 76 \dots$

iii $\frac{88.4}{29.02} + 5.4 \times 8.1 \dots$

iv $\frac{83}{38.2} \times 6.3 + 9.1 \dots$



Round numbers less than 10 to the nearest whole number. Round larger numbers to the nearest 10.



b Use a calculator to work out the accurate answers to the calculations in part a.

i $\dots$ ii $\dots$ iii $\dots$ iv $\dots$

Use your estimates to check your answers.

Guided

2 Work out

a $(15 - 5)^2 = 10^2 = \dots$

b $(2 + 2 \times 2)^2 = (2 + 4)^2 = \dots^2 = \dots$

c $(\frac{24}{6} + 5)^2 \dots$

d $\sqrt{40 - 4} = \sqrt{36} = \dots$

e $(-4)^3 = -4 \times -4 \times \dots = \dots$ f $\sqrt{120 + 12 \times 2} \dots$

The priority of operations is

- Brackets
- Indices or Powers
- Multiplication and Division
- Addition and Subtraction



3 Work out these calculations.

Check your answers using a calculator.

a $5 \times (\sqrt{64} - 1) \dots$

b $(52 - \sqrt{100})^2 \dots$

c $92 - (14 + \sqrt{49}) \dots$

d $(4 \times 6 - 21)^3 \dots$

e $4^3 + (3 + 2)^3 \dots$

f $3 \times 2^3 + 6 \dots$

Use the () and () buttons on your calculator.

Worked example



The dividing line of the fraction acts like a bracket.

$\frac{32 + 8}{6 - 2} = (32 + 8) \div (6 - 2)$

4 Work out

a $\frac{32 + 8}{6 - 2} \dots$

b $\frac{1 + 7^2}{5} \dots$

c $\frac{5^3 - 5^2}{4 \times 5} \dots$

d $\frac{\sqrt{64}}{4 + 4} \dots$

e $\frac{\sqrt{225} - 3}{3} \dots$

f $\frac{10^2 - 10}{\sqrt[3]{125}} \dots$



5 a Match each calculation card with the correct answer card.

Check your answers using a calculator.

$\sqrt{1 + 2^2 \times 20}$

$\sqrt[3]{30 - 3}$

$24 - 9 - \sqrt[3]{64}$

$7 \times (6 - \sqrt[3]{125})$

3

5

7

9

11

b There is one answer card left over.

Write a calculation card to go with this answer card.

The calculation must include a cube root or a square root.

Check

Tick each box as your confidence in this topic improves.



Need extra help? Go to pages 17 and 18 and tick the boxes next to Q7, 12, 13 and 14. Then try them once you've finished 2.1–2.6.

Working with numbers

- ☐ 1 Look at the numbers in the list.

4 9 10 15 31 47 63

- a i** Which are divisible by 2?
ii Explain how you know.
All the numbers divisible by 2 end in
b i Which are divisible by 5?
ii Explain how you know.
All the numbers divisible by 5 end in
c i Which are divisible by 10?
ii Explain how you know.
All the numbers divisible by 10 end in

Circle the numbers that are the same in both lists. These are the common factors.

- ☐ 2 **a** Work out the common factors of 16 and 24.

Factors of 16: 1, 2, 4, 8, 16

Factors of 24: 1, 2,

The common factors are 1, 2,

- b** What is the highest common factor of 16 and 24?



- ☐ 3 Work out the highest common factor of 18 and 27.

Follow the same steps as Q2.

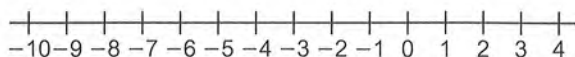
- ☐ 4 **a** Write a list of multiples of 3 that are less than 35.

3, 6, 9, 12, 15, 18,

- b** Write a list of multiples of 5 that are less than 35.
c Write down the common multiples of 3 and 5 that are less than 35.
d Write down the lowest common multiple of 3 and 5.

Circle the numbers that are the same in both lists. These are the common multiples.

- ☐ 5 Use the number line to work out the difference between these numbers.



- a** -4 and 0 **b** -4 and 2 **c** -4 and 3
d -9 and 0 **e** -9 and 2 **f** -9 and 4

- ☐ 6 Work out

- a** $9 - -4 = 9 \ominus -4 = 9 \oplus 4 = \dots\dots\dots$ **b** $8 + -5 = 8 \oplus -5 = 8 \ominus 5 = \dots\dots\dots$
c $-6 - -4 \dots\dots\dots$ **d** $-7 + -3 \dots\dots\dots$

Replace -- with +
 Replace +- with -

- ☐ 7 Estimate the answer to each calculation.

a $\frac{38}{5.8} \dots\dots\dots$

b $\frac{61}{8.2} \dots\dots\dots$

c $21.6 - \frac{11}{3.8} \dots\dots\dots$

Round the 'bottom' number.
 $5.8 \approx 6$
 Then round the 'top' number to a multiple of 6.

Powers and roots

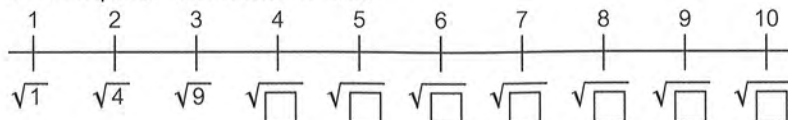
2^3 ← index
The index tells you how many 2s are multiplied together. $2^3 = 2 \times 2 \times 2$

- ☐ 8 Work out the missing numbers.

Guided

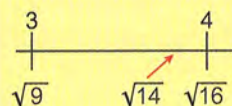
- a $2^3 = 2 \times 2 \times 2 = \dots\dots$
b $4^3 = \dots\dots \times \dots\dots \times \dots\dots = \dots\dots$
c $\dots\dots = 5 \times 5 = \dots\dots$
d $\dots\dots = 10 \times \dots\dots = \dots\dots$

- ☐ 9 a Complete this number line.



- b Use the number line to estimate a value for these square roots.

- i $\sqrt{14} \dots\dots$ ii $\sqrt{30} \dots\dots$ iii $\sqrt{84} \dots\dots$



- ☐ 10 Work out these calculations.

Guided

- a $3 \times 4^2 = 3 \times \dots\dots \times \dots\dots = 3 \times \dots\dots = \dots\dots$
b $\frac{9}{\sqrt[3]{27}} + 8^2 = \frac{9}{\square} + \dots\dots \times \dots\dots = \dots\dots + \dots\dots = \dots\dots$
c $12 + 2^3 = 12 + 2 \times \dots\dots \times \dots\dots = 12 + \dots\dots = \dots\dots$
d $\frac{10^3}{100} \dots\dots$

Work out numbers with an index before multiplication or division. Work out multiplication or division before addition or subtraction.



- ☐ 11 $1024 = 64 \times 16$
Use this fact to work out $\sqrt{1024}$.

$$\sqrt{1024} = \sqrt{64} \times \sqrt{16} = \square \times \square = \square$$

Working with brackets

- ☐ 12 Work out

Guided

- a $(5 \times 4 - 11)^2$ $5 \times 4 - 11 = 20 - 11 = \dots\dots$, Answer: $\dots\dots^2 = \dots\dots$
b $(21 - 8 \times 2)^3 \dots\dots$ c $6 + (13 - \sqrt{100})^2 \dots\dots$

Work out the brackets first.

- ☐ 13 Work out

Guided

- a $\sqrt{32 + 32} = \sqrt{64} = \dots\dots$ b $\sqrt{4^2 + 9} \dots\dots$

Work out the calculation under the square root first.

- ☐ 14 Work out

- a $\frac{44 + 6}{22 + 3} = \frac{\square}{\square} = \dots\dots$
c $\frac{8 + 24}{4^2} \dots\dots$

b $\frac{34 - 3^2}{5} \dots\dots$

d $\frac{10^2 - 20}{\sqrt{16}} \dots\dots$

e $\frac{\sqrt[3]{27} + 5}{2^2} \dots\dots$

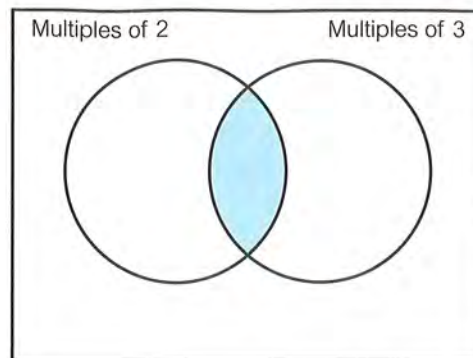
Calculate the top and bottom of the fraction first.

1 Here is a Venn diagram.

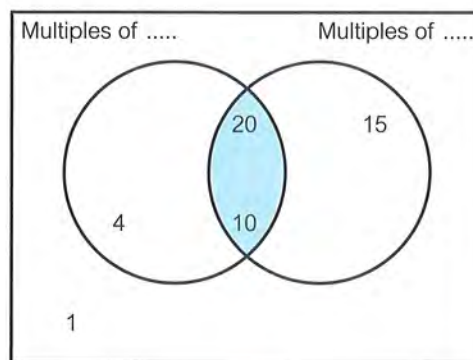
- a What can you say about the numbers that are in the intersection (the shaded area)?

.....

.....



- b Here is a partially completed Venn diagram. Complete the Venn diagram using numbers from 1 to 20, given that the only numbers in the intersection are 10 and 20.



2 a Find the smallest number divisible by

- i 2 and 5
- ii 2, 3, 4 and 5
- iii 2, 3, 4, 5 and 9

- b India says, 'To find the smallest number divisible by 2, 3, 4, 5, 9 and 10 you need to work out $2 \times 3 \times 4 \times 5 \times 9 \times 10$ '
- Is she correct? Explain your answer.

.....

3 Write these numbers in ascending order.

3^3 , 5^2 , 5^3 , 11^2

4 a Write down all the factors of

- i 27
- ii 36
- iii 45

- b Write down the HCF of 27, 36 and 45.

5 a Write down the first 10 multiples of

- i 4
- ii 5
- iii 8

- b Write down the LCM of 4, 5 and 8.

- 6 Problem-solving** Hassan turns on three sets of flashing lights at the same time.

One set flashes every 2 seconds, one set every 3 seconds and the third set every 5 seconds.

How long after they are first turned on do they next flash together at the same time?

Strategy hint

Write out the first 10 multiples of 2, 3 and 5.

- 7 Problem-solving / Reasoning** The area of a square is 40 cm^2 .

Ghida says, 'I think the side length of the square is about 5.9 cm .'

Without working out the side length, explain how you know there is a better estimate.

- 8 STEM** Tony tests electrical appliances to make sure they are safe. He uses the rule

$$\text{current} = \sqrt{\frac{\text{power}}{\text{resistance}}}$$

Current is measured in amperes, A. Power is measured in watts, W.

Resistance is measured in ohms, Ω .

Work out the current when power = 1500 W and resistance = 15Ω .



$$\text{current} = \sqrt{1500 \div 15}$$

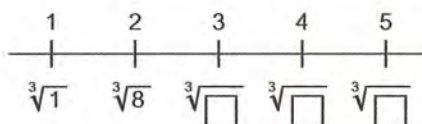


- 9** Estimate the answer to each calculation.

a 18×3.2 **b** $\sqrt{38} \times 41$

Round 38 to the nearest square number, so it is easy to find the square root.

- 10 a** Complete this number line.



- b** Use the number line to estimate a value for these cube roots.

i $\sqrt[3]{6}$ **ii** $\sqrt[3]{43}$ **iii** $\sqrt[3]{70}$

- 11 Problem-solving** The sum of these two values is 10.

$$\frac{4^2 - \sqrt{64}}{1^3}$$

$$\frac{20 - \square}{3^2}$$

Work out the missing number.

- 12 STEM / Reasoning** The distance travelled by an object is related to its acceleration and the time taken. Jeremy works out the distance travelled by a car using the rule

$$\text{distance} = \frac{\text{acceleration} \times \text{time}^2}{2}$$

- a** Work out the distance travelled by each car.

- b** Car C has the same acceleration as car A. It has travelled for twice the time of car A. Has it travelled twice as far?

Car	A	B	C
Acceleration (m/s^2)	15	10	15
Time (seconds)	20	15	40
Distance (m)			

$$\text{distance} = \frac{15 \times 20^2}{2}$$

1 Look at the list of numbers.

39 41 42 44 45 50

Write down the number that is divisible by

a 2 and 3

b 3 and 5

c 2 and 10

2 **a** What is the highest common factor of 16 and 18?

b Is your answer to part **a** a prime number?

3 **a** What is the lowest common multiple of 3 and 7?

b Is your answer to part **a** a prime number?

4 Write down the difference between

a -3 and 7

b 4 and -3

5 Work out

a $12 + -6$

b $-5 - 6$

c $8 - -7$

6 Work out an estimate for $\sqrt{18}$

7 Work out

a 2×4^3

b $\frac{2^3}{2^2}$

c $8 \times \sqrt[3]{27} + 6$

8 Use the fact that $324 = 9 \times 36$ to work out $\sqrt{324}$

9 Work out

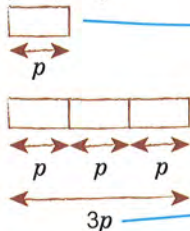
a $\frac{3^3 - 3^2}{6}$

b $\frac{62 + \sqrt[3]{1000}}{6^2}$

Guided

1 Simplify

a $p + p + p$



Think of a rod that is p cm long.

When you put three rods together the total length is $3p$ cm.

So $p + p + p = 3p$

An algebraic expression, for example $3x + 2y$, contains numbers and letters. Each part of an algebraic expression is called a term. Like terms contain the same letter (or do not contain a letter).

Worked example



b $w + w + w + w + w$ c $3p + 4p$ d $5w - 2w$

You simplify an expression by collecting like terms.

Guided

2 Simplify by collecting like terms.

a $3t + 2t + 5 = 5t +$

b $5w - 3w + 2y$

c $5h + 2h + 5j + 2 = 7h +$ +

d $7h + 1 - 4h + 2$

3 Simplify

a $t \times t$

b $n \times n \times n$

c $i \times i \times i \times i$

$2 \times 2 \times 2 = 2^3$

In the same way you can write $t \times t \times t = t^3$.



Guided

4 Simplify

a $3d^2 + 5d^2 = 8$

b $5b^2 + 4b^2 + 3b =$ + $3b$

c $7h^3 + 3h + 2h^3$

d $4c + 4c^2 + 4c$

e $6k^5 - k^5$

f $6m^2 + 4m^3 - 3m^3$

Like terms must have *exactly* the same letters and powers. For example, $2x^2$ and $3x^3$ are *not* like terms as the powers of x are different.

5 Simplify

a $b \times c$

b $a \times a \times c \times c$

c $s \times 3$

d $d \times 3 \times c$

Write letters in alphabetical order.
 $n \times m = mn$
Write numbers before letters.
 $a \times 2 = 2 \times a = 2a$

Guided

6 Simplify

a $5c \times 3c = 5 \times c \times 3 \times c$
 $= 5 \times 3 \times c \times c$
 $=$ c^2

The order of multiplication does not matter.

b $2d \times 7d$

c $\frac{10b}{5} = 2b$

$\frac{10b}{5}$ means $10b \div 5$.
Work out $10 \div 5$.

d $\frac{18t}{6}$

7 Write $=$ or $\neq$ between equivalent expressions.

a $x + y$ $y + x$

b $x - y$ $y - x$

c xy yx

d $x \div y$ $y \div x$

Test with some numerical values for x and y .

The identity symbol ($=$) shows that two expressions are always equivalent. For example, $a + 2b = 2b + a$.

Check

Tick each box as your confidence in this topic improves.

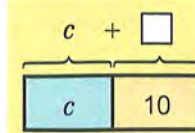


☐ ☐ ☐

Need extra help? Go to page 27 and tick the boxes next to Q1, 2, 4, 5 and 7. Then try them once you've finished 3.1–3.5.

- 1 Hannah collects football cards. She has c cards.
Write an expression for how many she has when there are

- a 10 more b 7 fewer
c 12 fewer d twice as many
e 4 times as many f half as many



Finding half is the same as dividing by 2.

- 2 a Barney has f football cards and r rugby cards.
Write an expression for the total number of football and rugby cards he has.

- b Barney gives away 5 football cards and is given 3 rugby cards.
Write an expression for the total number of football and rugby cards he has now.



- 3 Write an algebraic expression for

- a d more than c b c multiplied by d
c d less than c d d more than 7 times c
e 5 times d add 3 times c f c multiplied by itself
g 9 times d multiplied by itself h 1 less than c multiplied by itself
i c divided by d j 7 more than 9 divided by c

Try it with numbers.
How would you write 5 more than 3?

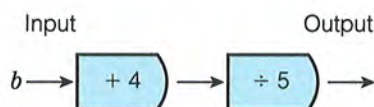
- 4 Write an expression for the output of each function machine.

a



$$a \times 3 + 5 = 3a + 5$$

b



$$(b + 4) \div 5 = \frac{b + 4}{5}$$

a is multiplied by 3
then 5 is added.

To show that the
whole expression is
divided by 5 draw a
long division line.

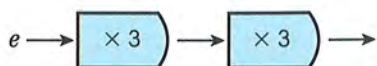
c



d



e

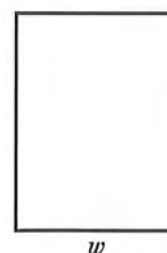


f



- 5 A rectangle has width w . The height is 2 more than the width.

- a Write an expression for the height.
b Write and simplify an expression for the perimeter.

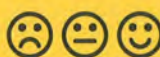


- c Calculate the perimeter of the rectangle when $w = 8$ cm.

Guided

Check

Tick each box as your
confidence in this
topic improves.



Three empty boxes for confidence tracking.

Need extra help? Go to page 28 and tick
the boxes next to Q12–14. Then try them
once you've finished 3.1–3.5.

Guided

1 Work out the value of each expression when $a = 5$.

- a $3a = 3 \times a = 3 \times 5 = 15$ b $7a$ c $a + 7$
 d $a - 7$ e a^2 f $9 - a$

Worked example



2 Given $a = 3$, $b = 4$ and $c = 6$ work out the value of

- a ab b $ac + 2$ c $3(b + 1)$
 d $2(a + c)$ e $\frac{c}{2}$ f $\frac{b + c}{5}$



3 **STEM** Use the formula $\text{density} = \frac{\text{mass}}{\text{volume}}$ to work out the density of

a a piece of plastic with a mass of 12 g and a volume of 6 cm³

Guided

$$\text{density} = \frac{12}{6} = 2 \text{ g/cm}^3$$

Substitute the values into the formula.
Write the units.
g/cm³ means grams per cubic cm.

A **formula** is a general rule for a relationship between quantities. You use a formula to work out an unknown quantity by substituting.

Literacy hint

Density is the mass (in grams) of 1 cm³ of a substance.

b a lump of metal with a mass of 28 g and a volume of 8 cm³

c a sample of liquid with a mass of 250 g and a volume of 200 cm³.

4 **STEM** Use the formula $\text{distance} = \text{speed} \times \text{time}$ to work out the distance travelled when

Guided

a speed = 20 m/s, time = 4 seconds

$$\text{distance} = 20 \times 4 = \dots \text{ metres}$$

b speed = 5 m/s, time = 30 seconds

c speed = 50 km/h, time = 2 hours

d speed = 4 mph, time = $\frac{1}{2}$ hour.

m/s means metres per second.
km/h means kilometres per hour.
mph means miles per hour.

5 **STEM** The formula to calculate pressure (P) in N/m², is $P = \frac{F}{A}$, where F is the force in N and A is the area in m².

Work out the pressure when
 $F = 40$ and $A = 5$.



6 **STEM** The formula for converting from a temperature in Celsius (C) to Fahrenheit (F) is

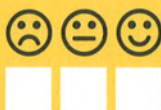
$$F = 1.8C + 32.$$

Convert these temperatures into °F.

- a 100°C b 0°C
 c -100°C d -40°C

Check

Tick each box as your confidence in this topic improves.



Need extra help? Go to pages 27 and 28 and tick the boxes next to Q8–11. Then try them once you've finished 3.1–3.5.

1 A mobile phone company charges £0.25 per minute for talk time and £2.50 per gigabyte (GB) for downloads. It uses the formula $C = 0.25t + 2.5d$.

- a What do you think t stands for?
- b What do you think d stands for?
- c How much would 100 minutes of talk time and 2 GB of downloads cost?

2 Renting a car costs £15 per day.

Guided

a How much does it cost to rent a car for 4 days?

$£15 \times 4 = £60$

Write down the cost per day. Multiply the cost by the number of days.

Literacy hint

'per day' means each day.

b How much does it cost to rent a car for a week?

c Write an expression for how much a car costs to rent for d days. $15d$

d Write a formula for the cost, C , of renting a car for d days. $C =$

3 Davina organises graduation parties. She always orders 5 more party bags than the number of guests.

Write a formula that connects the number of guests, g , to the number of party bags, b .

4 Modelling

a Write an algebraic expression for finding the mean of 4 numbers a , b , c and d

b Write a formula for the mean of 4 numbers.

mean of 4 numbers = $\frac{\text{sum of 4 numbers}}{4}$

c Use your formula to work out the mean when $a = 2$, $b = 5$, $c = 6$ and $d = 7$.

Write $m =$

5 **Real / STEM** The mean total lung volume is worked out from 3 different readings.

The readings are p , q and r .

Write a formula to work out the mean total lung volume, T .

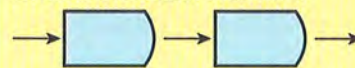
6 A function machine multiplies each input by 2 and then adds 7.

a What is the output if the input is

- i 5
- ii -4
- iii a ?

b Write a formula which connects the output, b , with the input, a

Draw the function machine.



7 A taxi charges £1.25 a mile plus an extra £4.

a How much does a 3-mile taxi ride cost?

b Write a formula which connects the charge, C , to the distance travelled, d

Check

Tick each box as your confidence in this topic improves.



Need extra help? Go to page 28 and tick the boxes next to Q15 and 16. Then try them once you've finished 3.1–3.5.



Guided

1 Expand

a $3(y + 5) = 3 \times y + 3 \times 5 = 3y + \dots$

b $7(h - 2) = 7 \times h - 7 \times 2 = \dots$

c $2(d + 10) \dots$

d $5(p - 5) \dots$

e $2(2 + k) \dots$

f $5(3 - a) \dots$

g $4(2 - c) \dots$

h $3(3 - n) \dots$

i $4(6 + t) \dots$

j $5(x + 6) \dots$

Expand a bracket means multiply every number inside the bracket by the number or letter outside the bracket.

- 2 A company making hockey sticks works out their profit, P , by subtracting £17 from the cost of a hockey stick, H , and multiplying the answer by the number of hockey sticks sold, a . Write a formula for calculating P

Guided

3 Expand

a $t(t + 2) = t \times t + t \times 2 = t^2 + \dots$

b $d(d + 5) \dots$

c $s(s - 3) \dots$

d $y(5y + 3) = y \times 5y + y \times 3 = 5y^2 \dots$

e $j(5 - 7j) \dots$

f $3q(2q + 4) = 3q \times 2q + 3q \times 4 = 6q^2 \dots$

g $5t(5t - 1) \dots$

h $3x(10 - 3x) \dots$

- 4 Naima has £ x . Kate has the square of Naima's amount. Meinir has £10 more than Kate.

a Write an expression for Kate's money.

b Write an expression for Meinir's money.

c Write and simplify an expression for the sum of all their money.

d Naima has £5. What is the sum of all their money?.....

Check

Tick each box as your confidence in this topic improves.



Need extra help? Go to page 27 and tick the boxes next to Q3 and 6. Then try them once you've finished 3.1–3.5.

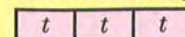
Simplifying expressions

☐ 1 Complete

a $t + t + t = \dots\dots\dots t$

b $p + p + p + p = \dots\dots\dots p$

Draw bars to help.



☐ 2 Simplify

a $2n + 3n = 5 \dots\dots\dots$

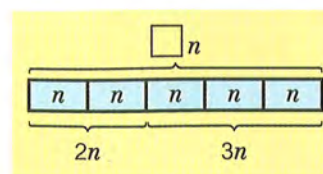
b $6a + 3a \dots\dots\dots$

c $9q - q = 9q - 1q = \dots\dots\dots$

d $3b + b \dots\dots\dots$

e $3g + 2 + 4g = 3g + 4g + 2 = 7g + \dots\dots\dots$

f $6s + 5t - 2s \dots\dots\dots$



☐ 3 Expand

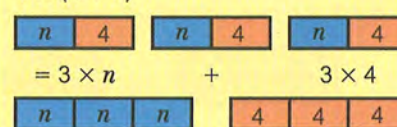
a $3(n + 4) = (n + 4) + (n + 4) + (n + 4) = 3n + \dots\dots\dots$

b $2(p + 5) = (p + 5) + (p + 5) = \dots\dots\dots$

c $4(a + 3) \dots\dots\dots$

d $5(4 - b) \dots\dots\dots$

$3 \times (n + 4)$



☐ 4 Fill in the missing indices.

a $5 \times 5 \times 5 = 5 \dots\dots$

b $t \times t \times t \times t \times t = t \dots\dots$

☐ 5 Simplify $6p \times 3p \dots\dots\dots$

☐ 6 Expand

a $n(n + 2) = n \times n + n \times 2 = n^2 + \dots\dots\dots$

b $t(t + 3) \dots\dots\dots$

c $p(5 + p) \dots\dots\dots$

d $g(1 - g) \dots\dots\dots$

$n \times n$
 $n(n \times 2)$
 $n \times 2$

☐ 7 Simplify by collecting like terms.

a $a^2 + a^2 + 5a = \dots\dots\dots a^2 + \dots\dots\dots$

b $5b + b^2 + 4b \dots\dots\dots$

You can only add terms with the same letters and powers.

Substitution

☐ 8 The formula to work out the distance a train travels is distance = speed $\times$ time.

A train travels at a speed of 100 km per hour for 3 hours.

How far does it travel?

distance = speed $\times$ time

= $\underbrace{100} \times \underbrace{3} = \dots\dots\dots \text{km}$

- ☐ 9 Work out the value of each expression when $x = 4$ and $y = 8$.

a $x + 6$

d $10x$

$x + 6$
↓
 $4 + 6 =$

b $y - 5$

e $xy + 3$

c $x + y$

f $\frac{y}{2}$

- ☐ 10 $T = 4(p + q)$. Work out the value of T when $p = 5$ and $q = 3$.

- ☐ 11 Use the formula $T = 4 + p$ to work out the value of T when

a $p = -2$

b $p = -4$

$T = 4 + -2$
 $= 4 - 2$

Writing expressions and formulae

- ☐ 12 Match each algebraic expression to its description.

$x + 5$

$x - 5$

$5 - x$

$5x$

$\frac{x}{5}$

5 times x

5 less than x

5 more than x

One fifth of x

x less than 5

- ☐ 13 Write an expression for each function machine.

a $a \rightarrow$ $+ 5$ $\rightarrow$

b $r \rightarrow$ $\times 2$ $\rightarrow$

c $x \rightarrow$ $- 4$ $\rightarrow$

- ☐ 14 Write a description for each expression.

a $a + b$

b ab

c $b - a$

d $\frac{a}{b}$

Use these phrases:
more than, less than,
multiplied by, divided by.
For example, b more than

- ☐ 15 To convert from cm, C , to inches, I , multiply by 4 then divide by 10.
Write the formula.

- ☐ 16 I think of a number, add 12, and then divide by 9.

a What would the result be if the original number was 15?

b Complete the function machine.

$x \rightarrow$ $\square$ $\rightarrow$ $\square$ $\rightarrow y$

c Which of these formulae correctly connects x with y ?

$y = 12x + 9$

$y = \frac{x + 12}{9}$

$y = 9(x + 12)$

$y = \frac{x}{12} + 9$

- 1 A hexagon has sides of length x .
Write and simplify an expression for its perimeter.

- 2 A cube has edges of length 4 cm.

a Work out the area of one of the square faces.

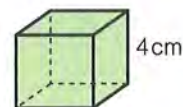
b The cube is painted.

Work out the total area that is painted.

Another cube has edges of length e .

c Write an algebraic expression for the area of one of the faces.

d Write an algebraic expression for the total area of all the faces.



- 3 **Finance** A party organising company uses the formula $P = 4.5c + 6a$ for calculating profit (financial gain), where c is the number of children and a is the number of adults.
Work out the profit when there are

a 20 children and 10 adults

b 30 adults.



- 4 A quadrilateral has one side of length y cm.

The second side is 2 cm more than double this length.

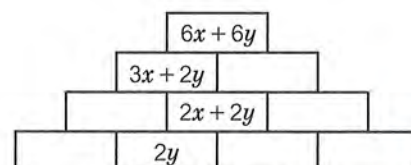
The other two sides are each 3 times the length of the second side.

Write an expression for the perimeter of the quadrilateral.

Simplify your expression as much as possible.

Sketch and label the quadrilateral.

- 5 In the pyramid each brick is the sum of the two bricks below.
Work out the missing expressions.



- 6 A maths teacher uses this number puzzle: *Think of a number. Double it. Add 2. Multiply by 5. Subtract 10 times the number you first thought of. Your answer is 10.*
Explain the teacher's trick.

Call the unknown number ' x ' and construct an algebraic expression.

- 7 When $x = 4$ all but one of these expressions have the same value.
Which is the odd one out?

$$x^2 - 20$$

$$x - 8$$

$$\frac{x}{4} - 5$$

$$8 - 2x$$

$$-7 + \frac{12}{x}$$

- 8 The product of two terms is $12x^2$.

a What could the two terms be?

b Give two other possible terms.

Literacy hint

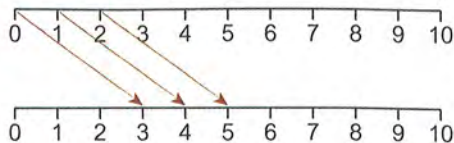
Product means multiply.

- 9 The sum of two terms is $10x$. Their product is $24x^2$.
What are the terms?

- 10 The length of a rectangle is 5 times the width. Write and simplify an expression for
 a the area b the perimeter.

Guided

- 11 Show the mapping $x \rightarrow x + 3$ on a pair of number lines from 0 to 10.



When $x = 0$, $x + 3 = 0 + 3 = 3$

When $x = 1$, $x + 3 = 1 + 3 = 4$

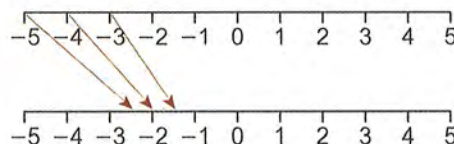
When $x = 2$, $x + 3 = 2 + 3 = 5$

Substitute each number
on the top number line
into the function $x + 3$.

- 12 Show the mapping $x \rightarrow 2x - 2$ on a pair of number lines from -5 to 5.

Guided

- 13 a Complete the mapping diagram for $x \rightarrow \frac{1}{2}x$.



- b What value maps to 5?



- 14 The first of five consecutive whole numbers is x .

Guided

- a Write expressions for the next three numbers.

x , $x + 1$, $x + \dots$, $x + \dots$, $x + \dots$

- b Write and simplify an expression for the sum of the five numbers.

- c Factorise the expression.

- d Write an expression for the mean of the five numbers.
 What do you notice?

Literacy hint

Consecutive numbers
follow each other.
4, 5, 6 are consecutive.

- 15 The first of three consecutive whole even numbers is x .
 Write an expression for the mean of the three numbers.

Look at Q14.

- 16 What value(s) of x would make each of these statements true?

a $x^2 = 3x$

b $x^2 > 3x$

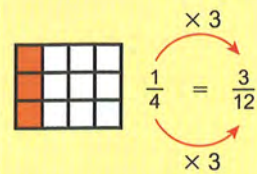
c $x^2 < 3x$

- 1 To convert between days and hours use the formula
 $\text{hours} = \text{number of days} \times 24$
 Work out the number of hours in 5 days.
- 2 The formula for calculating the perimeter of a shape, P , is $P = 2x + 5y$.
 Work out the value of P when $x = 12$ and $y = 3$.
- 3 The formula $k = \frac{m}{1000}$ changes metres, m , to kilometers, k .
 Work out the value of m when $k = 4325$.
- 4 Expand $5(p - 3)$
- 5 Write an expression for
 - a 5 less than t
 - b 4 times w
 - c p divided by 3.
- 6 Sophia jogs one day and swims the next. When she jogs she covers 1 mile. When she swims she covers 3 miles. Write a formula connecting the total distance she travels, T , with the number of days she jogs, j , and the number of days she swims, s , over two days.
- 7 Work out the value of each expression when $x = 2$ and $y = 5$.
 - a $3(x + 4)$
 - b $2(5x + y)$
- 8 By collecting like terms, simplify $4 + 3e - 1 + 2e$
- 9 Simplify
 - a $t \times t \times t \times t$
 - b $2p \times p$
 - c $2y \times 3y$
- 10 By collecting like terms, simplify $2v^3 + 3v^2 + 4v^3$
- 11 Expand $5d(3d + 3)$
- 12 Work out the value of x^2 when $x = 8$
- 13 Find the value of each expression when $p = 3$ and $q = 7$.
 - a p^2
 - b $2p + q$
 - c $3q - p$
 - d pq
 - e $\frac{p+q}{2}$

- 1 Sort these fractions into pairs of equivalent fractions.

$\frac{1}{4}$ $\frac{4}{8}$ $\frac{2}{3}$ $\frac{3}{12}$ $\frac{6}{10}$ $\frac{1}{2}$ $\frac{6}{9}$ $\frac{3}{5}$

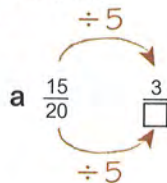
Equivalent fractions
have the same value.



2 Problem-solving

Which is larger, $\frac{2}{3}$ or $\frac{4}{5}$?

3 Simplify



You can write a fraction in its simplest form by dividing the numerator and denominator by their highest common factor (HCF) to give an equivalent fraction.

a $\frac{15}{20}$ $\frac{3}{4}$

b $\frac{3}{15}$ c $\frac{27}{63}$

- 4 A shop sells 60 pasties. 45 of them are vegetarian.
What fraction are vegetarian pasties?
Write your answer in its simplest form.
.....

5 Work out

- a $\frac{1}{2}$ of £10 = £10 $\div$ 2 = b $\frac{1}{10}$ of 50 kg
c $\frac{1}{4}$ of 80 ml d $\frac{3}{4}$ of 80 ml
e $\frac{4}{5}$ of £30



You worked out $\frac{1}{4}$ of 80 ml in part c;
now multiply by 3 for part d.

- 6 **Problem-solving** A bottle contains 500 ml of water. Rees drinks half of the water.
Owen drinks $\frac{2}{5}$ of what is left. How much does Owen drink?

Work out half
of 500 first.

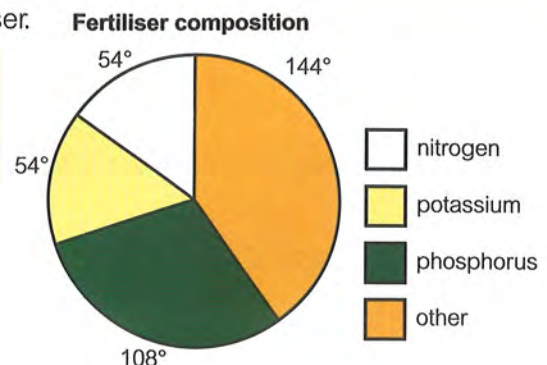
- 7 **STEM** The pie chart shows the composition of a fertiliser.
What fraction of the fertiliser is

a phosphorus

b nitrogen

c other?

How many degrees
are there altogether
in a pie chart?
Simplify your answer.



Check

Tick each box as your
confidence in this
topic improves.



Need extra help? Go to page 37 and tick
the boxes next to Q1–3. Then try them once
you've finished 4.1–4.5.

Guided

1 Which is larger, $1\frac{3}{4}$ or $\frac{9}{4}$?

$9 \div 4 = 2$ remainder 1, so $\frac{9}{4} = 2\frac{1}{4}$
..... is larger than

A **mixed number** has a whole number part and a fraction part. In an **improper fraction** the numerator is greater than the denominator.

A fraction greater than 1 can be written as a mixed number or an improper fraction.

Worked example



2 Write these improper fractions as mixed numbers.

a $\frac{9}{5}$

b $\frac{13}{4}$

c $\frac{27}{2}$

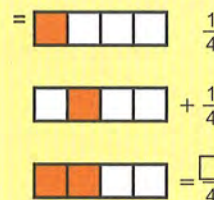
Guided

3 Work out these. Give each answer in its simplest form.

a $\frac{1}{4} + \frac{1}{4} = \frac{2}{4} = \frac{1}{2}$

b $\frac{5}{12} + \frac{3}{12}$

c $\frac{9}{16} - \frac{5}{16}$



When two fractions have the same denominator, add or subtract by adding or subtracting the numerators.

Guided

4 Work out these. Give each answer in its simplest form.

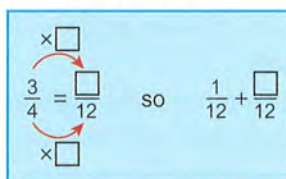
a $\frac{1}{12} + \frac{3}{4} = \frac{1}{12} + \frac{\square}{12} = \frac{\square}{12} = \frac{\square}{\square}$

b $\frac{9}{10} - \frac{2}{5}$

c $\frac{9}{14} - \frac{1}{2}$

d $\frac{5}{12} + \frac{1}{4}$

e $\frac{2}{3} - \frac{1}{6}$



When two fractions have different denominators, first write them as equivalent fractions with the same denominator (**common denominator**).

5 Work out these. Give your answers as mixed numbers.

a $\frac{3}{4} + \frac{5}{8}$

b $\frac{2}{3} + \frac{7}{12}$

c $\frac{4}{5} + \frac{13}{15}$

d $\frac{7}{8} + \frac{9}{24}$

Check

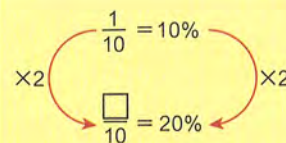
Tick each box as your confidence in this topic improves.



Need extra help? Go to page 37 and tick the box next to Q4. Then try it once you've finished 4.1–4.5.

- 1 Complete this table of equivalent fractions, decimals and percentages.

Fraction	$\frac{1}{10}$				$\frac{2}{5}$			$\frac{7}{10}$	
Decimal		0.2		0.3		0.5			0.75
Percentage			25%				60%		



- 2 Complete this table.

Mixed number	$1\frac{1}{4}$					$1\frac{4}{5}$
Decimal		1.4			1.7	
Percentage			175%	150%		

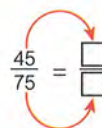
Equivalent fractions, decimals and percentages have the same value. You can convert a fraction to a decimal by dividing the numerator by the denominator.

When a positive mixed number is greater than 1, its decimal equivalent is greater than 1, and its percentage equivalent is greater than 100%. For example, $1\frac{2}{5} = 1.4 = 140\%$

- 3 Write these fractions as decimals.

a $\frac{5}{8}$ b $\frac{3}{20}$ c $\frac{15}{4}$ d $\frac{45}{75} = \frac{\square}{\square}$

0.6
 $8 \overline{)5.0^200}$



Worked example



- 4 Last season, the Year 7 hockey team drew 7 out of their 20 matches.

- a What fraction of their games did they draw?
 b Write your answer to part a as a decimal.
 c What percentage of their games did they draw?

- 5 **Modelling / STEM** Some groups of chicken eggs were hatched in incubators at different temperatures.

The table shows the incubator temperature, the number of eggs in each group and the number of eggs that hatched successfully.

Incubator	A	B	C	D	E
Temperature (°C)	36.5	37.0	37.5	38.0	38.5
Number incubated	200	150	250	320	700
Number hatched	164	126	220	288	560

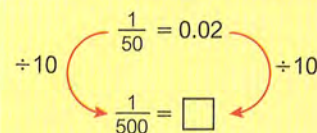
- a What fraction of each group hatched successfully?
 b Gerry says, 'The best temperature to hatch chicken eggs is 38.0 °C'. Is Gerry correct? Explain.

Literacy hint

An egg incubator is a type of heated box to keep eggs at the right temperature for hatching.

- 6 Use the fact that $\frac{1}{50} = 0.02$ to write these fractions as decimals.

a $\frac{1}{500}$ b $\frac{1}{25}$ c $\frac{1}{250}$



Check

Tick each box as your confidence in this topic improves.



Need extra help? Go to page 37 and tick the boxes next to Q5, 6 and 7. Then try them once you've finished 4.1–4.5.

1 Work out

a $\frac{3}{7}$ of 21

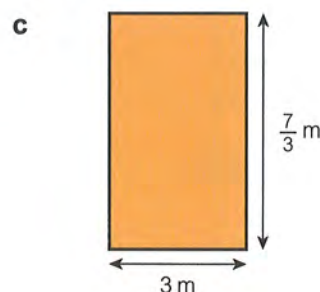
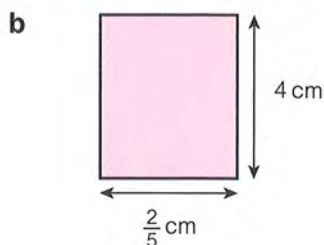
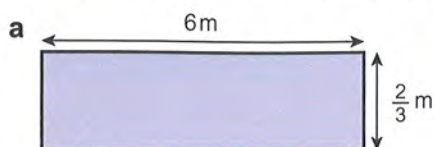
b $18 \times \frac{5}{6}$

c $33 \times \frac{5}{11}$

d $56 \times \frac{4}{7}$

In maths $\frac{3}{4}$ of 100 is the same as $\frac{3}{4} \times 100$.

2 Work out the area of these rectangles. Write each answer in its simplest form.



Guided

3 Work out these multiplications. Write each answer in its simplest form.

a $\frac{1}{2} \times \frac{1}{5} = \frac{1 \times 1}{2 \times 5} =$

b $\frac{1}{3} \times \frac{6}{7} = \frac{1 \times 6}{3 \times 7} =$

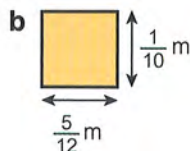
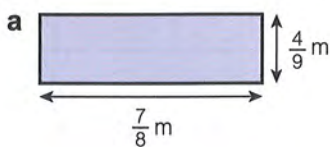
c $\frac{4}{9} \times \frac{1}{2}$

d $\frac{3}{5} \times \frac{3}{5}$

To multiply two fractions, multiply their numerators and multiply their denominators.

You can cancel common factors before multiplying fractions.

4 Work out the area of each rectangle.



5 $\frac{5}{6}$ members of a community are married.

$\frac{3}{4}$ of those who are married have children.

What fraction of the committee members have children?

Worked example



Check

Tick each box as your confidence in this topic improves.



Need extra help? Go to page 38 and tick the boxes next to Q8–13. Then try them once you've finished 4.1–4.5.

Guided

1 Write these improper fractions as decimals.

a $\frac{21}{5} = 4 \frac{\square}{\square} = 4 \dots\dots$

b $\frac{11}{4} = \dots\dots \frac{\square}{\square} = \dots\dots$

Write as a mixed number first. Then write the fraction part as a decimal.

Guided

2 Work out these additions. Write each answer in its simplest form.

a $1\frac{3}{8} + 2\frac{1}{2} = 1 + 2 + \frac{3}{8} + \frac{1}{2} = 3 + \frac{3}{8} + \frac{\square}{8} = \dots\dots$

b $7\frac{2}{3} + 5\frac{2}{9} \dots\dots$

c $8\frac{7}{8} + 5\frac{5}{24} \dots\dots$

When you add mixed numbers, add the whole numbers first, then add the fraction parts.

Guided

3 Work out these subtractions. Write each answer in its simplest form.

a $6\frac{1}{2} - 2\frac{2}{5} = \frac{13}{2} - \frac{12}{5} = \frac{\square}{10} - \frac{\square}{10} = \frac{\square}{10} = \dots\dots$

b $4\frac{1}{6} - 2\frac{1}{3} \dots\dots$

c $7\frac{2}{3} - 2\frac{8}{9} \dots\dots$

Write the mixed numbers as improper fractions. Now write fractions with a common denominator, and then subtract. Then write your answer as a mixed number.

Guided

4 Hanif works out the range of $1\frac{9}{10}$, $3\frac{7}{8}$, $1\frac{3}{4}$, $2\frac{3}{11}$ and $3\frac{1}{3}$.

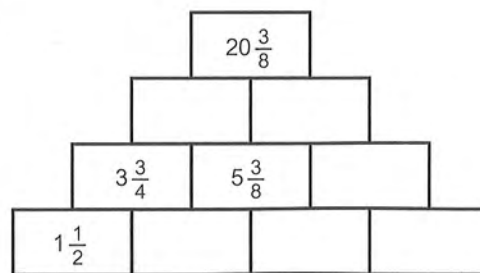
He writes $3\frac{1}{3} - 1\frac{9}{10} = 1\frac{13}{20}$

He is wrong.

Work out the correct range.

5 **Problem-solving** In a number pyramid the value in each brick is the sum of the two bricks beneath it.

Work out the missing values.



Guided

6 Work out these.

Write each answer in its simplest form.

a $4\frac{1}{2} \times 3 = \frac{9}{2} \times 3 = \frac{9 \times 3}{2} = \frac{\square}{2} = \dots\dots \frac{\square}{2}$

b $7 \times 2\frac{2}{3} \dots\dots$

c $3 \times 1\frac{1}{5} \dots\dots$

Check

Tick each box as your confidence in this topic improves.



Need extra help? Go to page 38 and tick the box next to Q14–16. Then try it once you've finished 4.1–4.5.

Equivalence

- ☐ 1 Write each fraction in its simplest form.

Guided

a $\frac{4}{8} = \frac{2}{4} = \frac{\square}{\square}$

$\div 2 \quad \div 2$

$\div 2 \quad \div 2$

Start by dividing both numbers by 2, then check to see if you can divide again.

b $\frac{9}{12} = \frac{\square}{\square}$

$\div 3$

$\div 3$

c $\frac{6}{18} = \frac{3}{9} = \frac{\square}{\square}$

$\div 2 \quad \div \square$

$\div 2 \quad \div \square$

- ☐ 2 Out of 28 people, 8 have blue eyes.
What fraction of the people have blue eyes?

Work out $\frac{\text{number with blue eyes}}{\text{total number of people}}$

- ☐ 3 The table shows the types of birds in a park.

Type of bird	Duck	Goose	Swan	Other
Number of birds	36	4	2	6

- a Work out the total number of birds.
b What fraction of the birds are ducks?

- ☐ 4 Work out these. Give each answer in its simplest form.

a $\frac{1}{8} + \frac{3}{4}$

b $\frac{5}{6} - \frac{4}{5}$

- ☐ 5 Complete these equivalent fractions, decimals and percentages.

Guided

a $\frac{1}{10} = 0.1 = 10\%$
 $\times 2 \quad \frac{2}{10} = \square = \square\%$

b $\frac{1}{10} = 0.1 = 10\%$
 $\times \square \quad \frac{7}{10} = \square = \square\%$

c $\frac{1}{5} = 0.2 = 20\%$
 $\frac{3}{5} = \square = \square\%$

Worked example



- ☐ 6 Use your answers to Q5 to complete this table.

Fraction	$1\frac{1}{10}$	$1\frac{7}{10}$		
Decimal			2.2	
Percentage				320%

- ☐ 7 Write these fractions as decimals.

Guided

a $\frac{3}{8} = 3 \div 8$

b $\frac{5}{6}$

0.3
8)3.3000

Multiplying by a fraction

- ☐ 8 Work out

Guided

a $\frac{1}{4}$ of 20 = $20 \div 4 = \dots\dots\dots$ b $\frac{1}{6}$ of 30 = $30 \div \dots\dots = \dots\dots\dots$
 c $\frac{1}{7}$ of 28 = $\dots\dots \div \dots\dots = \dots\dots\dots$

- ☐ 9 a Work out $\frac{1}{9}$ of 72 $\dots\dots\dots$

Use your answer to part a to work out

b i $\frac{2}{9}$ of 72 $\dots\dots\dots$ ii $\frac{3}{9}$ of 72 $\dots\dots\dots$ iii $\frac{4}{9}$ of 72 $\dots\dots\dots$

- ☐ 10 Work out

a $\frac{3}{4}$ of £20 b $\frac{5}{6}$ of 18 kg

- ☐ 11 Work out

a $\frac{2}{5} \times 35$ b $21 \times \frac{2}{3}$

$\frac{2}{5} \times 35 = \frac{2}{5}$ of 35
 Work out $\frac{1}{5}$ of 35,
 then multiply by 2.

- ☐ 12 Work out

Guided

a $\frac{3}{4}$ of 17m = $\frac{3 \times 17}{4} = \frac{51}{4}$, $51 \div 4 = 12\text{r} \dots\dots = 12\frac{\square}{4}$ m

b $\frac{2}{5}$ of 23g = $\frac{2 \times 23}{\square} = \dots\dots\dots$

$\frac{1}{4}$ of 17 isn't a
 whole number.
 Multiply then
 simplify.

- ☐ 13 Work out

Guided

a $\frac{3}{4} \times \frac{2}{7} = \frac{3 \times 2}{4 \times 7} = \frac{\square}{\square} = \frac{\square}{\square}$ b $\frac{5}{8} \times \frac{2}{5}$

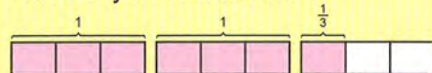
Simplify your answers
 if possible.

Working with mixed numbers

- ☐ 14 Write these mixed numbers as improper fractions.

a $2\frac{1}{3}$ $\dots\dots\dots$

How many thirds are there?



b $5\frac{1}{2}$ $\dots\dots\dots$

c $3\frac{3}{10}$ $\dots\dots\dots$

- ☐ 15 Write these improper fractions as whole numbers or mixed numbers.

a $\frac{8}{5}$ $\dots\dots\dots$

How many wholes can you make from 8 fifths?



b $\frac{21}{7}$ $\dots\dots\dots$

c $\frac{19}{8}$ $\dots\dots\dots$

- ☐ 16 Work out

Guided

a $1\frac{1}{4} + 2\frac{7}{8} = 1 + 2 + \frac{1}{4} + \frac{7}{8} = 1 + 2 + \frac{\square}{8} + \frac{\square}{8} = 3 + \frac{\square}{8} = \dots\dots\dots$

b $2\frac{1}{5} - 1\frac{7}{10} = \frac{11}{5} - \frac{\square}{10} = \frac{\square}{10} - \frac{\square}{10} = \dots\dots\dots$

c $2\frac{1}{3} \times 5 = \frac{\square}{3} \times 5 = \frac{\square}{3} = 11\frac{\square}{3} = \dots\dots\dots$

- 1 **Problem-solving / Reasoning** Here are some fractions.

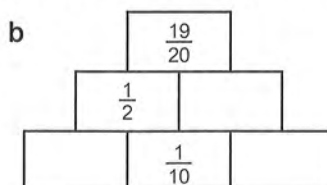
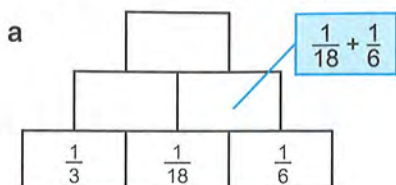
$$\frac{12}{14} \quad \frac{10}{35} \quad \frac{20}{28} \quad \frac{10}{70} \quad \frac{21}{56} \quad \frac{9}{21} \quad \frac{28}{49}$$

Which fraction is the odd one out? Explain your answer.

Strategy hint

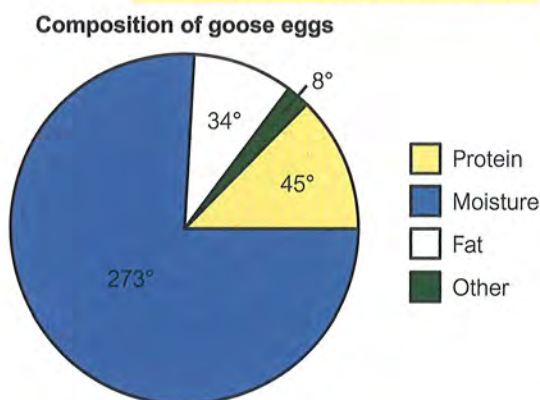
Start by writing each fraction in its simplest form.

- 2 Complete these fraction pyramids. Each brick is the sum of the two bricks below it.



- 3 **STEM / Problem-solving** The pie chart shows the composition of goose eggs. Work out the amounts of protein and moisture in a goose egg of mass 120 g.

Work out the fractions of the egg that are protein and moisture first.



- 4 **Reasoning** Omar writes the fraction $\frac{11}{18}$ as a decimal. This is what he writes.

$$\begin{array}{r} 1.636 \\ 11 \overline{)18.000} \\ \underline{11} \\ 70 \\ \underline{66} \\ 40 \\ \underline{36} \\ 40 \end{array} \quad \text{so } \frac{11}{18} = 1.6363\dots$$

- a Explain the mistake that Omar has made.
b Work out the correct decimal equivalent of $\frac{11}{18}$.

- 5 Work out

a $2\frac{1}{2} + 2\frac{1}{3} = \frac{\square}{2} + \frac{\square}{3} = \frac{\square}{6} + \frac{\square}{6} = \dots\dots\dots$

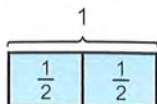
b $4\frac{1}{4} - 3\frac{1}{5}$



Simplify your answers.

- 6 **STEM** In a 750 ml bottle of sunflower oil there is 82 ml of saturated fat, 150 ml of monounsaturated fat and 518 ml of polyunsaturated fat. What fraction of the sunflower oil is monounsaturated fat? Give your fraction in its simplest form.

- 7 a How many $\frac{1}{2}$ s are there in 1 whole?



- b How many $\frac{1}{2}$ s are there in 2 wholes?

- c How many $\frac{1}{2}$ s are there in 3 wholes?

- d Complete.

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

$$2 \div \frac{1}{2} = \dots\dots\dots$$

$$3 \div \frac{1}{2} = \dots\dots\dots$$

$$4 \div \frac{1}{2} = \dots\dots\dots$$

- e Dividing by $\frac{1}{2}$ is the same as multiplying by

8 $\frac{1}{3} \times 12 = 4$

Therefore $4 \div \frac{1}{3} = \dots\dots\dots$

Dividing by $\frac{1}{3}$ is the same as multiplying by

- 9 A plant is $5\frac{1}{2}$ cm tall

It grows $2\frac{3}{10}$ cm each week.

How tall will it be after 4 weeks?

- 10 Two numbers sum to 5.

Their difference is $\frac{1}{2}$.

What are the numbers?

- 11 90 students choose whether to study Spanish, Mandarin or both.

In total $\frac{1}{5}$ of the students study only Mandarin.

$\frac{2}{9}$ study only Spanish.

What fraction study both languages?

1 Write each fraction in its simplest form.

a $\frac{10}{15}$

b $\frac{9}{36}$

c $\frac{24}{30}$

2 In a field there are 20 goats.

12 of the goats are white.

What fraction of the goats are white?

Give your answer in its simplest form.

3 Work out

a $\frac{1}{8}$ of 16

b $\frac{2}{3}$ of 21

c $\frac{4}{7}$ of 35

4 Write these amounts in order of size, starting with the smallest.

$\frac{5}{6}$ of £30 $\frac{1}{3}$ of £69 $\frac{2}{5}$ of £60

5 Work out these. Give each answer in its simplest form.

a $\frac{1}{2} + \frac{1}{6}$

b $\frac{11}{15} - \frac{1}{3}$

6 Write $\frac{32}{5}$ as a mixed number.

7 Write $5\frac{3}{7}$ as an improper fraction.

8 Work out $18 \times \frac{5}{6}$.

9 Complete this table.

Fraction		$\frac{3}{4}$		$1\frac{3}{10}$	
Decimal	0.1				5.5
Percentage			60%		

10 Work out these. Write each answer in its simplest form.

a $3\frac{3}{4} + 2\frac{7}{12}$

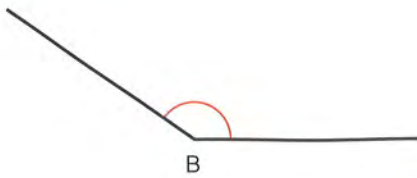
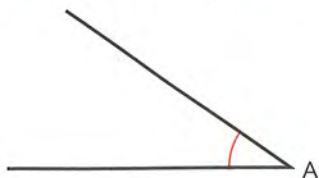
b $3\frac{1}{3} - 2\frac{8}{9}$

11 Work out $2\frac{5}{12} + 5\frac{1}{8} - 4\frac{3}{4}$. Write your answer in its simplest form.

12 Work out $\frac{3}{4} \times \frac{8}{9}$.

13 Work out $4 \times 3\frac{3}{5}$.

1 Look at these angles.



a Estimate the size of angle

i A ii B

b Measure to the nearest degree angle

i A ii B

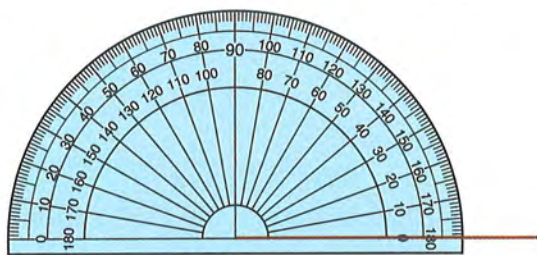
Worked
example



Place the cross of the protractor on the point of the angle. Line up the zero line with one line of the angle. Read up from 0 on the inner scale.

2 Use a protractor to draw an angle of

a 30° b 220° .



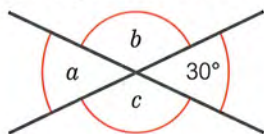
Guided

Place the protractor on the line with the cross exactly on one end. Start at 0 and read up to 30° . Mark the point. Use a ruler to join up the point to the end of the line. Label the angle 30° .



If you have a semicircular protractor, work out $360^\circ - 220^\circ = 140^\circ$, then draw an angle of 140° . The reflex angle is 220° .

3 **Reasoning** Work out the angles marked with letters. Give your reasons.



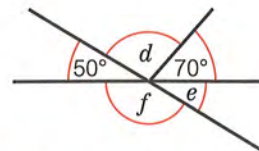
Guided

$a = \dots\dots\dots^\circ$ (vertically opposite angles are equal)
 $b = 180^\circ - 30^\circ = \dots\dots\dots^\circ$ (angles on a straight line add up to 180°)
 $c = \dots\dots\dots^\circ$

Vertically opposite angles are equal.
 The light blue angles are equal.
 The dark red angles are equal.

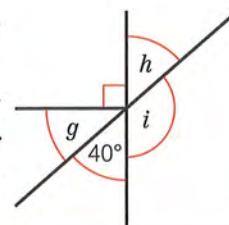


4 **Reasoning** Work out the angles marked with letters. Give reasons for your answers.



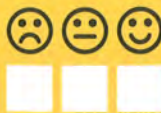
Guided

$d = 180^\circ - 50^\circ - 70^\circ = \dots\dots\dots^\circ$ (angles on a straight line add up to 180°)
 $e = \dots\dots\dots^\circ$
 $f = \dots\dots\dots^\circ$
 $g = \dots\dots\dots^\circ$
 $h = \dots\dots\dots^\circ$
 $i = \dots\dots\dots^\circ$



Check

Tick each box as your confidence in this topic improves.



Need extra help? Go to page 46 and tick the boxes next to Q1–4. Then try them once you've finished 5.1–5.4.

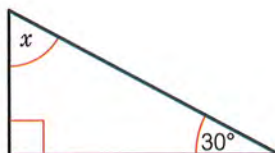
- 1 Complete this table showing the number of lines of symmetry and the order of rotational symmetry of these triangles.

Triangle	Equilateral	Isosceles	Scalene
number of lines of symmetry			
order of rotational symmetry			

A **line of symmetry** divides a shape into two halves that fit exactly on top of each other. The **order of rotational symmetry** of a shape is the number of times it exactly fits on top of itself when rotated a full turn.

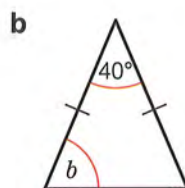
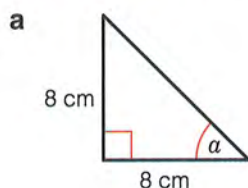
If a shape has no line or rotational symmetry, write 'None'.

- 2 **Reasoning** Work out the size of angle x .
Give a reason for your answer.



$x = \square$ (angles in a triangle add up to $\square^\circ$)

- 3 **Reasoning** Work out the angles marked with letters.
Give a reason for each step.



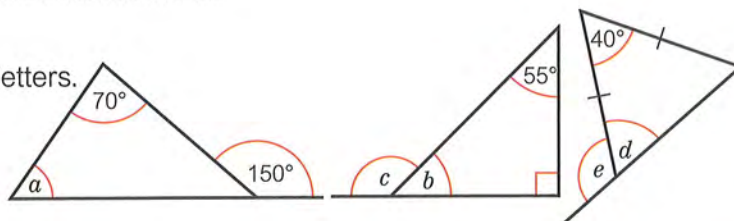
Worked example



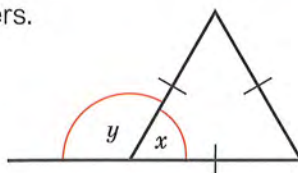
Strategy hint

Explain how you know that each triangle is isosceles. Next, identify the two equal angles.

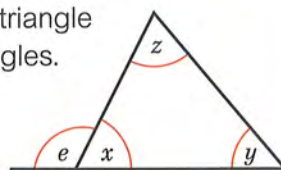
- 4 Work out the missing angles marked by letters.
Give reasons for each answer.



- 5 Work out the angles marked with letters.
Give reasons for your answers.



- 6 **Reasoning** Prove that an exterior angle of a triangle is equal to the sum of the opposite interior angles. The exterior angle e is opposite the two interior angles y and z . Complete this proof.



An **interior angle** is inside a shape.

An **exterior angle** is outside the shape on a straight line with the interior angle.



$e + x = \dots\dots\dots^\circ$ because they lie on a $\dots\dots\dots$

$x + y + z = \dots\dots\dots^\circ$ because the angles in a triangle sum to $\dots\dots\dots^\circ$.

This proves that $e = \dots\dots\dots$

Check

Tick each box as your **confidence** in this topic improves.



Need extra help? Go to pages 46 and 47 and tick the boxes next to Q5, 7 and 8. Then try them once you've finished 5.1–5.4.

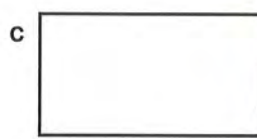
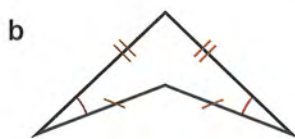
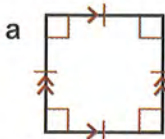
- 1 Complete this table showing the number of lines of symmetry and the order of rotational symmetry of these quadrilaterals.

Quadrilateral	Square	Rectangle	Parallelogram	Rhombus	Kite	Arrowhead	Trapezium	Isosceles trapezium
								
number of lines of symmetry								
order of rotational symmetry								

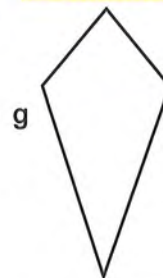
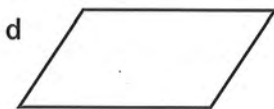
- 2 On each shape below:

- Mark equal sides with dashes. Use double dashes for a second pair of equal sides.
- Mark equal angles with arcs. Use double arcs for a second pair of equal angles.
- Mark right angles.
- Mark parallel sides with arrows. Use double arrows for a second pair of parallel sides.

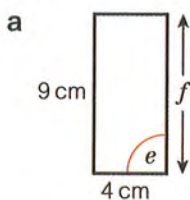
Guided



Use line and rotational symmetry to find equal sides and angles.

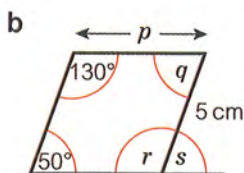


- 3 Work out the angles and sides marked with letters.



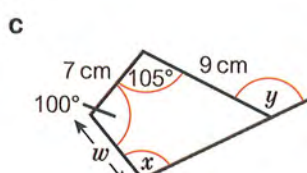
rectangle

.....
.....



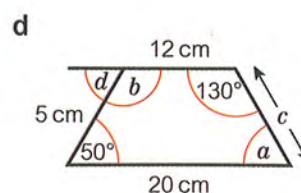
rhombus

.....
.....
.....



kite

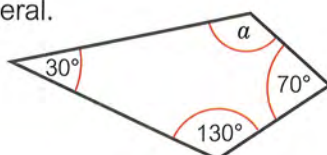
.....
.....
.....



isosceles trapezium

.....
.....
.....

- 4 Work out angle a in the quadrilateral. Give your reason.



Angles in a quadrilateral sum to 360° .

Check

Tick each box as your confidence in this topic improves.



Need extra help? Go to pages 46 and 47 and tick the boxes next to Q6, 9 and 10. Then try them once you've finished 5.1–5.4.

1 Use a ruler and protractor to accurately draw each triangle XYZ.

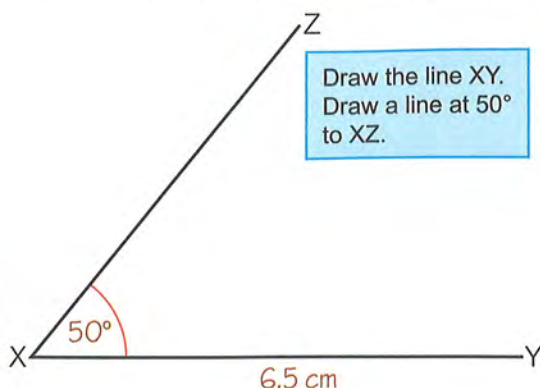
a $XY = 6.5 \text{ cm}$, $\angle YXZ = 50^\circ$, $\angle XYZ = 45^\circ$

b $XY = 7.7 \text{ cm}$, $YZ = 8.5 \text{ cm}$, $\angle XYZ = 35^\circ$

Strategy hint

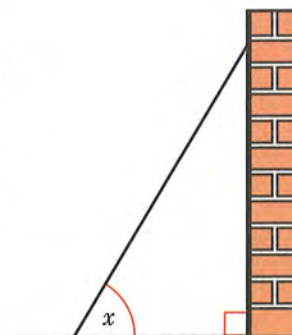
Sketch each triangle first.

Guided



2 **Reasoning** The diagram shows a ladder leaning against a house. The base of the ladder is 230 cm from the house and the top of the ladder reaches 550 cm up the wall.

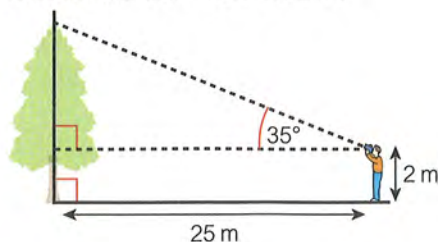
- Make an accurate scale drawing of the right-angled triangle formed by the ladder, the ground and the house. Use a scale of 1 cm to 100 cm.
- Measure the angle labelled x .
- Measure the length of the ladder on the scale drawing.
- What is the actual length of the ladder?



A scale of 1 cm to 100 cm means that 1 cm on the scale drawing represents 100 cm in real life.

Scale drawing	Real life
$\times \square$	1 cm is 100 cm
$\square$	is 230 cm $\times 2.3$

3 **STEM / Real** Emma uses a clinometer to work out the height of a tree by measuring the angle between the top of the tree and her eye level. She is 2 m tall. Make a scale drawing of the right-angled triangle and work out the height of the tree. Use a scale of 1 cm to 2 m.



Literacy hint

A clinometer is a tool used to measure the angle from the horizontal in a right-angled triangle.

Don't forget to add Emma's height to the height of the triangle.

Check

Tick each box as your **confidence** in this topic improves.

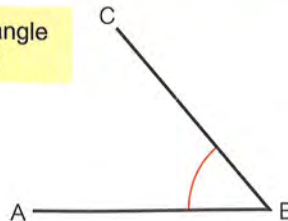


Need extra help? Go to page 47 and tick the boxes next to Q11–13. Then try them once you've finished 5.1–5.4.

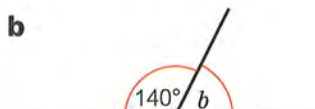
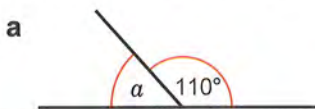
Working with angles

- ☐ 1 Hakim uses a protractor to measure angle ABC. He says, 'Angle ABC is 130° .' Without using a protractor, say whether or not he is correct. Give a reason for your answer.

What type of angle is angle ABC?



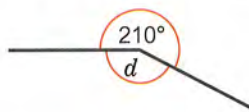
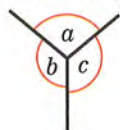
- ☐ 2 Work out the size of each angle marked with a letter.



Angles on a straight line add to 180° . $180 - 110 = a$

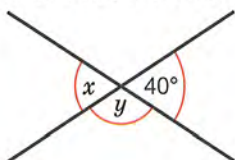
$a = 180 - \dots = \dots^\circ$

- ☐ 3 **a** What do the angles a , b and c add up to? **b** Work out the size of angle d .



$360^\circ - 210^\circ = d$

- ☐ 4 Work out the sizes of angles x and y . Write down the reasons.



Vertically opposite means the angles are opposite and meet at their vertices.

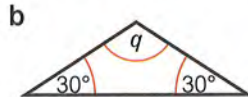
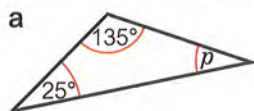
Worked example



angle $x = \dots^\circ$ Vertically opposite angles are $\dots$
angle $y = 180^\circ - \dots^\circ = \dots^\circ$ Angles on a $\dots$ add up to $\dots^\circ$

Triangles and quadrilaterals

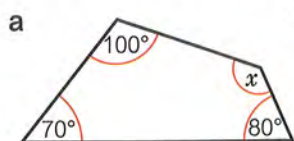
- ☐ 5 Work out the angles marked with letters. Give a reason for each answer.



The angles in a triangle add up to 180° . Start with 180° and subtract the other angles.

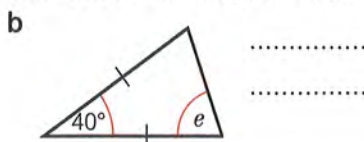
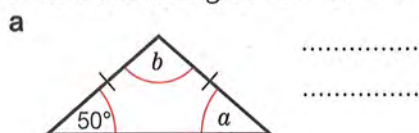
$p = 180 - 135 - \dots = \dots^\circ$
(angles in triangle sum to $\dots^\circ$)

- ☐ 6 Work out angle x for each quadrilateral.



In part a, start with $x = 360 - 100 - \square - \square = \dots^\circ$
(angle sum of a quadrilateral)

- ☐ 7 All of these triangles are isosceles. Work out the angles marked with letters. Give a reason for each answer.



The two angles at the base of the equal sides of an isosceles triangle are equal.

☐ 8 a Which is the exterior angle, g or h ?

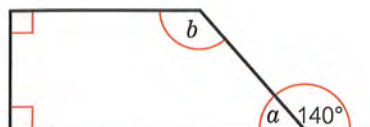
b Work out angle h . Give a reason for your answer.



☐ 9 Which of these quadrilaterals have 1 line of symmetry and order of rotational symmetry 1?

Square	Rectangle	Parallelogram	Rhombus	Kite	Arrowhead	Trapezium	Isosceles trapezium

☐ 10 Work out angles a and b . Give reasons for your answers.



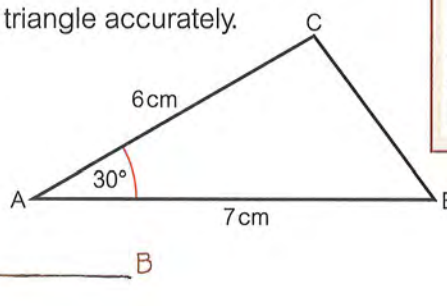
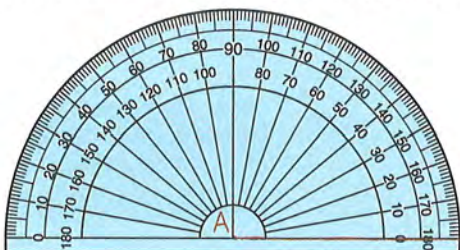
Accurate drawings

☐ 11 a Use a ruler to draw a line of length 7 cm. Label it AB.

b Use a protractor to draw an angle of 30° at point A.

c Draw in the other lines needed to complete this triangle accurately.

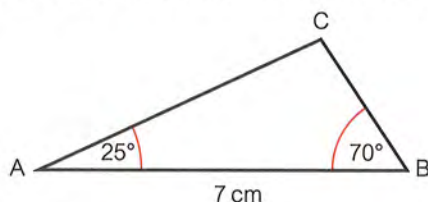
Guided



Worked example



☐ 12 Use a ruler and protractor to draw this triangle accurately.



Worked example



☐ 13 Here is a sketch of Jack's kite.

a On a scale drawing of the kite, where 1 cm represents 10 cm, how long is

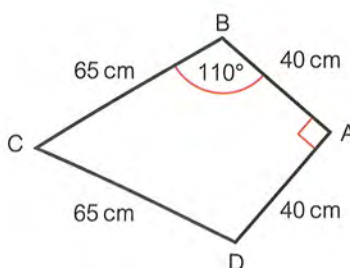
i 40 cm

ii 65 cm?

b Make an accurate scale drawing of the kite using a ruler and protractor.

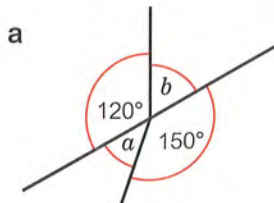
c Measure the diagonal BD.

d Work out the real distance BD.

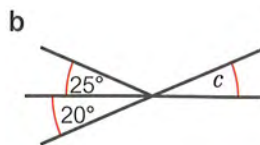


Use a double number line.
Scale drawing
1 cm 2 cm
10 cm 20 cm 40 cm
Real distance

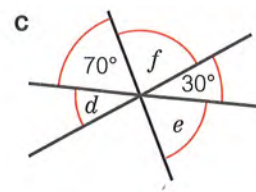
- 1 Work out the angles marked with letters. Give reasons for your answers.



.....
.....



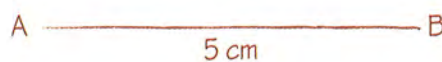
.....



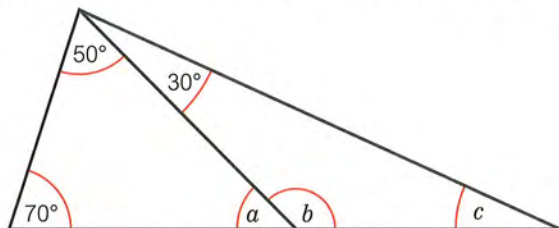
.....
.....
.....

- 2 Accurately draw triangle ABC with $AB = 5\text{ cm}$, $AC = 4\text{ cm}$ and angle $CAB = 150^\circ$.

Guided



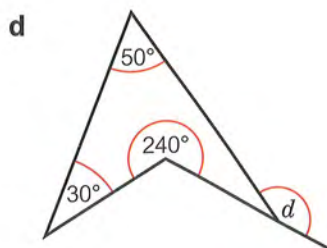
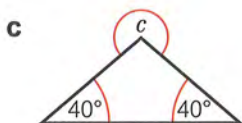
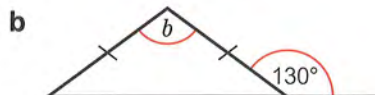
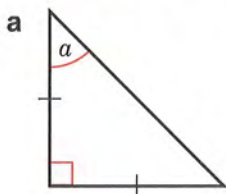
- 3 Work out the size of each unknown angle.



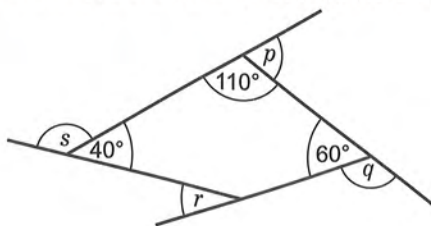
Strategy hint

Write on the angles as you work them out.

- 4 Work out the size of each unknown angle.



- 5 Work out the sum of the exterior angles shown on this diagram.



- 6 A swimmer is 100 m from the base of a 30 m high rock face.

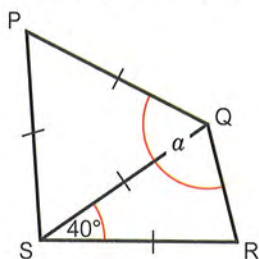
- a Accurately draw a triangle to represent this.
b At what angle does the swimmer look up to see the top of the rock face?°



Use a vertical line to represent the cliff.

- 7 Work out the angle marked a .

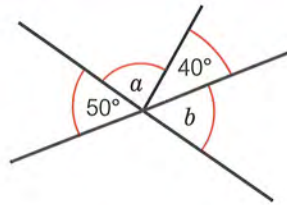
Give a reason for each stage of your working.



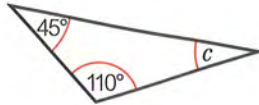
- 8 Which of these quadrilaterals have diagonals that bisect each other at right angles?

Square	Rectangle	Parallelogram	Rhombus	Kite	Arrowhead	Trapezium	Isosceles trapezium

- 1 Work out the angles marked with letters.
Give a reason for each answer.



- 2 Work out angle c .

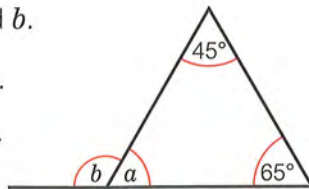


- 3 Sheila measured the angles in a triangle. She said, 'The angles are 70° , 20° and 80° .'
Is she correct? Explain.

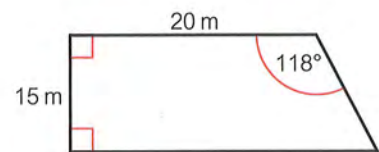
- 4 Work out the sizes of angles a and b .

$a =$

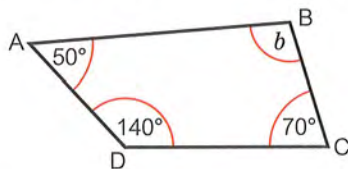
$b =$



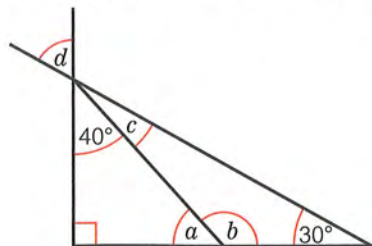
- 5 Use a ruler and protractor to draw a plan of this garden.
Use a scale of 1 cm to 5 m.



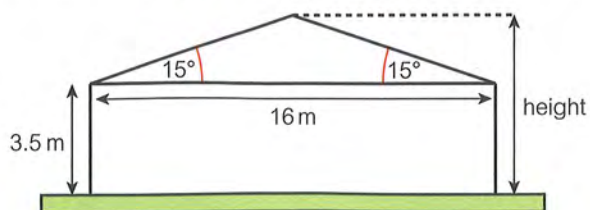
- 6 ABCD is a quadrilateral. Work out the size of angle b .



- 7 Work out the sizes of angles a , b , c and d .



- 8 A farm building has a roof with a triangular cross-section.



Make a scale diagram of the roof and work out the height of the farm building.
Use a scale of 1 cm to 2 m.

1 Write these numbers in the place value table. The first one has been done for you.

a 3 260 000

b 14 075 800

c 2 130 473 000

d 3 200 510 600

Guided

Billions	Millions			Thousands				Hundreds	Tens	Ones
			3	2	6	0		0	0	0

2 Write down in words the value of the digit 2 in each of these numbers.

a 342 465 910

b 47 526 431

c 1 825 100 550

.....

.....

.....

3 **Real** In 2019 the population of the UK was estimated to be 68 million to the nearest million.

What is the smallest possible value of the population?

4 a What number is exactly half-way between 4.2 and 4.3?

b Alex needs to round the number 4.2635 to 1 decimal place.

Complete the number line for Alex. Draw an arrow to show the approximate position of 4.2635. Then round the number to 1 decimal place.



5 Round each of these numbers to 1 decimal place.

a 14.719

b 321.852

c 8.183

d 95.349

.....

.....

.....

.....



6 Work out

a $47.1 \times 2.43 - 0.362$

b $\frac{\sqrt{75}}{3.2^2}$

Remember the priority of operations.

c $6.4^3 - \sqrt[3]{37}$

Give your answers to 1 decimal place.

.....

.....

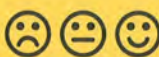
.....

7 **Real / Problem-solving** A car travels 425.2 km to 1 decimal place.

What is the smallest number of km that the car has travelled?

Check

Tick each box as your confidence in this topic improves.



Need extra help? Go to page 58 and tick the boxes next to Q2 and 3. Then try them once you've finished 6.1–6.7.

- 1 Write these **decimals** in order from smallest to largest.

2.6, 2.39, 2.08

Guided

H	T	U	•	$\frac{1}{10}$	$\frac{1}{100}$	$\frac{1}{1000}$
		2	•	6	0	
		2	•	3	9	
		2	•	0	8	

On a place value table, the numbers look like this. Write a **zero place holder** when ordering decimals with different numbers of decimal places.

Digits after the decimal point are fractions.

$$0.1 = \frac{1}{10}$$

$$0.01 = \frac{1}{100}$$

$$0.001 = \frac{1}{1000}$$

2.08,,

The units are all 2.

$\frac{8}{100}$ is the smallest fraction and $\frac{60}{100}$ is the largest.

- 2 Write these decimals in order from smallest to largest.

a 0.1, 0.001, 0.01

0.100, 0.001, 0.010

0.001,,

Write as decimals with the same number of decimal places.

b 0.05, 0.5, 0.005

- 3 **Reasoning** Ludger says, '1.4 is smaller than 1.25 because 4 is smaller than 25.' Is Ludger correct? Explain.



Ascending means increasing in value from low to high.

- 4 Write these decimals in ascending order.

a 0.515, 0.55, 0.509

b 25.7635, 25.8, 25.81, 25.764

c -0.805, -0.884, -0.8, -0.85, -0.88

d -1.95, -1.991, -1.97, -1.907, -1.99

- 5 Write these decimals in descending order.

a 9.4516, 9.47, 9.4106, 9.416, 9.446

b 77.339, 77.3933, 77.933, 77.9, 77.39

c -5.2, -5.02, -5.145, -5.323

d -6.66, -6.63, -6.663, -6.603, -6.636

Descending means decreasing in value from large to small.

- 6 **STEM** The bulletproof glass in a car needs to measure between 5.795 cm and 5.805 cm in thickness. The thicknesses of five sheets of glass are A 5.85 cm, B 5.79 cm, C 5.797 cm, D 5.8 cm, E 5.7955 cm

Which of these sheets are acceptable?

- 7 Write < or > between each pair of numbers.

a 7.3 7.7

b 4.2 4.17

c 42.106 42.007

d -0.7 -0.64

e -4.05 -4.044

f -5.1 -6.11

Check

Tick each box as your confidence in this topic improves.



Need extra help? Go to page 58 and tick the boxes next to Q1. Then try it once you've finished 6.1–6.7.

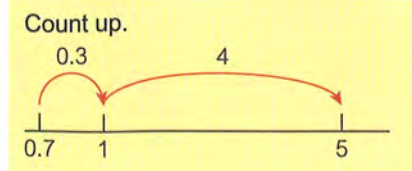
1 Work out

a $5 - 0.7$

c $10 - 4.56$

b $8 - 0.2$

d $100 - 9.99$



2 Work out

a $4.652 + 1.73$

b $6.081 + 4.8$

c $5.206 + 0.14$

3 **Reasoning** Jin says, ' $12.25 + 7.3 = 19.28$, because $12 + 7 = 19$ and $25 + 3 = 28$.' Explain why Jin is wrong.

Worked example



Estimate by rounding the values to the nearest whole number to do the calculation.

4 Work out these. Use an **estimate** to check your answers.

a $7.84 - 3.41$

b $33.33 - 8.8$

5 **Real / Problem-solving / Finance** Andy orders:

How much change does Andy get from £20?

Use an estimate to check your answer.

Pizza	£7.95
Apple pie	£3.99
Spring water	£1.55

6 **Real** Karen has a 4.25 m length of tubing. She saws off a piece 2.87 m long. How long is the remaining tubing?

7 Use the column method to work these out.

a $9.34 + 2.8 - 5.214$

b $4.752 + 5.578 - 8.263$

$$\begin{array}{r} 9.34 \\ + 2.8 \\ \hline 12.14 \end{array}$$

$$\begin{array}{r} 12.140 \\ - 5.214 \\ \hline \end{array}$$

Line up the ones, tenths, hundredths and thousandths.

Check: $9.34 \approx 9$, $2.8 \approx 3$, $5.21 \approx 5$, $9 + 3 - 5 = 7$

You can use a zero place holder when subtracting decimals with different numbers of decimal places.

8 A tree is 2.4 m tall.

Each year it grows 0.305 m.

How tall will it be in 3 years' time?

Check

Tick each box as your **confidence** in this topic improves.



Need extra help? Go to page 58 and tick the boxes next to Q4–6. Then try them once you've finished 6.1–6.7.

1 Work out

- a 5×9 b 5×0.9 c 0.5×9
 d 5×0.09 e 50×0.9 f 0.05×0.09



Your answer will have the digits 4 and 5. Where do you put the decimal point?

2 Use the multiplication facts given to work out the answers.

- a $51 \times 10 = 510$ Work out i 51×0.1 ii $51 \div 10$
 b $87 \times 10 = 870$ Work out i 87×0.1 ii $87 \div 10$

3 a Work out

- i 63×1 ii 63×0.1 iii 63×0.01

b **Reasoning** What division calculation is equivalent to $\times 0.01$?

4 Use the column method to work these out. Use an estimate to check your answers.

a 2.8×9

b 4.15×8

Estimate: $2.8 \approx 3$, $3 \times 9 = 27$

$$\begin{array}{r} 28 \\ \times 9 \\ \hline 252 \\ 7 \end{array}$$

$$2.8 \times 9 = 25.2$$

Ignore the decimal point and work out 28×9

Use your estimate to see where to put the decimal point.

You can use the column method to multiply a decimal by a whole number.

Worked example



5 **Real / Finance** It costs £2.25 to post a package. How much does it cost to post 7 packages?

6 Work out

a 6×3.5
 $\div 2$ 3×7 $\times 2$

b 16×1.5

c 24×4.5

d 20×11.5

You can use a doubling and halving method to work out the answers to some multiplications involving 0.5.

7 **Real / Finance** Ahmed changes £50 to dollars. The exchange rate is £1 = \$1.30. How many dollars does he get?

$$\begin{array}{l} \text{£1} = \$1.30 \\ \times 10 \quad \text{£10} = \$ \square \quad \times 10 \\ \times \square \quad \text{£50} = \$ \square \quad \times \square \end{array}$$

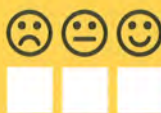
How many digits are there after the decimal point in both numbers in the question?

8 Use the fact that $0.47 \times 2.8 = 1.316$ to calculate

- a 0.047×2.8 b 4.7×28 c 470×0.028
 d Write down two other multiplications that will have an answer of 1.316.

Check

Tick each box as your confidence in this topic improves.



Need extra help? Go to pages 58 and 59 and tick the boxes next to Q7–10. Then try them once you've finished 6.1–6.7.

Guided

1 Work out

a $64.2 \div 3$

$$\begin{array}{r} 21.4 \\ 3 \overline{)64.2} \end{array}$$

$64.2 \div 3 = 21.4$

b $75.5 \div 5$

c $86.8 \div 7$

First write the decimal point for the answer above the decimal point in the question. Then divide as normal, starting from the left.

You can use short or long division to divide a decimal by a whole number.

2 Work out

a $36.24 \div 4$

b $112.32 \div 6$

c $43.145 \div 5$

3 Work out

a $4.361 \div 7$

b $8.47 \div 5$

c $22.59 \div 6$

$$\begin{array}{r} 0.6 \square \square \square \\ 7 \overline{)4.4316} \end{array}$$

4 **Real / Reasoning** Four friends go out for a meal. The total bill is £70.16. They decide to share the bill equally. How much does each friend pay?

5 **Reasoning** $0.73 \times 9 = 6.57$

Use this fact to work out

a 0.073×9

b 7.3×9

c $6.57 \div 9$

d $6.57 \div 0.73$

.....

.....

.....

.....

6 **Reasoning** $0.246 \times 7 = 1.722$

Use this fact to write down two different division calculations using the same numbers.

7 Work out the decimal answers for these calculations.

Round your answers to 1 decimal place.

a $1 \div 7$

b $2 \div 9$

c $5 \div 6$

d $\frac{2}{3}$

$$\begin{array}{r} 0.1 \square \square \square \\ 7 \overline{)1.1000} \end{array}$$

You need to work out the second decimal place to be able to round to 1 decimal place.

8 **Real / Reasoning** The total length of 6 pieces of identical fencing is 54.86m. Work out the length of 1 piece of fencing to 1 decimal place.

Check

Tick each box as your **confidence** in this topic improves.



☐ ☐ ☐

Need extra help? Go to page 59 and tick the box next to Q11. Then try it once you've finished 6.1–6.7.

- 1 Complete the table by finding the missing fractions, decimals or percentages.

Fraction					$\frac{3}{4}$	$\frac{4}{5}$		
Decimal	0.5			0.1			1.9	
Percentage		25%	20%					250%



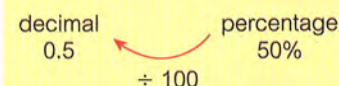
- 2 Convert these decimals to percentages.

a 0.22 b 0.03 c 4.04



- 3 Convert these percentages to decimals.

a 17% b 345% c 3.8%



- 4 Write these decimals as fractions. Simplify the fractions where possible.

a $0.4 = \frac{4}{10} = \frac{\square}{\square}$ b $0.44 = \frac{44}{100} = \frac{\square}{\square}$ c 1.35

Guided

- 5 Put these quantities in ascending order.

$\frac{2}{3}$ 66% 0.65 6.75% 0.608

Strategy hint

Convert all the values to decimals first.

Worked example



- 6 Convert these percentages to fractions. Give your answer in its simplest form.

a 17% b 2% c 85%

- 7 Write each time as a fraction of an hour in its simplest form.

a 45 minutes b 24 minutes c 36 minutes

Remember 1 hour = 60 minutes

- 8 a These are Faisal's test results at the end of term.

Write each result as a percentage.

i Maths: 18 out of 25 ii ICT: 40 out of 50 iii English: 12 out of 20

b In which subject did Faisal achieve the highest mark?

- 9 **Problem-solving / Reasoning** A shop has three different sale offers.

$\frac{1}{4}$ off

20% off

$\frac{2}{3}$ off

Which is the largest reduction?

Check

Tick each box as your confidence in this topic improves.



Need extra help? Go to page 59 and tick the boxes next to Q12, 13 and 16. Then try them once you've finished 6.1–6.7.

Guided

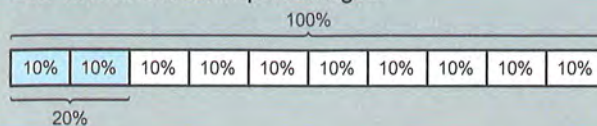
1 Work out

- a 10% of 40g $40 \div \dots = \dots$ g
 b 10% of 450m $\dots$
 c 20% of £60 $10\% = 60 \div 10 = \pounds \dots$
 $20\% = 2 \times \dots = \pounds \dots$
 d 90% of 30t
 e 30% of £25

Strategy hint

$$10\% = \frac{10}{100} = \frac{1}{10}$$

To find 10% of an amount, you divide by 10.
 Use 10% to find other percentages.



Write money correctly. £36 ÷ 10 = £3.60, not £3.6.

Guided

2 Work out

- a 50% of 18kg $18 \div \dots = \dots$ kg
 b 50% of £7
 c 25% of 300m
 d 25% of 6 litres

Strategy hint

50% is the same as $\frac{1}{2}$.
 25% is the same as $\frac{1}{4}$.



Guided

3 Work out these.

- a 75% of £80 $\pounds 80 \div 4 = \pounds \dots$ $\pounds \dots \times 3 = \dots$
 b 75% of £300 $\dots$

75% is the same as $\frac{3}{4}$. First find $\frac{1}{4}$ by dividing by 4, then multiply by 3 to find $\frac{3}{4}$ or 75%.

Guided

4 Work out these percentages. Use jottings to help.

- a 15% of 30ml $10\% \rightarrow 30 \div 10 = \dots$ ml, $5\% \rightarrow \dots \div 2 = \dots$ ml,
 $15\% = 10\% + 5\% = \dots + \dots = \dots$ ml
 b 35% of 60g

Strategy hint

Break down the percentages into multiples or fractions of 10%.

5 Work out

- a 1% of 260 $\dots$ b 10% of 260 $\dots$ c 42% of 260 $\dots$

How can you use your answers to parts a and b to help you?
 $42\% = 1\% \times \dots + 10\% \times \dots$

6 **Reasoning** The price of a jacket is reduced by 15% in a sale. The normal price of the jacket is £45. What is the sale price of the jacket?

7 **Reasoning** A box holds 450g of cereal. The amount of cereal for a new box is increased by 8%. How many grams of cereal are there in the new box?

Check

Tick each box as your confidence in this topic improves.

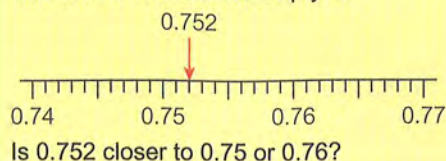


Need extra help? Go to page 59 and tick the boxes next to Q14 and 15. Then try them once you've finished 6.1–6.7.

Place value, ordering decimals and rounding

- ☐ 1 Write these numbers in order from smallest to largest.
- a 8.3, 9.5, 9.2, 8.4
- b 0.55, 0.006, 0.606, 0.055, 0.06

Use the number line to help you.



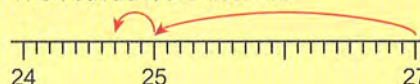
- ☐ 2 Write down in words the value of the digit **3** in each of these numbers.
- a 432756891 b 2347526401 c 3416200190

- ☐ 3 Round each number to 1 decimal place.
- a 5.809 b 15.67 c 9.015 d 23.462

Adding and subtracting decimals

- ☐ 4 Work out these. Use an estimate to check your answers.
- a $27 - 2.3 = 24$
- b $100 - 15.1$

First subtract the whole number.
Then subtract the decimal.



- ☐ 5 Work out these. Use an estimate to check your answers.
- a $6.7 + 1.43$ b $8.55 + 4.6$

Guided

$$\begin{array}{r} 6.70 \\ + 1.43 \\ \hline \end{array}$$

Write a zero
to make the
calculation easier.

When using the
column method,
always line up the
decimal points.

- ☐ 6 Work out these. Use an estimate to check your answers.
- a $3.7 - 0.22$ b $25.5 - 2.42$ c $7.3 - 0.898$

Write a zero to make
the calculation easier.

Worked
example



Multiplying and dividing decimals

- ☐ 7 Work out these multiplications. Use an estimate to check your answers.
- a 2.6×2
 $26 \times 2 = 52$, so $2.6 \times 2 =$
- b 21.5×3 c 10.13×4

Guided

Use a number pattern.

- ☐ 8 Use a mental method and the multiplication facts you know to work out
- a 8×0.3 b 70×0.2
c 0.04×6 d 30×0.06

Use a number pattern.
 $8 \times 3 = 24$, $8 \times 0.3 =$

☐ 9 Work out

Guided

a 0.5×0.5

$5 \times 5 = 25$, $5 \times 0.5 = 2.5$, $0.5 \times 0.5 = \dots\dots\dots$

b $0.04 \times 0.7 \dots\dots\dots$

c $0.08 \times 0.05 \dots\dots\dots$

☐ 10 Use multiplication facts to work out

a 18×2.5

b 12×3.5

c 42×2.3

d 24×3.6

$$\begin{array}{ccc} & 6 \times 3.5 & \\ \div 2 \swarrow & & \searrow \times 2 \\ & 3 \times 7 & \end{array}$$

$$42 \times 2.3 = (40 + 2) \times 2.3$$

$$= 40 \times 2.3 + 2 \times 2.3$$

☐ 11 Work out

a $42.3 \div 3$

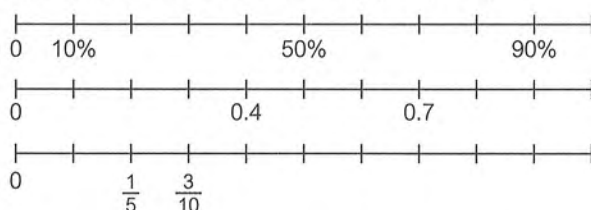
b $36.15 \div 5$

$$\begin{array}{r} 3 \overline{)423} \\ 423 \div 3 = \square \\ 42.3 \div 3 = \square \end{array}$$

Decimals, fractions and percentages

☐ 12 Complete these number lines showing percentages, decimals and fractions.

Write each fraction in its simplest form.



First complete the percentages number line, then the decimals, then the fractions. Write the fractions as tenths and simplify.

☐ 13 Which card does not have an equivalent card?

1.33

140

$\frac{2}{3}$

0.6

$\frac{14}{10}$

1.2

133.33...%

1.25

$\frac{5}{4}$

☐ 14 Work out

Guided

a 10% of 60g $60 \div 10 = \dots\dots\dots$ g

b 10% of £5 $\dots\dots\dots$

☐ 15 Work out

a 20% of 40t $\dots\dots\dots$

b 80% of \$800 $\dots\dots\dots$

c 40% of 250 ml $\dots\dots\dots$

d 70% of 70 kg $\dots\dots\dots$



To find 10% of an amount, you divide by 10. You can then use 10% to find other percentages.

☐ 16 Write these numbers in order of size, from smallest to largest.

$\frac{4}{5}$

78%

0.82

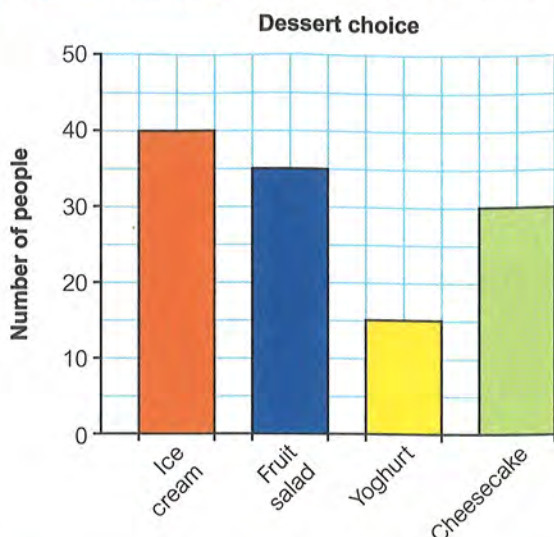
$\frac{17}{20}$

84%

0.786

$\dots\dots\dots$

- 1 Problem-solving** In a canteen each person selected one dessert.



Guided

- a** How many desserts were selected? $40 + 35 + 15 + 30 = \dots\dots\dots$
b What fraction of the people selected cheesecake?
 Write your answer in its simplest form. $\frac{30}{\square} = \frac{\square}{\square}$

- 2 Problem-solving** John rounded a number with 2 decimal places and got the answer 8.3.

- a** What is the smallest number John could have rounded up to 8.3? $\dots\dots\dots$
b What is the largest number John could have rounded down to 8.3? $\dots\dots\dots$

- 3** Billy's height was measured when he turned 12. He is now taller than 150 cm. His height has increased by 10% from when he was 12. Write a possible height for Billy when he turned 12. $\dots\dots\dots$

Try some different heights.

- 4 Problem-solving** In an experiment, two identical 1.4 m long metal bars are at room temperature. The first bar is cooled and shrinks by 1%. The second bar is heated and expands by 2%. Work out the range of the lengths of the metal bars.

- 5** $8.7 \times 43 = 374.1$

Use this number fact to work out these.

- | | |
|--|--|
| a $0.87 \times 43 \dots\dots\dots$ | b $0.87 \times 4.3 \dots\dots\dots$ |
| c $0.0087 \times 430 \dots\dots\dots$ | d $374.1 \div 43 \dots\dots\dots$ |
| e $374.1 \div 8.7 \dots\dots\dots$ | f $37.41 \div 4.3 \dots\dots\dots$ |



Check your answers using estimates.



- 6** Work out

- | | | |
|------------------------------------|--------------------------------|----------------------------------|
| a $(5.72 - 1.3) \times 0.2$ | b $8.31 - 4.6 \div 1.5$ | c $6.2 - (2.71 - 1.05)^2$ |
|------------------------------------|--------------------------------|----------------------------------|
- Give your answers to 1 decimal place.

Remember to use the priority of operations.

- 7 Finance** Majid wants to buy a new racing bike. The price is £1320. He can pay in 12 equal monthly payments.

a How much would he pay per month?

He is offered a 15% discount for paying all at once.

b How much will he save by choosing this option?

c How much will he pay if he chooses this option?

- 8** Carla says, ' $0.1 \times 0.3 \times -0.5 = -0.15$ because $1 \times 3 \times -5 = -15$.' Explain why Carla is wrong. What is the correct answer?

- 9 Finance** Rita invested £1000. She earned 3% simple interest per year.

a How much interest will Rita have after 1 year?

b How much money will Rita have altogether after 39 months?

Write 39 months in years and months. Then convert this to a decimal number of years.

- 10 Finance / Problem-solving** Jasmine invested £300. She earned simple interest over 3 years. At the end of 3 years, her investment was worth £345. It increased by the same amount every year. What interest rate did she receive?

- 11** Write these in ascending order.

5%

$\frac{4}{90}$

0.5

$\frac{5}{99}$

4.52%

$\frac{9}{200}$

- 12 Reasoning** Write $<$ or $>$ between each pair of numbers.

a i 0.5 0.2

ii -0.5 -0.2

b i -0.63 -0.45

ii 0.63 0.45

c If $x > y$, then $-x$ $-y$.



Use your answers to parts **a** and **b** to answer part **c**.

- 13** 2% of a number is 28.

a What is 10% of the number?

b What is 100% of the number?

- 1 a Work out 10% of 45.
 b Work out 1% of 45.
 c Use your answers to parts **a** and **b** to work out 33% of 45.

- 2 A roll of wallpaper is 10.5m long.
 Eva cuts off a piece that measures 2.65m.
 How long is the remaining piece?

- 3 Complete this table of fractions, decimals and percentages.
 Write all fractions in their simplest form.

Fraction	$\frac{7}{10}$				$1\frac{2}{5}$
Decimal		0.75		1.4	
Percentage			60%		

- 4 A test has a total of 20 marks. Yousef scores 16 marks.

- a Write Yousef's score as a fraction in its simplest form.
 b Write Yousef's score as a percentage.

- 5 Use the fact that $38 \times 3.03 = 115.14$ to work out

- a 3.8×3.03 b 38×303 c $115.14 \div 3.8$

- 6 Write these decimals in ascending order: 1.38, 1.08, 1.8, 1.183, 1.083

.....

- 7 Round 12.577 to 1 decimal place.

- 8 Work out

- a 4×0.8 b 0.03×70 c $0.28 \div 0.04$

- 9 The same 3D TV is on sale in two different shops.

- a What is the cost of the 3D TV at Tom's TVs?



- b What is the cost of the 3D TV at TV4U?



- 10 25% of an amount is 7.5. Work out the original amount.

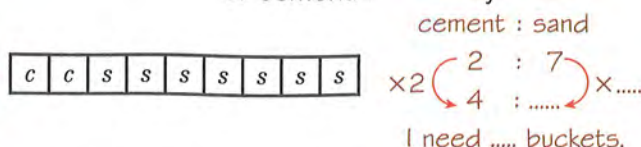
- 11 Write < or > for this pair of numbers. -8.23 -8.32

Writing ratios

- 1 **Real** To make concrete to repair a path, you mix 2 buckets of cement with 7 buckets of sand. The ratio of cement to sand is 2 : 7.

I have 4 buckets of cement. How many buckets of sand do I need?

Guided



A **ratio** is a way of comparing two or more quantities.

Find the multiplier.
Multiply each part.

- 2 Tick the ratios which are equivalent to the ratio 1 : 4.

- a 2 : 2 b 3 : 12
 c 10 : 40 d 8 : 2

The ratios 2 : 5 and 4 : 10 are called **equivalent ratios**.
Equivalent ratios show the same proportion.
Both sides of a ratio are multiplied or divided by the same number to give an equivalent ratio.

- 3 **STEM** 50 ml of vinegar reacts with 25 ml of calcium carbonate solution.

- a Write the ratio of vinegar to calcium carbonate solution.
 b How much calcium carbonate solution is needed to react with 200 ml of vinegar?
 c How much vinegar is needed to react with 75 ml of calcium carbonate solution?

- 4 Write each ratio in its **simplest form**.

- a 4 : 8 b 20 : 2 c 15 : 35

Guided

$\div 4 \left(\begin{array}{c} 4 : 8 \\ 1 : \dots \end{array} \right) \div 4$

You can make the numbers in a ratio as small as possible by **simplifying**. You simplify a ratio by dividing the numbers in the ratio by the **highest common factor**.

- 5 **Real** Sandra puts 1000 ml of petrol and 20 ml of oil into her chainsaw (mechanical saw). The recommended ratio of petrol to oil is 50 : 1. Is Sandra's ratio of petrol to oil correct?

- 6 Write each ratio in its simplest form.

- a 2 : 4 : 8
 b 10 : 20 : 15
 c 8 : 16 : 100

The highest common factor of 2, 4 and 8 is .

- 7 Simplify these ratios.

- a £5 : 70p b 2 days : 10 hours c 45 minutes : 1 hour

Guided

$\div 10 \left(\begin{array}{c} 500 : 70 \\ \dots : \dots \end{array} \right) \div 10$

Ratios in their simplest form do not have units. To simplify a ratio involving quantities, first convert the quantities to the same unit.

- 8 Write these ratios in their simplest form.

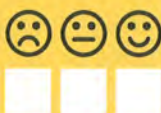
- a 3 : 3.5
 b $1 : 1\frac{1}{3}$
 c $4 : 1\frac{1}{5}$

$\times 2 \left(\begin{array}{c} 3 : 3.5 \\ 6 : \dots \end{array} \right) \times 2$

For a ratio with fractions or decimals, first multiply both sides of the ratio to get whole numbers.

Check

Tick each box as your **confidence** in this topic improves.



Need extra help? Go to page 68 and tick the boxes next to Q1–4. Then try them once you've finished 7.1–7.5.

Sharing in a given ratio

1 Share these amounts in the ratios given. Show how you check your answers.

Guided

a £40 in the ratio 1 : 4

$$1 + 4 = 5 \text{ parts}$$

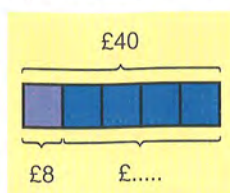
$$5 \text{ parts} = £40$$

$$1 \text{ part} = £40 \div 5 = £8$$

$$4 \text{ parts} = £8 \times 4 = £ \dots\dots\dots$$

$$£8 : £ \dots\dots\dots$$

$$\text{Check: } 8 + \dots\dots\dots = 40$$



Check your answer
by adding the parts.

b £21 in the ratio 3 : 4

c \$88 in the ratio 3 : 8

d \$100 in the ratio 7 : 3

2 Akram and Zainab share \$150 in the ratio 2 : 3.
How much does each person receive?

3 **Problem-solving** Mrs Jones has a body fat to body mass ratio of 1 : 3.
Mrs Jones has a body mass of 60 kg.
Mr Jones has a body fat to body mass ratio of 1 : 4.
Mr Jones has a body mass of 80 kg.
Who has the greater mass of body fat?

Check

Tick each box as your
confidence in this
topic improves.



Need extra help? Go to page 68 and tick
the box next to Q5. Then try it once you've
finished 7.1–7.5.

- 1 Gerry has collected 10 autographs. 6 of them are from footballers, the rest are from rugby players.

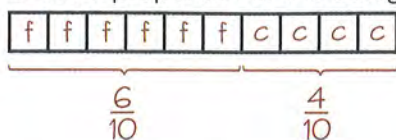
Guided

- a Write the ratio of footballers to rugby players in its simplest form.

football : rugby
 $\div 2 \quad \begin{array}{c} 6 : 4 \\ \swarrow \quad \searrow \\ 3 : \dots \end{array} \quad \div 2$

A ratio compares a part with a part.
 A proportion compares a part with the whole.
 Proportions can be written as fractions or percentages.

- b What proportion of the autographs are from footballers?



Write your answer as i a fraction ii a percentage

- 2 **Real** In the 2006 Commonwealth Games, India won gold, silver and bronze medals in the ratio 22 : 17 : 11.

- a What proportion of the medals were gold?

- b What proportion of the medals were bronze?

Write your answers as a fraction and as a percentage.

- 3 **Real / Problem-solving** Basketball player A scored 145 points in 5 professional games. Basketball player B scored 280 points in 10 professional games. Who has the better points to games ratio?

- 4 **Problem-solving** John and Gill make green paint.

The ratio of blue to yellow in John's green is 3 : 7.

The ratio of blue to yellow in Gill's green is 2 : 3.

Use proportions to explain whose green has more yellow in it.



Write the proportions as fractions.

- 5 **Real** Akiva divides his earnings like this:

65% for rent/household bills, 25% for food/car/fun, 10% for savings.

Write the ratio of rent/household to food/car/fun to savings, in its simplest form.

- 6 **Real** Approximately $\frac{3}{5}$ of an adult male's body mass is water and $\frac{2}{5}$ is other chemicals. Write this as a ratio.

Check

Tick each box as your confidence in this topic improves.

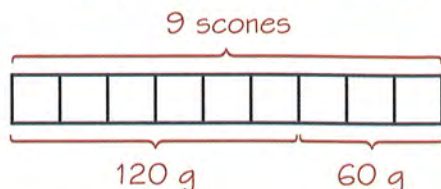
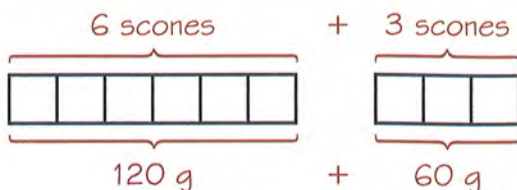


Need extra help? Go to pages 68 and 69 and tick the boxes next to Q6–8. Then try them once you've finished 7.1–7.5.

- 1 Yanto uses 120 g of raisins to make 6 scones.
What quantity of raisins would he need to make 9 scones?

Guided

$$6 \text{ scones} + 3 \text{ scones} = 9 \text{ scones}$$



$$120 \text{ g} + \dots \text{ g} = \dots \text{ g}$$



When two quantities are in **direct proportion**, as one increases or decreases, the other increases or decreases in the same ratio.

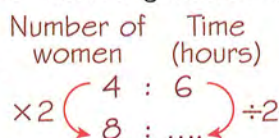
- 2 Two kilograms of bananas cost £1.20. Work out the cost of
- a 4 kg b 6 kg c 1 kg d 5 kg

- 3 **Problem-solving** To make 100 kg of waterproof concrete, Juan mixes 1 bag of cement, 10 buckets of sand and 2 litres of waterproofer.
Juan needs 350 kg of waterproof concrete. He has 4 bags of cement, 30 buckets of sand and 11 litres of waterproofer. Does he have enough of the materials?

Show your working.
Write a sentence to answer the question.

- 4 **Real / Problem-solving** 4 women dig a vegetable plot in 6 hours.

- a How long would it take 8 women to dig it?



- b How long would it take 1 woman to dig it?

When two quantities are in **inverse proportion**, as one increases, the other decreases in the same ratio.

The fewer people there are, the more time it takes. Dividing the number of people by 4 means you have to multiply the time by $\square$.

- 5 **Problem-solving** It takes 100 minutes to drive home at 30 mph.

- a How long will it take to drive home at a speed of
- i 60 mph ii 15 mph iii 50 mph?

- b What speed is needed to drive home in 1 hour?

Check

Tick each box as your **confidence** in this topic improves.



Need extra help? Go to page 69 and tick the boxes next to Q9, 12 and 13. Then try them once you've finished 7.1–7.5.

Using the unitary method

- 1 3 pineapples cost £3.60.

a Work out the cost of

i 1 pineapple

ii 4 pineapples.

Guided

pineapples	cost
3	£3.60
÷ 3	1 : £.....

÷ 3

- b How many pineapples can you buy for £7.20?

- 2 5 ice creams cost £6.50.

How much do 11 ice creams cost?



Work out the cost of 1 ice cream first.

- 3 **Problem-solving** Tim earns £42 for 7 hours' work.

a Tim works for 16 hours. How much does he earn?

Find how much he gets paid for 1 hour first.

- b Tim earns 'time and a half' for overtime. He works 4 hours of overtime in addition to his normal 16 hours. How much does he earn altogether?

'Time and a half' means one and a half times as much as normal pay.

- 4 **Finance / Real / Problem-solving** A supermarket sells kiwi fruit at £1.50 for a 6-pack and £2.25 for a 10-pack. Which pack is better value for money?

Work out how much it costs to buy 1 kiwi fruit first and then compare.

- 5 **Real / Problem-solving** Ali's car can travel 225 miles on 25 litres of petrol. Ben's car can travel 160 miles on 20 litres of petrol. Whose car is more economical?

Literacy hint

'Economical' means cheaper.

- 6 **Real** Here are some multipacks of cola cans. Each can is the same brand and contains the same size can.



a Work out the price of each can from the

i small multipack

ii medium multipack

iii large multipack.

b Which is best value for money? Explain your answer.

Check

Tick each box as your confidence in this topic improves.



☐ ☐ ☐

Need extra help? Go to page 69 and tick the boxes next to Q10 and 11. Then try them once you've finished 7.1–7.5.

Ratio

- ☐ 1 In a bag of marbles there are 3 red marbles for every 2 white marbles.
Write the number of red marbles to the number of white marbles as a ratio.

- ☐ 2 For each bar write down the ratio of blue to red.
Give your answers in their simplest form.



- c Explain why the two ratios are equivalent.

- ☐ 3 Write each ratio in its simplest form.

Guided

a $3 : 15$

$\div 3 \quad 3 : 15 \quad \div 3$
 $\dots : \dots$

3 is the largest number you can divide both 3 and 15 by.

b $2 : 22$

Worked example



- ☐ 4 Write each ratio in its simplest form.

Guided

a $0.1 : 0.3$

$\times 10 \quad 0.1 : 0.3 \quad \times 10$
 $1 : \dots$

b $0.2 : 0.6$

c $0.4 : 0.8$

Multiply by 10 to get whole numbers, then simplify if needed.

d $\frac{1}{5} : \frac{4}{5}$

$\times 5 \quad \frac{1}{5} : \frac{4}{5} \quad \times 5$
 $\dots : \dots$

e $\frac{2}{7} : \frac{3}{7}$

f $\frac{2}{8} : \frac{6}{8}$

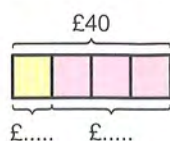
Multiply by the denominator to get whole numbers, then simplify if needed.

- ☐ 5 Share these amounts in the ratio given.

a £40 in the ratio $1 : 3$

b £35 in the ratio $4 : 1$

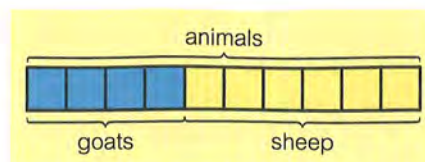
c £56 in the ratio $3 : 4$



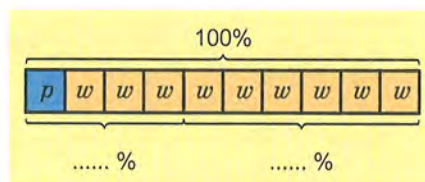
- ☐ 6 The ratio of lentils to tomatoes used in a recipe is $1 : 8$.
25 grams of lentils are used. How many grams of tomatoes are used?

Direct and inverse proportion

- ☐ 7 There are 4 goats and 6 sheep in a barn.
- Guided**
- a How many animals are in the barn? $4 + 6 = 10$
- b What proportion of the animals are goats? $\frac{4}{10}$
- c Write the fraction in part b in its simplest form.
- d What proportion of the animals are sheep?
Write your answer as a percentage.



- ☐ 8 **Reasoning** In a surfing competition, Jo has a ratio of perfect-score runs to wipeouts (falls) of 1 : 9.
- a What percentage of Jo's runs are perfect?
- Ben has a perfect-score run to wipeout ratio of 3 : 2.
- b What percentage of Ben's runs are perfect?
- c Who would probably win in a surfing competition between Ben and Jo?



- ☐ 9 4 pizzas cost £20. Work out the cost of
- a 1 pizza
- b 5 pizzas
- c 11 pizzas.
- ☐ 10 In shop A, 20 pens cost £4.80. In shop B, 30 pens cost £7.50.
- a How much does one pen cost in shop A?
- b How much does one pen cost in shop B?
- c Which shop offers better value for money?



- ☐ 11 Kamilah has two cars.
- The red car travels 40 km on 4 litres of fuel.
- The blue car travels 60 km on 5 litres of fuel.
- a For each car, write a ratio to show the number of km to litres.
- b Express each ratio as litres to km in the form $n : 1$
- c Which car is more economical to run?

Literacy hint

'Economical' means cheaper.

- ☐ 12 It takes one student 12 hours to build a go-cart (small, low car). How long will it take
- a 2 students
- b 3 students?

Guided

students hours

$$\begin{array}{rcl} \times 2 & \begin{array}{c} 1 \\ 2 \end{array} & : \begin{array}{c} 12 \\ \dots \end{array} \\ & \curvearrowright & \curvearrowright \end{array} \div 2$$

Multiply and divide by the same number.

- ☐ 13 It takes 10 students 4 hours to build a tree platform. How long does it take
- a 5 students
- b 20 students
- c 1 student?

- 1 Problem-solving** Allen is 10 years old. Haley is 2 years older than Allen and 4 years younger than Tony. Write the ratio of Haley's age to Tony's age in its simplest form.

- 2 Problem-solving** In a class there are 10 boys with blue eyes. There are 5 more boys with brown eyes than boys with blue eyes.
What proportion of the class are boys with brown eyes? Write your answer as a fraction and as a percentage.

- 3** The table shows the numbers of matches two hockey teams win, lose and draw in a season.

Team	Win	Lose	Draw
A	5	3	2
B	6	3	0

- a** Write the proportion of matches lost by each team as a percentage.
b Which team loses the higher proportion of matches?

- 4 STEM / Problem-solving** 2kg of bronze is made from approximately 1.8kg of copper and 200g of tin.

1 kg = 1000g

- a** Write this ratio in its simplest form.
b A small bronze statue contains 100g of copper.
How much does the statue weigh?
- 5** Two divers took part in a funded river clean-up to raise money for charity.
Neal picked up three times as much litter as Zander.
- a** Write the ratio of litter picked up by Neal and Zander.
b Altogether they picked up 80 kg of litter. How much did each person pick up?

- 6 Problem-solving** A chef chops potatoes and carrots in the ratio 2 : 1.
She chops 60 potatoes altogether.
How many carrots does she chop?

- 7 Problem-solving** Some people are watching a film in a cinema.
 $\frac{2}{5}$ are female adults, $\frac{1}{5}$ are male adults and the rest are children.

- a** Write the ratio of female adults to male adults to children in its simplest form.

60 children are watching the film.

- b** How many people are watching the film in total?

- 8 Problem-solving / Reasoning** A can holds 330 ml of drink.

A supermarket has two deals:

6 × 330 ml cans for £2.90 and 10 × 330 ml cans for £4.75.

Guided

- a** Work out how much 1 can costs in each deal.

£2.90 ÷ 6 = 290p ÷ 6 = each; £4.75 ÷ 10 = each

- b** Which deal is the better value for money?

Worked
example



- 9 Finance / Problem-solving** Each week Fran spends $\frac{1}{2}$ of her pocket money on music downloads and $\frac{1}{6}$ on judo lessons. She saves the rest.

Write the ratio of her spending on music downloads to judo to saving, in its simplest form.

Work out the fraction of her pocket money she saves.

- 10 Problem-solving** In a health food shop, $\frac{1}{4}$ of the chocolate bars are dairy-free. Write the ratio of dairy to dairy-free chocolate bars, in its simplest form.

Work out the fraction of bars that are not dairy-free first.

- 11 Problem-solving** Each month Dom spends 15% of his paper round wages on music downloads and he saves the rest.

- a** Write the ratio of his spending on music downloads to saving, in its simplest form.

- b** One week he spends £9 on music downloads. How much does he save?



Work out the percentage of pocket money he saves.

- 12 STEM** The table gives the power (in horse power) and mass (in tonnes) of two cars.

Car	Mass, m (t)	Power, p (hp)	Mass : power
A	1.1	880	
B	1.25	155	

Write the ratio of mass to power for each car in its simplest form.

- 13 Problem-solving** It takes 16 artists 30 hours to paint a mural.

- a** How long would it take 4 artists?

- b** How many artists are needed to paint the mural in 40 hours?

- 1 Write the ratio 12 : 16 in its simplest form.
- 2 Share £30 in the ratio 2 : 3.
- 3 Write each ratio in its simplest form.
 - a 15 : 20 : 30
 - b 1 day : 10 hours
 - c £4.50 : 90p
- 4 The ratio of red flower bulbs to yellow flower bulbs in a box is 5 : 4.
There are 20 yellow flower bulbs in the box. How many red flower bulbs are there?
- 5 In a garden, the ratio of vegetables to flowers is 1 : 4. Write this ratio as
 - a a fraction
 - b a percentage.
- 6 4 sandwiches cost £10. Work out the cost of 3 sandwiches.

- 7 A shop sells doughnuts.
The shop has 3 different deals on doughnuts.
Which offer is the best value for money?
.....



- 8 Write the ratio 0.6 : 0.9 in its simplest form.
- 9 One month Jack spent $\frac{1}{3}$ of his money allowance on clothes and saved the rest.
Write the amount of money he spent on clothes and savings as a ratio in its simplest form.
- 10 A forester wants 35% of her trees to be deciduous and the rest to be evergreen.
 - a Work out what percentage of trees will be evergreen.
 - b She has 140 deciduous trees.
How many evergreen trees does she need to plant?
- 11 It takes 4 students 8 hours to build a robot.
 - a How long does it take
 - i 2 students
 - ii 8 students?
 - b How many students are needed to build the robot in 1 hour?

Guided

1 Complete the metric unit conversions.

- a 3 cm to mm $3 \text{ cm} = 3 \times \dots = \dots \text{ mm}$
 b 400 cm to m $400 \text{ cm} = 400 \div \dots = \dots \text{ m}$
 c 70 000 m to km $70\,000 \text{ m} = \dots \div \dots = \dots \text{ km}$
 d 8 m to mm $8 \text{ m} = \dots = \dots \text{ mm}$

Metric units of length include these relationships:
 $10 \text{ mm} = 1 \text{ cm}$
 $100 \text{ cm} = 1 \text{ m}$
 $1000 \text{ mm} = 1 \text{ m}$
 $1000 \text{ m} = 1 \text{ km}$
 Use 10, 100 or 1000 to work out each conversion.

Guided

2 Complete the metric unit conversions.

- a 3.5 km to m $3.5 \text{ km} = 3.5 \times \dots = \dots \text{ m}$
 b 450 m to km $450 \text{ m} = 450 \div \dots = \dots \text{ km}$
 c 55 mm to cm $55 \text{ mm} = \dots = \dots \text{ cm}$
 d 0.65 m to cm $0.65 \text{ m} = \dots = \dots \text{ cm}$

3 **Modelling** An average baby boy is 50 cm long at birth.

This table shows the average boy's increase in height over the first 4 years.

End of year	Increase in height (cm)
1	24
2	13
3	8
4	7

- a Work out the mean increase in height over the first 4 years.
 b Use your mean increase in height to estimate the height of an average boy at the end of the 5th year.
 Give your answer in metres. $\dots \text{ m}$
 c Is the model used in part b a good model? Explain your answer.



4 Complete the metric unit conversions.

- a 3 kg to g $\dots$
 b 4000 ml to litres $\dots$

Metric units of mass are the gram (g) and the kilogram (kg).
 $1000 \text{ g} = 1 \text{ kg}$
 Metric units of capacity include the millilitre (ml) and the litre.
 $1000 \text{ ml} = 1 \text{ litre}$

5 **Problem-solving** Here is a list of measures.

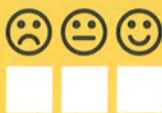
2.5 m, 3000 mm, 200 cm, 3.5 m

- a Put the measures in order of length, from shortest to longest.
 $\dots$
 b Write down the median measure. $\dots$
 c For the mode to be 2 m, what measure, in mm, needs to be added to the list? $\dots$

6 **Problem-solving** Gerry buys a 1 kg bag of sugar. On the side of the pack it says, 'Enough for 200 teaspoons of sugar.' Approximately how much sugar is in one teaspoon?
 $\dots$

Check

Tick each box as your confidence in this topic improves.

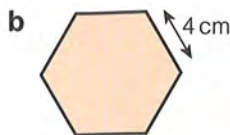


Need extra help? Go to page 77 and tick the boxes next to Q1–3. Then try them once you've finished 8.1–8.4.

- 1 Calculate the perimeter of each regular polygon using the given side lengths.



Perimeter = $8 \times \dots = \dots \text{ cm}$



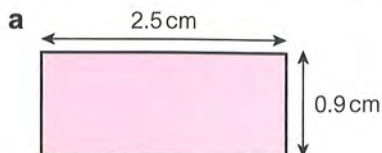
Perimeter = $4 \times \dots = \dots \text{ cm}$

The **perimeter** is the total distance around the edge of a shape. To work out the perimeter of a shape, add up the lengths of all the sides.

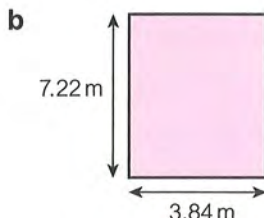
Literacy hint

A regular polygon is a straight-sided closed shape with all sides and all angles equal.

- 2 Calculate the perimeter of each rectangle.



.....



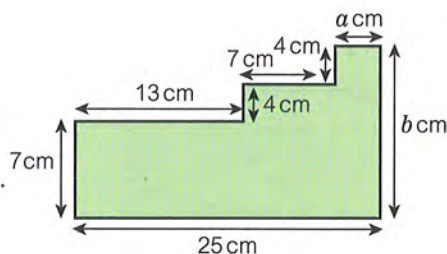
.....

- 3 Work out the perimeter of this shape.

$a = 25 - 13 - \dots = \dots \text{ cm}$

$b = 7 + 4 + \dots = \dots \text{ cm}$

Perimeter = $25 + 7 + 13 + 4 + \dots$
 $+ \dots + \dots + \dots = \dots \text{ cm}$



Work out the two missing lengths. Write them on the diagram

- 4 **Problem-solving** A rectangle measuring 10 cm by 6 cm has a smaller rectangle measuring 5 cm by 4 cm cut out of one corner. Work out the perimeter of the shape.

Strategy hint

Draw a diagram of the shape first

- 5 A regular octagon has a perimeter of 80 cm. What is the side length of the octagon?

$80 \div \dots = \dots \text{ cm}$

For a regular polygon
 side length = perimeter $\div$ number of sides.

- 6 **Problem-solving** A regular hexagon has side length 12 m. A rectangle has the same perimeter as the hexagon and length 14 m. Find the width of the rectangle.

.....

Check

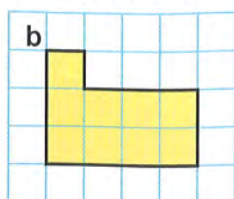
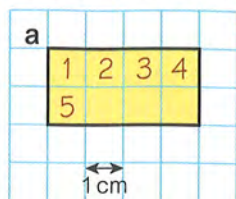
Tick each box as your confidence in this topic improves.



Need extra help? Go to pages 77 and 78 and tick the boxes next to Q4–6. Then try them once you've finished 8.1–8.4.

Guided

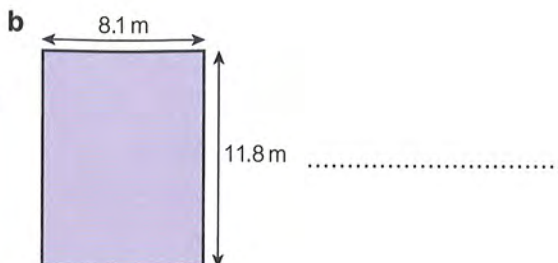
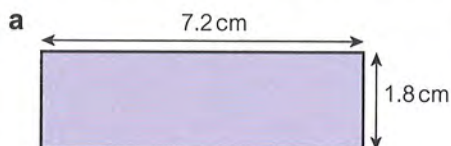
- 1 Find the area of each shape by counting squares. Give the units.



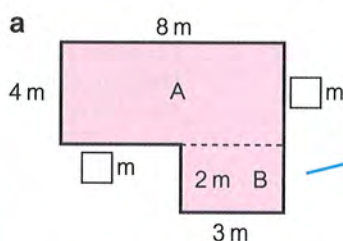
Find the area of a shape on squared paper by counting the squares inside it. Units used for area are square units, such as mm^2 , cm^2 , m^2 and km^2 . A square 1 cm by 1 cm has area 1 cm^2 .



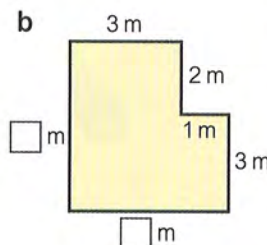
- 2 Calculate the area of each rectangle.



- 3 **Real** The diagrams show the dimensions of two rooms. Work out the area of carpet needed for each room.



Divide the shape into 2 rectangles, A and B. Work out any missing lengths.



Worked example



Guided

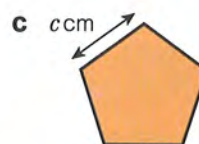
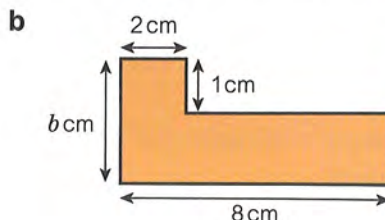
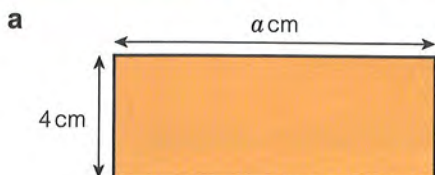
$$\text{Area A} = 8 \times 4 = 32 \text{ m}^2$$

$$\text{Area B} = \dots \times \dots = \dots \text{ m}^2$$

$$\text{Total} = 32 + \dots = \dots \text{ m}^2$$

Work out the area of A and the area of B and then add them together.

- 4 **Problem-solving** The shapes below each have a perimeter of 20 cm. Find the missing lengths.



- 5 **Problem-solving** A rectangle has a width of 5 cm and an area of 45 cm^2 . What is its perimeter?

Strategy hint

Start by drawing a sketch and working out the length of the rectangle.

Check

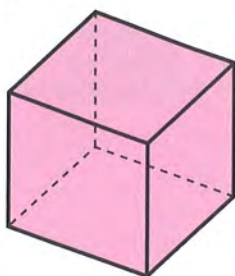
Tick each box as your confidence in this topic improves.



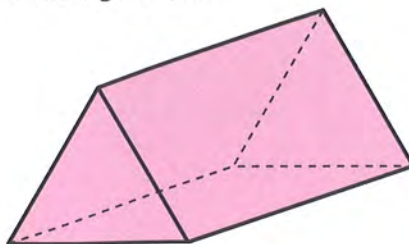
Need extra help? Go to pages 77 and 78 and tick the boxes next to Q7–8. Then try them once you've finished 8.1–8.4.

1 Write down the number of faces, edges and vertices in each solid.

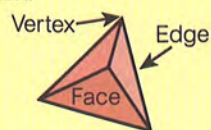
a Cube



b Triangular prism



3D solids have **faces** (flat surfaces), **edges** (where two faces meet) and **vertices** (corners). One corner is called a vertex.



Guided

faces: 6

edges:

vertices: 8

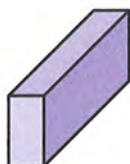
faces:

edges: 9

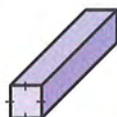
vertices:

2 For each solid, draw in a plane of symmetry.
How many planes of symmetry does each solid have?

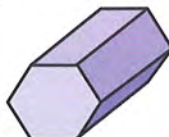
a



b

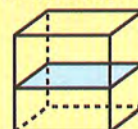


c



The end face of this prism is a regular hexagon.

A 2D shape can have lines of symmetry. A 3D solid can have planes of symmetry. On either side of the plane of symmetry the solid is identical.



A 3D solid has 4 triangular faces and 1 square face. What is the name of this solid?



4 triangles and 1 square gives 5 faces.

As it has mostly triangular faces, it must be a pyramid.

As the other face is a square, it must be a square-based pyramid.

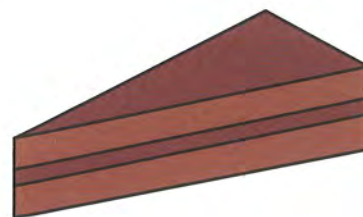
3 **Problem-solving** The faces of a 3D solid are two octagons and eight rectangles.
What is the name of this solid?

4 **Problem-solving** A solid has 9 planes of symmetry and all its faces are the same shape.
What is the name of this solid?

5 **Real** This is a piece of chocolate cake.

a How many faces, edges and vertices does it have?

b How many planes of symmetry does it have?



Check

Tick each box as your confidence in this topic improves.

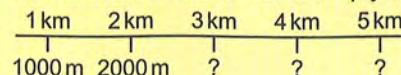


Need extra help? Go to page 78 and tick the boxes next to Q9 and 10. Then try them once you've finished 8.1–8.4.

Metric measures

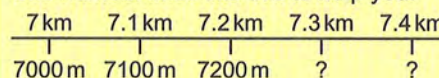
- ☐ 1 Complete these metric conversions.
- a 1 km = 1000 m, so 4 km = m
 - b 1 m = 100 cm, so 8 m = cm
 - c 1 cm = mm, so 5 cm = mm
 - d 1 litre = mL, so 6 litres = mL

Use number lines like this to help you.



- ☐ 2 Complete these metric conversions.
- a 2.2 m = cm
 - b 8750 g = kg
 - c 80 cm = m
 - d 0.5 km = m

Use number lines like this to help you.



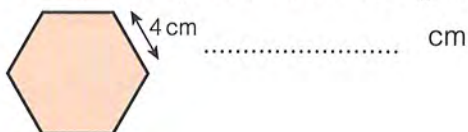
- ☐ 3 Here is a list of measures.
0.5 m, 320 mm, 1.2 m, 45 cm, 780 mm



- a Convert the measures to cm.
- b Calculate the mean.

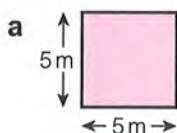
Perimeter and area

- ☐ 4 Calculate the perimeter of this regular hexagon.



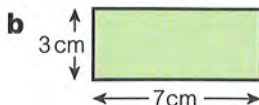
The **perimeter** is the total distance around the edge of a shape. In a regular polygon all the sides are the same length.

- ☐ 5 Work out the perimeter and area of these shapes.



perimeter = 5 + 5 + + = m

area = 5 × = m²



perimeter = =

area = =

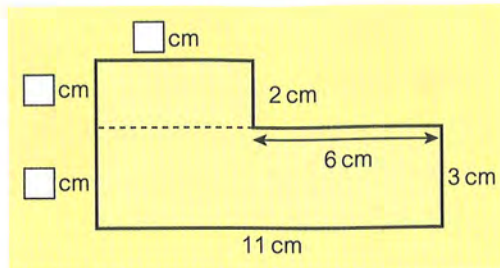
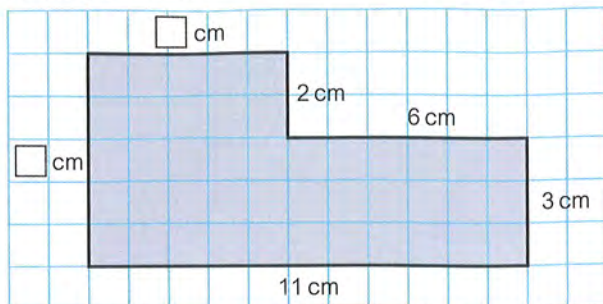
To work out the perimeter, add up the lengths of all the sides. To work out the area, multiply the length by the width.

Guided

- ☐ 6 For this shape work out

a the perimeter

b the area.

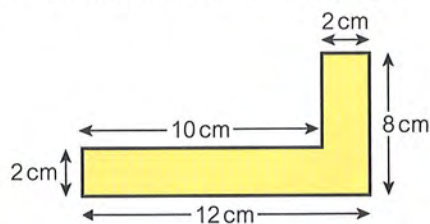


Guided

a Perimeter = $11 + 3 + 6 + 2 + \dots + \dots = \dots \text{ cm}$

b Area = $\dots \times \dots + \dots \times \dots = \dots + \dots = \dots \text{ cm}^2$

- ☐ 7 Work out the area of this shape.



Divide the shape into two rectangles and label them A and B. Work out the lengths of the missing sides.

- ☐ 8 A regular decagon has sides of length 30 cm.

a What is its perimeter?

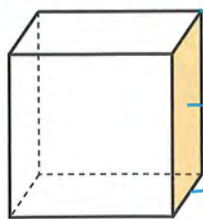
A square has the same perimeter as the decagon.

b What is the side length of the square?

3D solids

- ☐ 9 Write down the number of **faces**, **edges** and **vertices** of this cube.

Guided



A vertex is a corner.

A face is a flat surface.

An edge is where two faces meet.

number of faces =

number of edges =

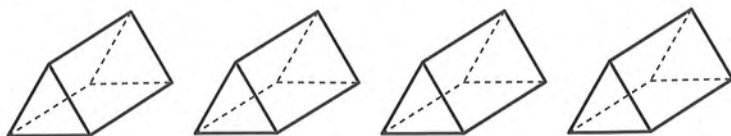
number of vertices =



A vertex is one corner; vertices are more than one corner.

- ☐ 10 In this triangular prism the cross-section is an equilateral triangle.

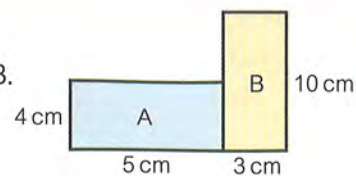
How many planes of symmetry does the prism have?



How many ways could you cut it in half? Would each half be a reflection of the other? Use the diagrams to draw the planes of symmetry.

1 Reasoning

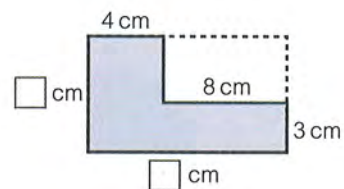
a Find the area of this shape by adding together the areas of A and B.



b Find the area of the same shape again. This time, find the area of the whole rectangle and subtract the shaded area.

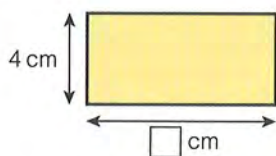


2 The area of this L shape is 52 cm^2 . Find the perimeter of the shape.

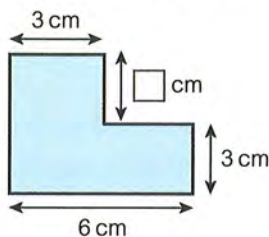


3 Each of these shapes has an area of 24 cm^2 . Find the missing numbers.

a



b

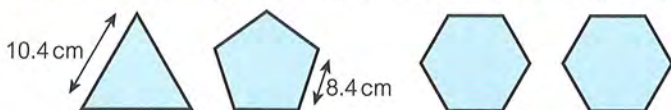


.....

.....



4 Problem-solving The diagrams shows four regular polygons.



The sum of the perimeters of the triangle and pentagon is equal to the sum of the perimeters of the two identical hexagons.
Work out the side length of the hexagons.

5 A square has an area of 36 cm^2 .
Its side length is increased by 2 cm.
What is the new area of the square?

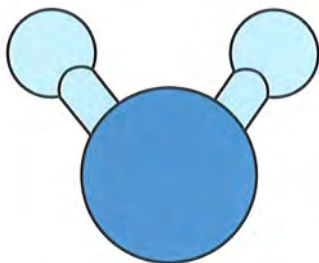
.....

- 6 A 3D solid has the same number of vertices as faces.
What solid could it be?

.....

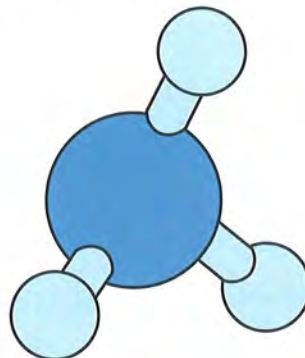
- 7 **STEM** These are models of the molecules in two substances a farmer may use on his crops.
How many planes of symmetry does each molecule have?

a Water (H_2O)



.....

b Ammonia (NH_3)



.....

- 8 A regular octagon has the same perimeter as a regular hexagon.
The hexagon has sides of length of 4 cm.
What is the side length of the octagon?

.....

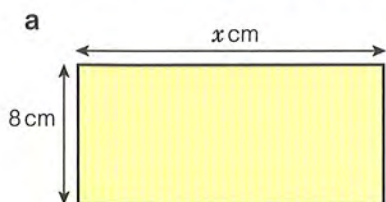
- 9 A square has an area of 36 cm^2 . A rectangle has an area that is $\frac{2}{3}$ of the area of the square.

a What is the area of the rectangle?

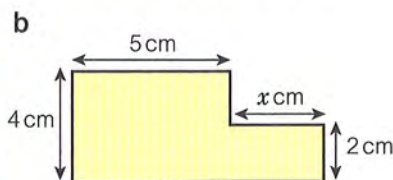
The width of the rectangle is 24 mm.

b What is the length of the rectangle in mm?

- 10 Write expressions for the perimeter and area of each shape.

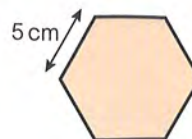


.....
.....

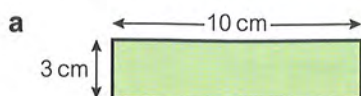


.....
.....

- 1 Calculate the perimeter of this regular hexagon.

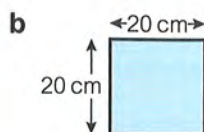


- 2 For each shape, calculate **i** the perimeter **ii** the area



i

ii



i

ii

- 3 Complete these statements.

a 3 m = cm

b 2000 ml = litres

c 4 kg = g

d 250 mm = cm

e 0.5 litres = ml **f** 350 m = km

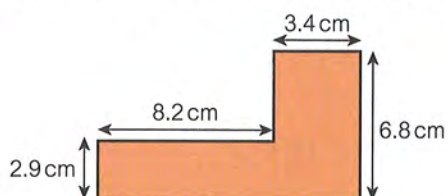
- 4 A square has a perimeter of 40 cm. Calculate the area of the square.

- 5 State the number of edges, faces and vertices in a square-based pyramid.

.....

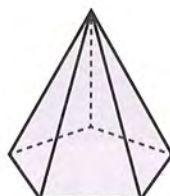


- 6 Calculate the area and perimeter of this shape, giving the correct units.



.....

- 7 How many planes of symmetry does this regular pentagonal-based pyramid have?



- 1 Here is a sequence of positive odd numbers.
1, 3, 5, 7,, 11, 13, 15, ...

- a Write in the missing term.
b Is the sequence ascending or descending?
c Is the sequence finite or infinite?



Numbers in a **sequence** are called **terms**.
Numbers *increase* in **ascending** sequences.
Numbers *decrease* in **descending** sequences.
A **finite** sequence has a fixed number of terms.
An **infinite** sequence goes on forever.

Guided

- 2 Describe each sequence by giving the **1st term** and the **term-to-term rule**.

- a 4, 6, 8, 10, ... 1st term =, rule: add 2
b 3, 8, 13, 18, ... 1st term = 3, rule:
c 20, 17, 14, 11,
d 12, 12.5, 13, 13.5,

You can describe a sequence by giving the 1st term and the **term-to-term rule**.
The term-to-term rule tells you how to get from one term to the next.

Worked example



- 3 Tick the **arithmetic sequences**.

- a 77, 76, 75, 74, ... b 2, 4, 8, 16, ...
c 5, 6, 5, 6, 5, ... d 3, 6, 9, 12, ...

An **arithmetic** sequence goes up or down in equal steps. This step is called the **common difference**.

Guided

- 4 Work out the first five terms of each arithmetic sequence.

- a 1st term = 3 common difference = 2 3, 5, 7,
b 1st term = 0 common difference = 10
c 1st term = 20 common difference = -10
d 1st term = 8 common difference = -3



- 5 Describe each arithmetic sequence by writing the 1st term and the common difference.

- a 100, 105, 110, 115,
b 7, 10, 13, 16,
c 50, 30, 10, -10,
d 20, 11, 2, -7,

- 6 Sally decides to increase the number of sit-ups she does by 2 each day.

- a Continue the sequence to show how many sit-ups she does for the first week.
1, 3, 5,
b On which day will Sally first do more than 30 sit-ups?

- 7 The first five terms of a sequence are 4, 8, 12, 16, 20.

- a What is the 10th term?
b What is the 50th term?
c What is the 100th term?

n is the term number.
1st 2nd 3rd 4th ...
 n is always a positive integer.
You can describe a sequence by giving the **general term** (or **n th term**). The general term relates the term number, **n** , to the term.

Check

Tick each box as your **confidence** in this topic improves.



Need extra help? Go to page 88 and tick the boxes next to Q1, 2, 4 and 5. Then try them once you've finished 9.1–9.6.

1 The general term of a sequence is $4n$

a Write the first five terms in the sequence.

1st term, 2nd term, 3rd term, 4th term, 5th term

4×1 4×2 4×3 4×4 4×5

Substitute the term number for n .

Answer: 4, 8,

b Work out the 20th term.

2 Write the first five terms of the sequence with the general term $10n$.

.....

3 The general term of a sequence is $n + 5$.

a Write the first four terms of the sequence.

1st term, 2nd term, 3rd term, 4th term

$1 + 5$ $2 + 5$ $3 + 5$ $4 + 5$

Answer: 6,

b Work out the 20th term.

c Describe the sequence by giving the 1st term and the common difference.

4 Find the general term of each sequence.

a 5, 6, 7, 8, ...

Term number 1 2 3 4 ...
 +
 Term 5 6 7 8 ... $n + \dots$

What do you do to the term number to get the term?

b 12, 13, 14, 15, ...

5 Work out the first five terms of the sequence for each general term.

a $5n + 2$

b $2n - 2$



$5 \times 1 + 2,$
 $5 \times 2 + 2,$
 $5 \times 3 + 2, \dots$

6 Work out the general term of each sequence.

a 10, 12, 14, 16, ...

$+2$ $+2$ $+2$

First work out the common difference.

$+8$ 2 4 6 8
 10 12 14 16

The common difference is 2, so compare it to the multiples of 2 (called $2n$). You need to add 8 to get the sequence.

b 6, 8, 10, 12, ...

c 1, 11, 21, 31, ...

Worked example



Check

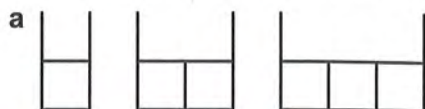
Tick each box as your confidence in this topic improves.



Need extra help? Go to pages 88 and 89 and tick the boxes next to Q6, 7, 8 and 9. Then try them once you've finished 9.1–9.6.

- 1 For each sequence in parts **a** and **b**
- i draw the next two patterns
 - ii complete the table
 - iii write the 1st term and the term-to-term rule.

Worked example



Term number	1	2	3	4	5
Number of lines	6	9			



Term number	1	2	3	4	5
Number of dots	3	8			

- 2 The 1st term of a sequence is 5. The term-to-term rule is 'double the previous term'. Write the first five terms in the sequence.

- 3 Describe each sequence by giving the 1st term and the term-to-term rule.

- a** 1, 2, 4, 8, ... 1st term =, term-to-term rule: $\times 2$
- b** 32, 16, 8, 4, ... 1st term = 32, term-to-term rule:
- c** 81, 27, 9, 3,
- d** 0.02, 0.2, 2, 20,



- 4 Decide whether each sequence is arithmetic or geometric.

- a** 1, 3, 9, 27,
- b** 5, 10, 15, 20,
- c** 1000, 100, 10, 1,

In a **geometric sequence**, the term-to-term rule is 'multiply by $\square$ '. You find each term by multiplying the previous term in the sequence by a constant value.

- 5 For each geometric sequence write the next two terms.

- a** 500, 250, 125,,
- b** 4, 16, 64,,
- c** 500, 50, 5,,
- d** 2, 10, 50,,

- 6 Work out the first three terms of the sequence for each general term.

- a** $n^2 + 10$
- b** $10n^2$
- c** $\frac{n^2}{10}$

Check

Tick each box as your confidence in this topic improves.



Need extra help? Go to pages 88 and 89 and tick the boxes next to Q3, 10 and 11. Then try them once you've finished 9.1–9.6.

1 The length of the line segment CD is 10 units.

a Work out the length of the line segment AB.

b Write the coordinates of each point.

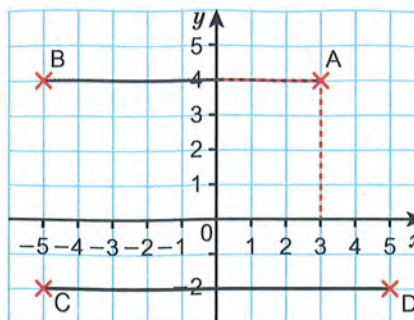
A (3,)

B

C

D

Look at point B. Read off the coordinate from the x -axis and then the y -axis.



A line segment is part of a line. It has a beginning and an end point.



The x - and y -axes extend below 0, so you can plot points with negative x - and y -coordinates. The point (0, 0) is called the **origin**.

2 a On the grid from Q1, plot and label these points.

E (-1, 0) F (-2, 1) G (0, 3) H (1, 2)

b Join the points in alphabetical order. What shape have you made?

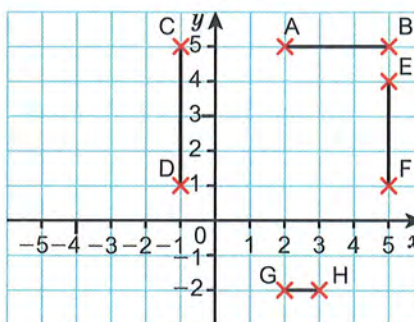
3 Work out the coordinates of the midpoint of each line segment.

a AB

b CD

c EF

d GH



Find the point halfway between A and B. Write its coordinates.

4 Work out the midpoint of each line segment.

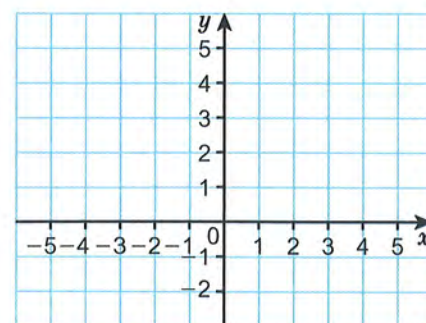
a I (-5, 4) J (3, 4)

b K (4, 5) L (4, -1)

c M (-5, 3) N (-5, 0)



Plot each pair of points on the grid and join them. Then mark the midpoints.



5 Find the midpoint of the line segment joining each pair of points.

a O (-4, -1) P (-2, -3) b Q (-1, -2) R (0, -1)

c S (1, -2) T (3, 3) d U (10, -7) V (-5, 12)

Worked example



Check

Tick each box as your confidence in this topic improves.



Need extra help? Go to pages 89 and 90 and tick the boxes next to Q12 and 17. Then try them once you've finished 9.1–9.6.

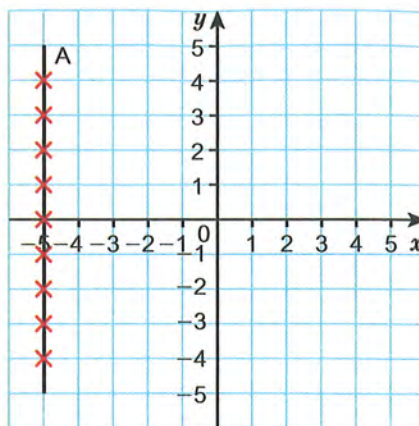
- 1 a Write the coordinates of four points on line A.

- b What do you notice about the x -coordinates?

- c Complete this statement.
The equation of line A is
 $x = \dots\dots\dots$

- d Draw and label these graphs.

- i $x = -2$ ii $x = 4$
iii $y = 4$ iv $y = -2$



A line on a coordinate grid is called a **graph**. You can describe it by giving the **equation** of the line.

When you draw a graph it should go to the edge of the grid.

- 2 Look at these points.

V (4, 3) W (3, 6) X (-3, 3) Y (3, -5) Z (3, 3)

Which of them are on the line a $x = 3$ b $y = 3$

- 3 a Complete the table of values for the equation $y = x$.

x	0	1	2	3	4
y	0	1			

- b Write down the coordinate pairs from the table.
(0, 0),

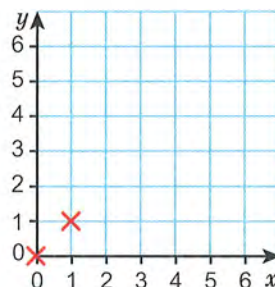
- c Plot and label the graph of $y = x$.

- d Complete the table of values for the equation $y = x + 2$.

x	0	1	2	3	4
y	$0 + 2 = 2$				

- e Write down the coordinate pairs from the table. (0, 2),

- f Plot and label the graph of $y = x + 2$.

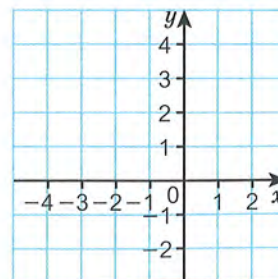


Plot the coordinate pairs. Draw a straight line through the points and continue it to the edge of the grid.

- 4 a Complete the table of values for the equation $y = 2x + 2$.

x	-2	-1	0	1	2
y					

- b Plot and label the graph of $y = 2x + 2$.



Worked example



- 5 On the grid from Q1

- a plot and label the graph of $y = x$

- b plot and label the graph of $y = -x$.

In part a, use the points from Q3a to help you.

In part b, the y -coordinate will always be equal to the x -coordinate, but with the opposite sign, for example (2, -2) or (-2, 2).

Check

Tick each box as your confidence in this topic improves.



Need extra help? Go to pages 89 and 90 and tick the boxes next to Q13–16. Then try them once you've finished 9.1–9.6.

- 1 **Real** An electrician charges \$70 to come to a house and then \$40 per hour.

a Copy and complete the table.

Time (hours)	0	1	2	3	4
Cost (\$)	70	110			

b Plot the points on a graph and join them with a straight line.

c The electrician works at a house for 1.5 hours.

Use the graph to work out how much she should charge.

Time goes along the x -axis as it is the independent variable.



- 2 **Real** Zara has a 500 ml bottle of water. She drinks 50 ml every hour.

a Copy and complete the table.

Time (hours)	0	1	2	3	4	5	6
Volume of water in the bottle (ml)	500	450					

b Plot the points on a graph.

c Join the points with a straight line and extend the line to the x -axis.

d After how many hours does Zara finish her water?

x -axis is time, 0–10, going up in 1s.
 y -axis is volume, 0–500, going up in 50s.

How many ml are in the bottle when she has finished her water?

3 Problem-solving

a Draw a coordinate grid on squared paper with both axes going from 0 to 8.

Plot the points A (4, 6), B (7, 3) and C (4, 0).

b Work out the possible coordinates of a fourth point

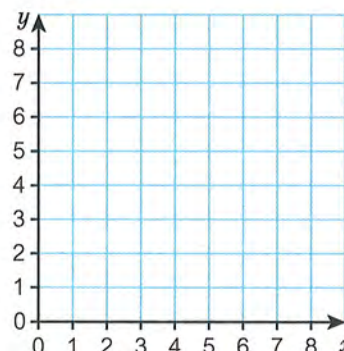
i D, so that ABCD is a square

ii E, so that ABCE is a kite

iii F, so that ABCF is an arrowhead

iv G, so that ABCG is a trapezium.

c **Reasoning** Explain why it is not possible to have coordinates of a fourth point H, so that ABCH is a rectangle (that isn't a square).



Check

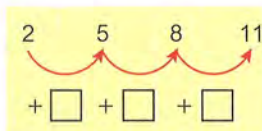
Tick each box as your confidence in this topic improves.



Need extra help? Go to page 90 and tick the boxes next to Q18 and 19. Then try them once you've finished 9.1–9.6.

Sequences

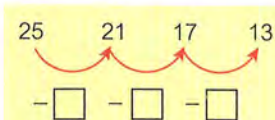
- ☐ 1 An arithmetic sequence starts 2, 5, 8, 11, ...
- a What is the common difference?
- b Work out the next two terms.



In an arithmetic sequence you add or subtract the **same** number each time.

- ☐ 2 a Work out the next three terms of each sequence.

- i 25, 21, 17, 13,,,
- ii 12, 17, 22, 27,,,
- iii 8, 17, 26, 35,,,



Literacy hint

Ascending numbers get bigger.
Descending numbers get smaller.

- b Is each sequence ascending or descending? i ii iii

- ☐ 3 Look at this sequence made of dots.
- a Draw the next pattern in the sequence.
- b Complete the table.
- c Work out the number of dots in pattern number 6.



Pattern number	1	2	3	4	5
Number of dots	3	6			

- ☐ 4 The 1st term of an arithmetic sequence is 2. The common difference is 4. Complete the table to find the first five terms of this sequence.

Term number	1	2	3	4	5
Term	2	$2 + 4 = 6$	$6 + \dots = \dots$	$\dots + \dots = \dots$	

- ☐ 5 Find the next three terms of each arithmetic sequence.

- a 1st term = 7 common difference = 4 2nd term =, 3rd term =, 4th term =
- b 1st term = 15 common difference = -3 2nd term =, 3rd term =, 4th term =

- ☐ 6 For each sequence work out i the general term ii the 10th term.

- a 4, 8, 12, 16, ...

- i These are multiples of 4, so the general term is $4n$.

1st term: $1 \times \square = 4$
2nd term: $2 \times \square = 8$
:
10th term: $10 \times \square = \square$

- ii General term is $4n$, so 10th term is $4 \times 10 = \dots$

- b 10, 20, 30, 40, ...

- i

- ii

- c 7, 14, 21, 28, ...

- i

- ii

- ☐ 7 Look at the sequence in the table.

Term number	1	2	3	4	n
Term	6	7	8	9	$\square$

- a What do you add to the term number each time to get the term?

- b Write the general term of the sequence. $n + \square$

- ☐ 8 Work out the general term of each sequence.

a 13, 14, 15, 16, 17, ... b -1, 0, 1, 2, 3, ...

Draw a table to help you.

$n = \square$

- ☐ 9 The general term (n th term) of a sequence is $2n + 5$. Work out the first five terms.

Guided

n th term: $2 \times n + 5$

1st term: $2 \times 1 + 5 = 7$

7,

Substitute $n = 1, n = 2, \dots, n = 5$ into $2n + 5$.

- ☐ 10 Tick the geometric sequences.

a 1, 2, 3, 4, ...

b 1, 2, 4, 8, ...

c 7, 11, 15, 19, ...

d 100, 50, 25, 12.5, ...

In a geometric sequence the term-to-term rule is to multiply or divide by the same number each time.

- ☐ 11 For each sequence work out i the next two terms in the sequence ii the term-to-term rule.

Guided

a 1 3 9 27 $\square$ $\square$ rule:

$\times \square \times \square \times \square \times \square \times \square$

For ascending sequences try $+$ $\square$ and $\times$ $\square$

For descending sequences try $-$ $\square$ and $\div$ $\square$

b 2, 10, 50, 250,, rule: c 4, 9, 14, 19,, rule:

d 5, 15, 45, 135,, rule: e 20, 18, 16, 14,, rule:

Coordinates

- ☐ 12 a Plot these points.

$(-3, 2), (-1, 2), (0, 2), (2, 2), (4, 2)$

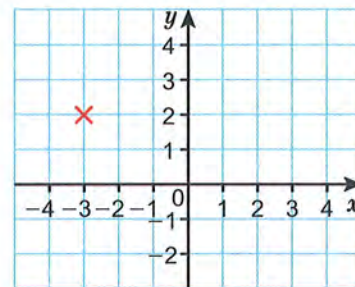
Draw a line through all the points.

b What do you notice about the y -coordinate of all the points?

c Complete this statement.

'The equation of the line is $y = \dots\dots\dots$. It is parallel to the $\dots\dots\dots$ -axis.'

To plot the point $(-3, 2)$ move 3 left along the x -axis and 2 up the y -axis.



- ☐ 13 a Complete the table of values for the equation $y = x + 4$.

b Write each pair of coordinates from the table.

$(0, 4), (1, \dots\dots\dots), (2, \dots\dots\dots), (3, \dots\dots\dots), (4, \dots\dots\dots), (5, \dots\dots\dots)$

x	0	1	2	3	4	5
y	4					

- ☐ 14 a Complete the table of values for the equation $y = 4x$.

b Write each pair of coordinates from the table.

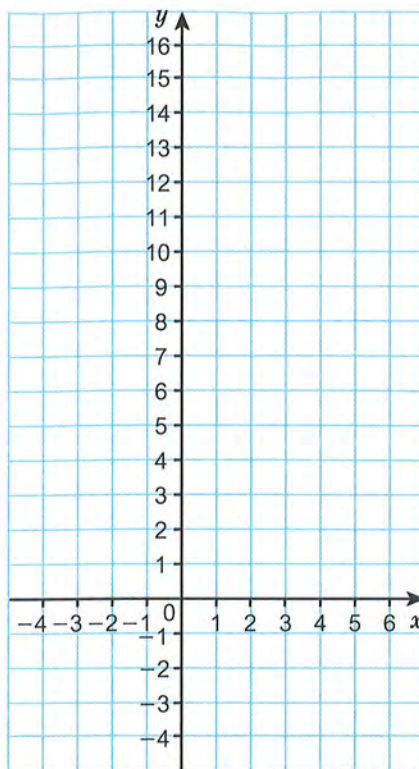
x	0	1	2	3	4
y	0				

- ☐ 15 Complete the table of values for the equation $y = 4x - 2$.

x	0	1	2	3	4
y	-2				

- 16 On the grid plot the points and join them with a straight line to draw each graph.

- a $y = x + 4$, from Q13
- b $y = 4x$, from Q14
- c $y = 4x - 2$, from Q15
- d $y = x$
- e $y = -x$



Read the equation of the graph aloud, 'y equals x'. This means that the x- and y-coordinates are the same.

Read the equation of the graph aloud, 'y equals minus x'. This means that the y-coordinate is the negative of the x-coordinate.

- 17 a What number is halfway between

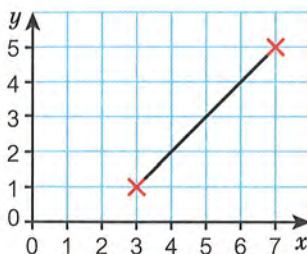
Add the values together and divide by 2.

- i 3 and 7
- ii 1 and 5?

- b Use your answers to help you find the coordinates of the midpoint of this line segment.

- c Work out the midpoint of the line segment joining

- i (1, 7) and (12, 16)
- ii (3, 4) and (6, 5)



The midpoint of a line segment is the point halfway between the two ends. Find the number halfway between 1 and 12, and the number halfway between 7 and 16.

- 18 A boat hire company charges €40 for initial rental and €10 for every hour.

- a Complete the table.

Time (hours)	0	1	2	3	4
Cost (€)	40	50			

- b Plot the points on a graph and join the points with a straight line.
c Use the graph to find the cost for 3.5 hours.

The total cost goes up €10 every hour, so add 10 each time.

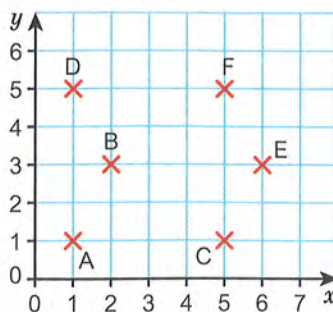
The x-axis is time and the y-axis is cost. Draw a grid from 0 to 4, going up in 1s, on the x-axis, and from 0 to 100, going up in 10s, on the y-axis.

- 19 Six points are marked on the grid: A, B, C, D, E and F.

- a Complete these statements.

- i Shape ABDE is a
- ii Shape ACEB is a
- iii Shape is a rectangle

- b Points B and E are the vertices of a square. What could the coordinates of the other vertices be?



Find 3.5 on the x-axis, then use the graph to find the corresponding value on the y-axis.

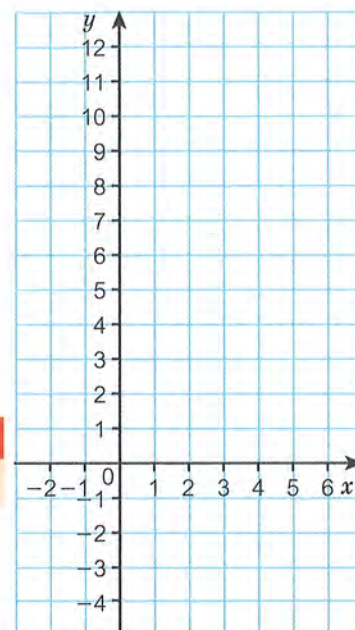
Draw the square first, then find the coordinates.

- 1 Two of the corners of a square are at the points $(-3, 1)$ and $(1, 1)$.

- a Write down possible coordinates for the other two corners.
b Write down two other possible coordinates for the two corners.



Plot the two points first.



Guided

- 2 a Complete the table of values for the equation $y = 2x - 2$.

x	-1	0	1	2	3
y	$2 \times -1 - 2 = -4$				

- b Complete the table of values for the equation $y = 10 - x$.

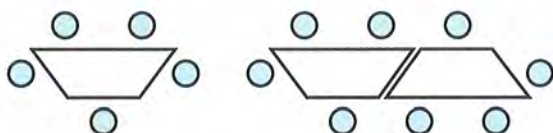
x	-2	0	2	4	6
y	$10 - -2 = 12$				

- c Plot and label the graphs of $y = 2x - 2$ and $y = 10 - x$ on the grid.
d Write the coordinates of the point where the two graphs **intersect**.

Literacy hint

Intersect means 'cross'.

- 3 **Reasoning** A restaurant has trapezium shaped tables, and 5 people can sit at each one.
When 2 tables are put together, 8 people can sit at them.



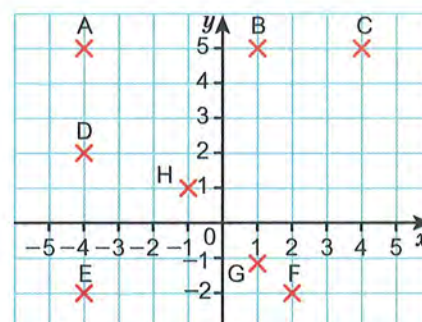
- a How many people can sit at 3 tables put together?
b Complete this table of values.

Number of tables	1	2	3	4	5
Number of seats	5	8			

- c How many people can sit at 10 tables?
d How many extra seats are made each time a table is added?
e Billy says the general term for the number of seats for n tables put together is $5n$, since five people can sit at each table. Is he right? Explain your answer.
f Work out the general term for the number of seats for n tables.
g How many tables are needed for 30 people?

- 4 **Reasoning** Write the equation of the line that goes through the points

- a A, B and C
b A, D and E
c F, G and H.
d Does the line in part c go through point A? Explain your answer.



- 5 On the grid in Q4 plot and label these three corners of a parallelogram WXYZ.

W (1, 1), X (4, 1), Y (5, 5)

- a What are the coordinates of point Z?
b Work out the coordinates of the midpoint of
i WX ii XY

- 6 **Reasoning** The general term of a sequence is $5n + 2$.

- a Which of these numbers are in the sequence? Explain your answers.

- i 7
ii 55
iii 672
iv -3

- b Which number term has the value 162?

- c Which term is the first term greater than 400?

- 7 **Problem-solving** The general term of a sequence is $-6n - 2.5$.

- a Is the sequence finite or infinite?

- b Which term has the highest value? What is this value?



- 8 The first two terms of a sequence are 1 and 5.
The sequence could be arithmetic or geometric.

- a For an arithmetic sequence starting 1, 5, ...

- i write the next two terms
ii work out the n th term.

- b For a geometric sequence starting 1, 5, ...

- i write the next two terms
ii describe the sequence, giving the 1st term and the term-to-term rule.

- 9 **Real** The table shows charges for a plumber.

Time (hours)	0	1	2	3	4
Cost (£)	80	120	160	200	240

- a Write down the initial call-out charge.

- b How much does the plumber cost per hour after the initial call-out charge?

- c Plot the points on a graph and extend the line to a time of 8 hours.

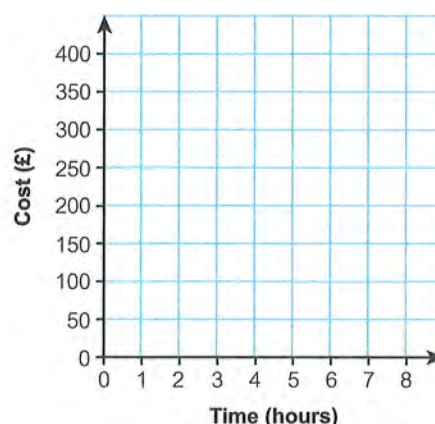
- d Use the graph to find out how long it will take for the cost to go above £300.

- e **Problem-solving** The plumber changes his rate so that it costs £100 per hour with no call-out cost.

- i How much will it cost to hire the plumber for 2 hours at the new rate?

- ii **Reasoning** Does the plumber get more money for 3 hours' work with the old rate or the new rate? Explain your answer.

Worked
example



1 Look at this sequence.

a Draw the next pattern.

b Complete the table.

Term number	1	2	3	4	5	6
Number of dots	1	4				

2 The first five terms of a sequence are 4, 8, 12, 16, 20.

What is the 8th term?

3 **Reasoning** Is the sequence 5, 10, 20, 40, ... arithmetic or geometric? Explain your answer.

4 Work out the general term of each sequence.

a 11, 22, 33, 44,

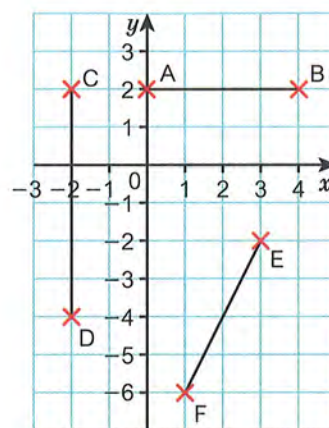
b 11, 15, 19, 23,

5 Calculate the midpoint of each line segment shown on the grid.

AB

CD

EF



6 a Work out the first three terms of the sequence with n th term $2n - 4$.

b Complete the table of values for $y = 2x - 4$.

x	-1	0	1	2	3
y					

c On the grid from Q5 plot the graph of $y = 2x - 4$.

7 **Problem-solving** Complete these statements.

a The points A (... , 0), B (4, 4), C (0, ...) and D (0, 0) can be joined to make a square ABCD.

b The points A (1, 1), B (3, 4), C (... , ...) and D (1, 3) can be joined to make a parallelogram ABCD.

c The lines $y = 2$, $x = 4$, $y = 5$ and $x = 8$ intersect to make a

8 A bathtub is filled with 100 litres of water and drains at a rate of 10 litres per minute.

a Complete the table to show the volume of water in the bathtub.

Time (minutes)	0	1	2	3	4
Volume of water in the bath (litres)	100	90			

b Draw a grid with x -axis from 0 to 10 and y -axis from 0 to 100.

Plot the points on the grid and join them to make a straight-line graph that extends to the x -axis.

c Use the graph to find out how much water is left after 6 minutes.

d How long does it take for the bathtub to empty?

1 Shade in the congruent parts of each shape in the same colour.

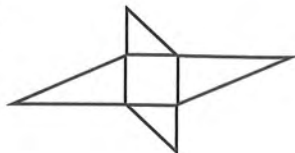
Guided

a

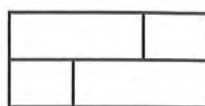


The shaded triangles are the same shape and size. Are there other triangles which are the same shape and size?

b



c



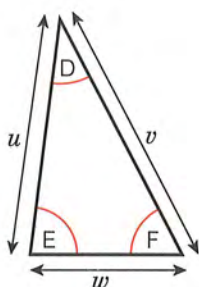
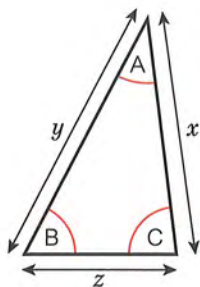
d



Shapes are **congruent** if they are the same shape and size. For example, these shapes are all congruent.



2 These two triangles are congruent.



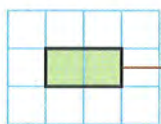
In congruent shapes, corresponding sides and corresponding angles are equal.

Complete these sentences.

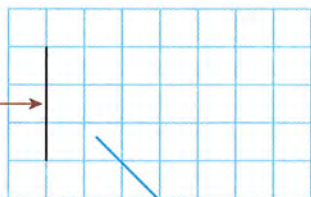
- a Length y is the same as length
- b Length is the same as length w .
- c Angle A is the same size as angle
- d Angle is the same size as angle F.

3 Enlarge each shape by the given scale factor.

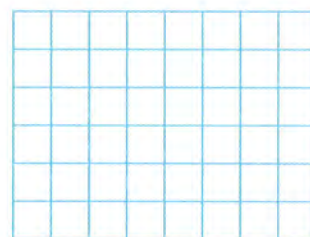
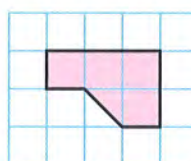
a Scale factor 3



$\times 3$



b Scale factor 2



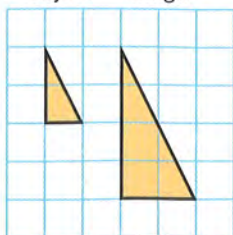
For scale factor 3, multiply each side length by 3.

4 For each of these enlargements:

- i Write the ratio of the length of a side of the object to the corresponding length in the image. Give the ratio in its simplest form.
- ii Write the scale factor of the enlargement.

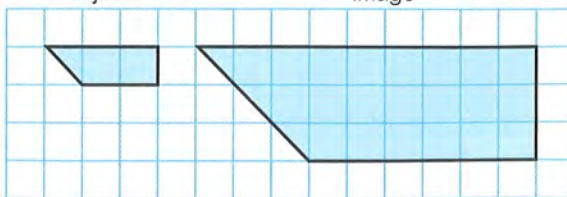
a

object image



b

object image



The original shape is called the **object**. The enlarged shape is called the **image**.

- i
- ii

- i
- ii

Height of object = 2 squares, height of image = 4 squares, so ratio is $2:\square$, which simplifies to $1:\square$.

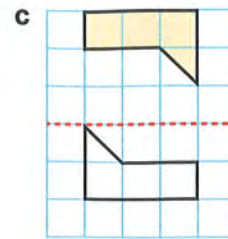
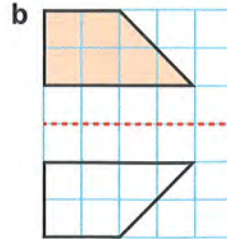
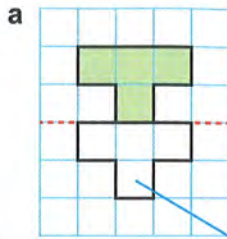
Check

Tick each box as your **confidence** in this topic improves.



Need extra help? Go to page 98 and tick the boxes next to Q1 and 2. Then try them once you've finished 10.1–10.4.

- 1 Reasoning** In each diagram, decide whether the white shape is a correct reflection of the coloured shape in the mirror line. If the reflection isn't correct, give a reason why. Then draw the correct reflection in pencil over the diagram.



Guided

No. The reflection should be upside down.

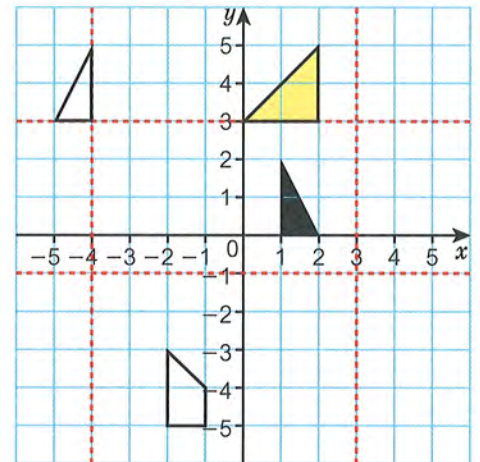
The shape has been moved down, not reflected. Draw it turned upside down, with the bottom of the 'T' touching the mirror line.



A **reflection** is a type of transformation. You reflect shapes in a **mirror line**. All points on the object are the same distance from the mirror line as the points on the image, but on the opposite side.

- 2** Draw and label the image of each shape after each reflection as described.

	Draw the image of this shape ...	... after reflection in the line	Label the image
a	white triangle	$x = -4$	A
b	white triangle	$y = 3$	B
c	black triangle	$x = 3$	C
d	quadrilateral	$y = -1$	D
e	yellow triangle	$y = 3$	E
f	black triangle	$y = -1$	F



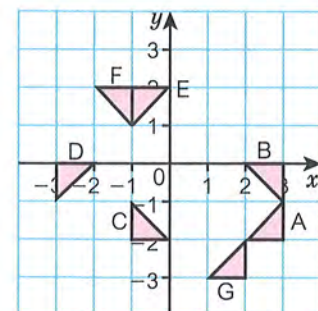
- 3 Problem-solving / Reasoning** Pippa says, 'I reflect a shape in the line $x = 1$, then reflect the image in the line $y = 1$, then reflect that image in the line $x = 1$ and finally reflect that image in the line $y = 1$. The shape will then be in the position I first started with.' Is she correct? Explain your answer.

Strategy hint

Draw a shape on a coordinate grid (you could use the grid from Q2) and follow Pippa's reflections.

- 4** The diagram shows six congruent shapes on a coordinate grid. Complete these statements.

- a A is a reflection of B in the line
- b A is a reflection of C in the line
- c E is a reflection of F in the line
- d B is a reflection of D in the line
- e G is a reflection of A in the line



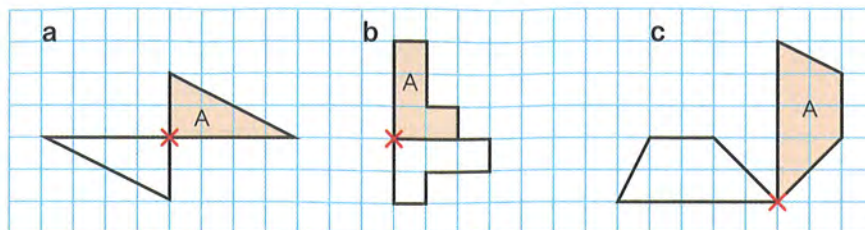
Check

Tick each box as your **confidence** in this topic improves.



Need extra help? Go to page 98 and tick the boxes next to Q3 and 4. Then try them once you've finished 10.1–10.4.

- 1 Each shape marked A has been rotated about the centre of rotation X. Describe each rotation.



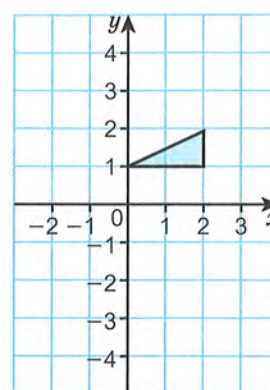
Give the angle and direction.

A **rotation** is a type of transformation. You rotate a shape by turning it around a point, called the **centre of rotation**. To describe a rotation fully you also need to give the angle and direction (clockwise or anticlockwise).

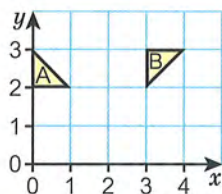
- 2 Write down the coordinates of the vertices of the triangle after a rotation of

- a 180° about $(0, 1)$
 b 90° anticlockwise about $(2, 2)$
 c 90° clockwise about $(-1, -1)$

Use tracing paper to help you draw the rotations.

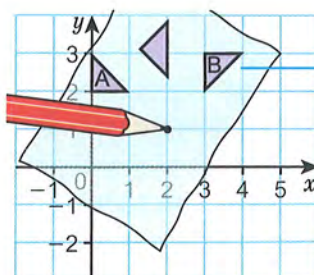
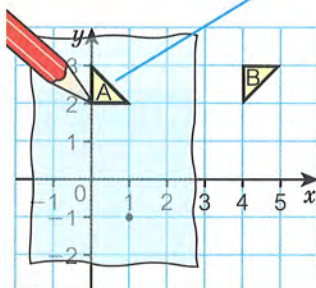


- 3 Describe the rotation that takes A to B.



Trace the object shape.

Guided



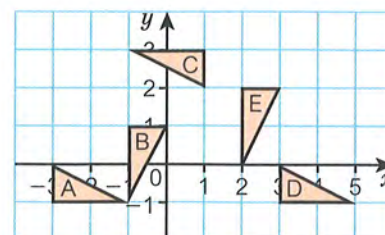
Rotate the tracing holding a point fixed with your pencil. Repeat for different points until your tracing ends up on the image.

Rotation through about $(\dots, \dots)$.

Give the angle, direction and centre of rotation.

- 4 Describe the rotation that takes

- a B onto A
 b A onto C
 c C onto D
 d D onto E



Check

Tick each box as your **confidence** in this topic improves.

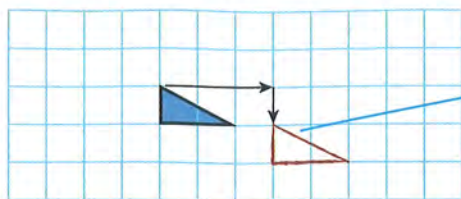


Need extra help? Go to page 99 and tick the boxes next to Q5 and 6. Then try them once you've finished 10.1–10.4.

- 1 Draw the image of the blue shape after each of these translations. Label the images A to E.



Guided



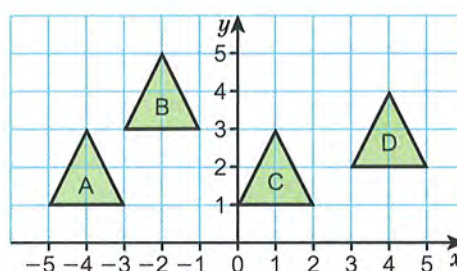
Choose a vertex (corner) of the object. Count 3 squares right and 1 square down and mark that point. Draw the shape in its new position.

A **translation** of a 2D shape is a slide across a flat surface. To describe a translation you need to give the movement left or right, followed by the movement up or down.

- A** 3 squares right, 1 square down **B** 2 squares right, 2 squares up
C 3 squares left, 1 square down **D** 1 square left, 1 square up
E 5 squares right

- 2 The diagram shows four triangles on a coordinate grid.

Triangle A to triangle B is a translation 2 squares right and 2 squares up. Describe each of these translations.



Worked example

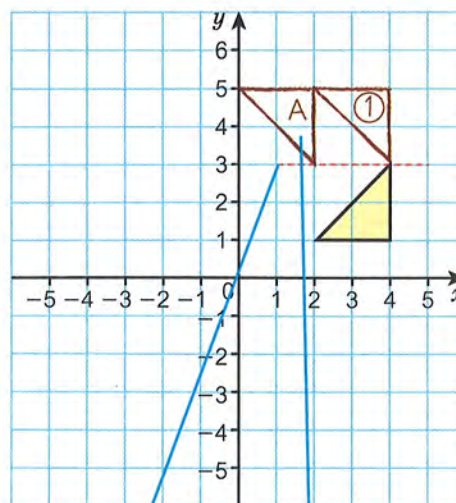


- a** C to D
b C to B
c D to A

- 3 Transform the yellow triangle using each of these two-step transformations. Label the images A to D.

Guided

- A** Reflection in the line $y = 3$ followed by a translation 2 squares left.
B Rotation 90° clockwise about $(2, 1)$ followed by a translation 1 square right and 3 squares down.
C Translation 4 squares left and 4 squares down followed by a rotation 180° about $(-2, -2)$.
D Rotation 90° anticlockwise about $(1, 1)$ followed by a reflection in the line $x = -1$.



First draw in the reflection line and reflect the triangle to give ①.

Then translate ① 2 squares left to give A.

- 4 Look at the diagram in Q2.

Write true or false for each of these statements. If a statement is false, explain why.

- a** C is a translation of A.
b C is a rotation of A.
c C is a reflection of A.

Check

Tick each box as your **confidence** in this topic improves.

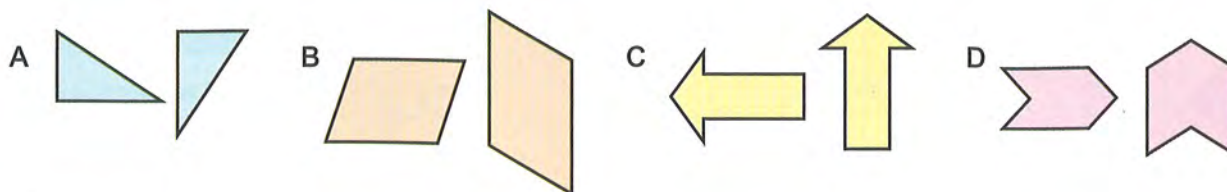


Need extra help? Go to page 99 and tick the boxes next to Q7–9. Then try them once you've finished 10.1–10.4.

Congruency and enlargements

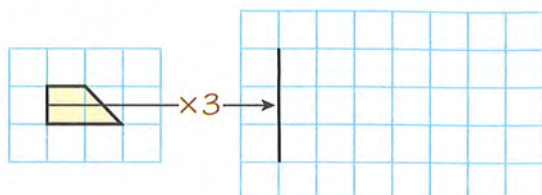
- ☐ 1 Which of these pairs of shapes are congruent?

Trace one pair. If the tracing fits exactly over the other shape, then they are congruent.



- ☐ 2 Enlarge the shape by a scale factor of 3.

Guided

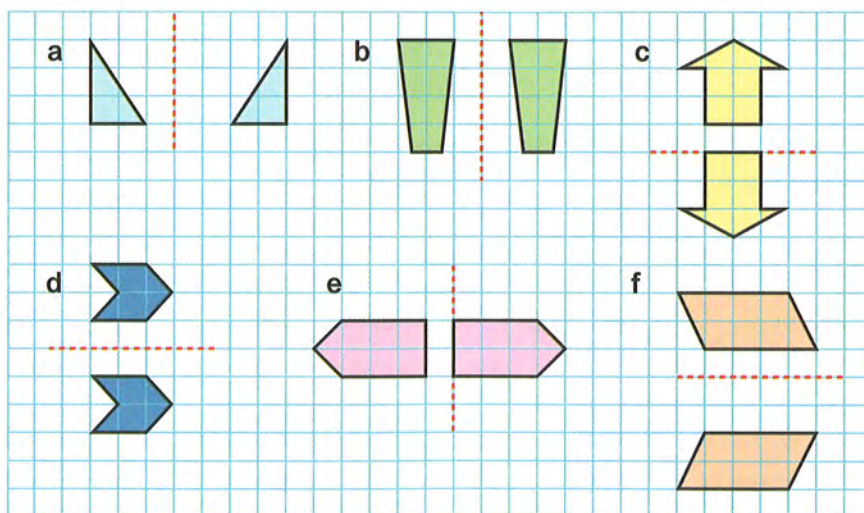


For scale factor 3, multiply each side length by 3.

Reflections and rotations

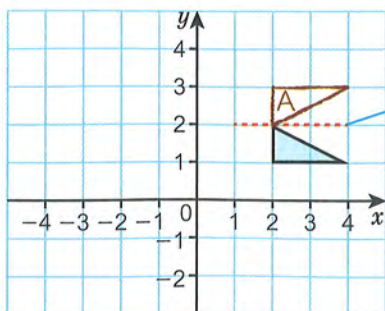
- ☐ 3 Circle the reflections that have the mirror line in the correct place.

Count the squares from each corner on the shape to the mirror line.



- ☐ 4 Draw the reflection of the blue triangle in each of these lines.

Guided



Draw $y = 2$.

Check: put your finger at different points along the line $y = 2$.

Do they all have a y -coordinate of 2? Check that your original shape and your reflection are the same distance from your line $y = 2$.

Literacy hint

The line $x = 0$ is the same as the y -axis.

a $y = 2$. Label the image A.

b $x = 1$. Label the image B.

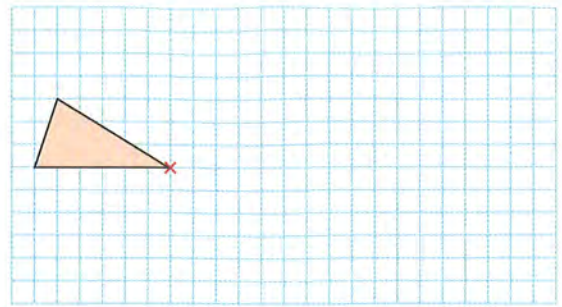
c $x = 0$. Label the image C.

d $y = 0$. Label the image D.

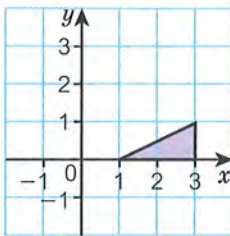
- ☐ 5 a Trace this triangle. Turn the tracing a $\frac{1}{2}$ turn about the cross.

Now draw the rotation.

- b Repeat for a $\frac{1}{4}$ turn clockwise.
c Repeat for a $\frac{3}{4}$ turn anticlockwise.
d What do you notice about **b** and **c**?



- ☐ 6 Draw the image of the triangle after these rotations.



Trace the triangle on tracing paper. Put your pencil on the point of rotation and turn your tracing paper the correct amount in the given direction.

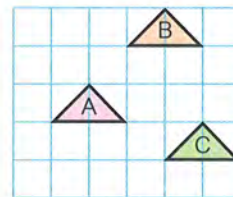
- a 90° anticlockwise about (1, 0). Label your rotated shape A.
b 90° clockwise about (3, 1). Label your rotated shape B.
c 180° about (1, 0). Label your rotated shape C.

Translations and combinations of transformations

- ☐ 7 The grid shows triangles A, B and C. Describe the translation that takes

Choose one vertex (corner) of the shape. Give the number of squares right or left followed by the number of squares up or down.

- a A to B
b A to C
c C to B
d B to C



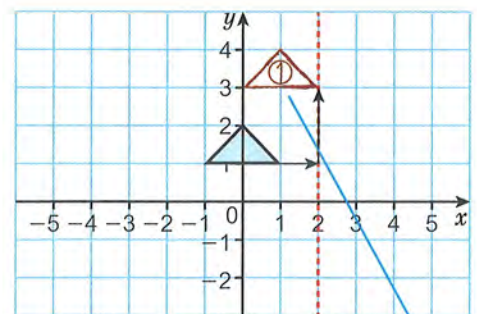
- ☐ 8 The triangle on the grid in Q6 is translated 2 squares left and 1 square up. Write down the coordinates of the vertices of the image.

.....

- ☐ 9 Transform the blue triangle using each of these two-step transformations. Label the images A to C.

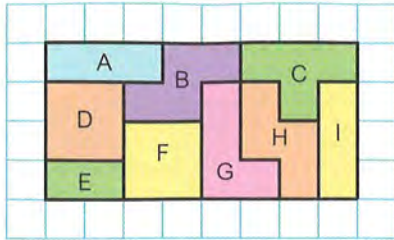
Guided

- A** A translation 1 square right and 2 squares up followed by a reflection in the line $x = 2$.
B A translation 1 square left and 3 squares down followed by a reflection in the line $y = -1$.
C A rotation 90° anticlockwise about (1, 1) followed by a translation 2 squares left and 3 squares up.



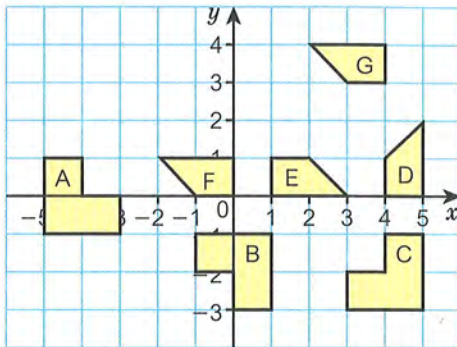
First move the triangle 1 square right and 2 squares up to give ①. Then reflect ① in the line $x = 2$.

- 1 **STEM** A computer programmer is working on a game where shapes fit together.



Which shapes are congruent?

- 2 Shape A has been rotated 180° about the point $(-2, -1)$ to get shape B.



Describe the rotation that takes

- a B to C
- b D to E
- c D to F
- d E to G

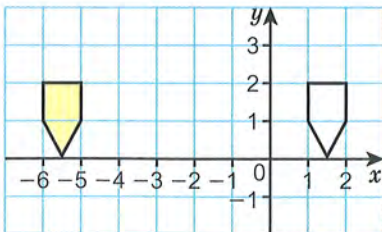


Use tracing paper to find the centres of rotation.

Worked
example

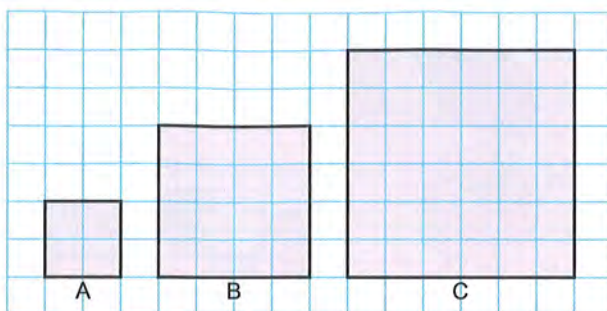


- 3 The diagram shows a white shape and a shaded shape.
Describe two different transformations that take the white shape onto the shaded shape.



- 4 **Problem-solving** A shape is translated 3 squares left and 2 squares up.
It is then translated 6 squares right and 3 squares down.
- a What single translation has the same effect as these two translations combined?
 - b Explain how you can answer part a without drawing and translating shapes.

- 5 Reasoning** The diagram shows three squares A, B and C, on a square centimetre grid.



Write the ratio of the side lengths first.

- What is the scale factor of enlargement from A to B? 1:.....
- What is the scale factor of enlargement from A to C?
- What is the scale factor of enlargement from B to C?
- Complete this table.

Guided

Square	Perimeter (cm)	Area (cm ²)
A	8	4
B		
C		

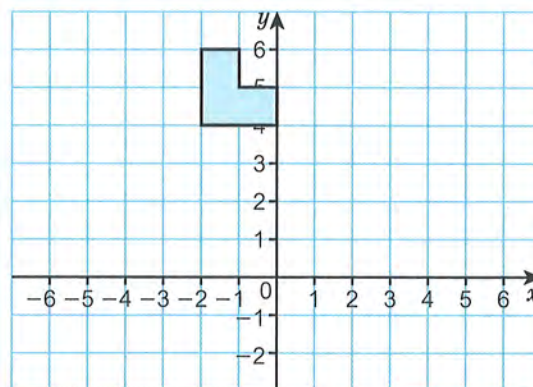
- Complete this table. Write each ratio in its simplest form.

Squares	Ratio of side lengths	Ratio of perimeters	Ratio of areas
A : B	1 : 2		
A : C			
B : C	2 : 3		

- What do you notice about the ratios you found in part e?

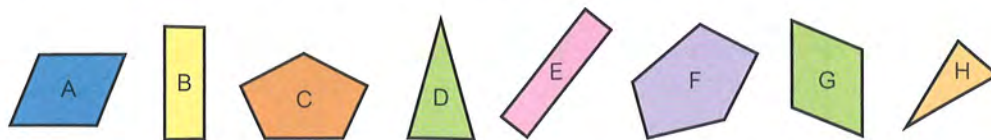
6 Reasoning

- Transform the blue shape on the grid below by carrying out a reflection in the line $y = -x$, followed by a rotation 90° clockwise about $(-2, -2)$. Label the image A.
 - Describe fully the single transformation that will take the image back to the object.



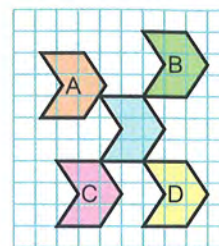
- Transform the blue shape by carrying out a reflection in the line $x = 1$, followed by a reflection in the line $y = x$, followed by a reflection in the y -axis. Label the image B.
 - Describe fully the single transformation that will take the image back to the object.

1 Which pairs of shapes are congruent?



2 The central arrow has been translated 2 right and 3 down.

Which is the correct image?

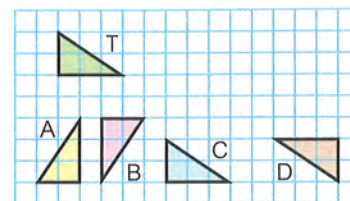


3 Which shape shows the position of triangle T after a

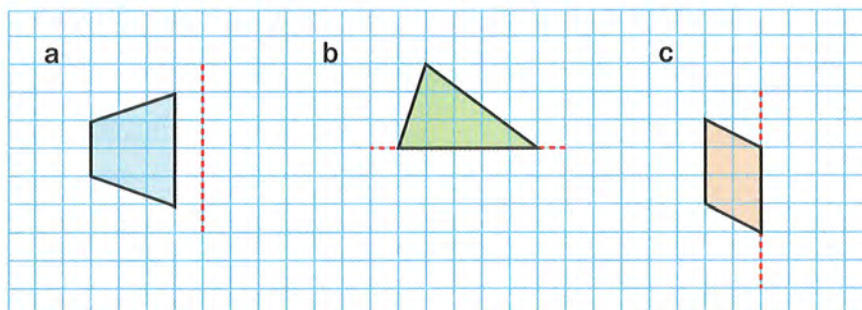
a $\frac{1}{2}$ turn

b $\frac{1}{4}$ turn clockwise

c $\frac{1}{4}$ turn anticlockwise?



4 Reflect the shapes in the mirror lines shown.



5 Draw the image of the triangle after each of these transformations.

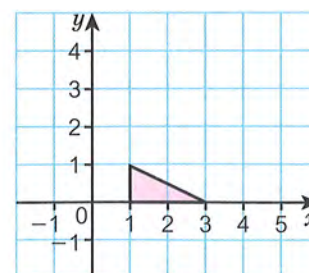
a Reflection in $x = 3$. Label this shape A.

b Reflection in $y = 2$. Label this shape B.

c Rotation 90° clockwise about $(1, 1)$. Label this shape C.

d Rotation 180° about $(3, 2)$. Label this shape D.

e Translation 3 squares left, 2 squares up. Label this shape E.



6 a Enlarge the shape by scale factor 3.

b Write the ratio of the length of the sides of the original shape to the enlarged shape.



- 1 Each of the fair spinners below is spun once.
For each spinner

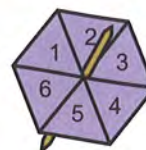
- i write all of the possible outcomes
ii write the total number of possible outcomes.



- a i
ii



- b i
ii



- c i
ii

An **outcome** is an end result. For example, one outcome of flipping a coin is heads.

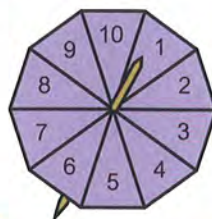
Literacy hint

'Fair' means that the spinner is equally likely to stop at any position.

- 2 Mya spins this fair spinner once.

- a What is the probability that it lands on

- i an even number $\frac{5}{10} = \frac{1}{2}$
ii a multiple of 3
iii a 2-digit number?



An **event** is something that may or may not happen.

Probability of an event happening

$$= \frac{\text{number of successful outcomes}}{\text{total number of possible outcomes}}$$

This formula only works if the outcomes are equally likely.

Successful outcomes are the outcomes you want.
There are 5 successful outcomes: 2, 4, 6, 8, 10.
The total number of possible outcomes is 10.

- b Write your answers as decimals.

- i ii iii

- c Write your answers as percentages.

- i ii iii

All probabilities have a value between 0 and 1. You can use fractions, decimals and percentages to describe probabilities.

- 3 a A bag has 13 red marbles and 15 yellow marbles.
Are you more likely to pick a red or yellow marble at random from the bag? Explain your answer.

Literacy hint

Picking an item at random means that each item has exactly the same chance of being picked.

- b Bag A has 9 milk chocolates and 7 white chocolates.
Bag B has 5 milk chocolates and 3 white chocolates.
Kate prefers milk chocolate.
Is she more likely to pick a milk chocolate at random from bag A or bag B? Explain your answer.

Calculate the probability of each event as a fraction.

- 4 **Problem-solving** Saif rolls this 20-sided fair dice.
Tick the correct statements.

- A Saif is more likely to roll a prime number than a multiple of 5.
B Saif has the same chance of rolling a factor of 20 as rolling a multiple of 3.
C Saif is less likely to roll an even number than a prime number.



A game is fair if each player has the same chance of winning.

Check

Tick each box as your **confidence** in this topic improves.



Need extra help? Go to page 105 and tick the boxes next to Q1 and 2. Then try them once you've finished 11.1 and 11.2.

- 1 Gary has 5 blue counters, 3 red counters and 1 silver counter in his pocket. He takes one out at random.

What is the probability that the counter is

a red or silver $\frac{\square}{9}$

There are $5 + 3 + 1 = 9$ counters altogether.
There are $3 + 1$ counters that are either red or silver.

b blue or silver $\frac{\square}{\square}$

c green

d blue or red or silver

- 2 Chantelle puts all the letters from her name into a box.

C H A N T E L L E

She then picks one of the letters at random. Find the probability that she picks

a a consonant $\frac{6}{9} = \frac{2}{3}$

b a vowel.

- 3 **Reasoning** A fair 4-sided spinner is spun once.

The probability of obtaining a 3 is the same as the probability of obtaining a 4.

a Complete the probability table.

Outcome	1	2	3	4
Probability	0.2	0.3		

- b Trish says that the probability of not obtaining a 3 is $\frac{3}{4}$. Is she correct? Explain your reasoning.

- 4 A sweet is taken at random from a bag containing various flavours. $P(\text{strawberry}) = 0.4$ $P(\text{lemon}) = 0.05$ $P(\text{blackberry}) = 0.2$
What is the probability that the sweet is

a strawberry or lemon $0.4 + 0.05 = \dots\dots\dots$

b strawberry, lemon or blackberry?

The other flavour sweet in the bag is lime.

c What is the probability that the sweet is lime?

$$P(\text{lime}) = \dots\dots\dots - P(\text{strawberry, lemon or blackberry}) = \dots\dots\dots - \dots\dots\dots = \dots\dots\dots$$

- 5 The probability of winning a prize at a fair stall is 0.03. What is the probability of not winning a prize?

- 6 **STEM** The chance of it raining in Sydney on a day in July is 42%. On the dry days, there is a 6% chance of cloud coverage. What is the probability that on a visit to Sydney in July, you will have a clear blue sunny sky with no rain?

Literacy hint

Picking an item at random means that each item has exactly the same chance of being picked.

Literacy hint

In the English alphabet A, E, I, O and U are vowels and all the other letters are consonants.

The probability of an event not occurring is $1 - P(\text{event occurring})$.

When events are mutually exclusive you can add their probabilities.

The sum of the probabilities of all the mutually exclusive outcomes is $\square$.

Worked example



The sum of the probabilities of all possible outcomes is $\square\%$.

Check

Tick each box as your confidence in this topic improves.



Need extra help? Go to page 105 and 106 and tick the boxes next to Q3–10. Then try them once you've finished 11.1–11.3.

Comparing and calculating probabilities

- ☐ 1 There are 20 sweets in a packet. Two of the sweets are blue. Ambia randomly selects a sweet from the packet.

Guided

a Write the probability that Ambia selects a blue sweet as

i a fraction in its simplest form $\frac{2}{20} = \frac{\square}{10}$

ii a decimal.....

$P(\text{event not occurring}) = 1 - P(\text{event occurring})$

b Find the probability that Ambia does not select a blue sweet.

- ☐ 2 Each of these spinners is spun once.

a Find the probability that

i spinner A will land on red

ii spinner B will not land on red.

b Misha says that the probability that the spinner will land on grey is the same for both spinners. Is she correct? Give reasons for your answer.



For spinner A, $P(\text{grey}) = \frac{\square}{4} = \frac{\square}{8}$

For spinner B, $P(\text{grey}) = \frac{\square}{8}$

- ☐ 3 These numbered counters are placed into a bag. One is picked at random.

1 1 2 2 3 3 3 3 4 5

a How many possible outcomes are there?

b How many of the possible outcomes are 3?

c Write the probability of picking a 3 as a fraction.

d Work out the probability of picking

i 1 or 2

ii 6

iii an even number

iv a number less than 4.

How many counters are in the bag in total?

$\frac{\text{number of 3s}}{\text{total number of counters}}$

- ☐ 4 This fair spinner is spun once. It is a fair spinner because it is equally likely to land on any edge.

a How many possible outcomes are there?

b Work out

i $P(\text{blue})$

What fraction of the spinner is blue?

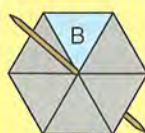
iii $P(\text{blue or yellow})$

v $P(\text{not blue})$

ii $P(\text{yellow})$

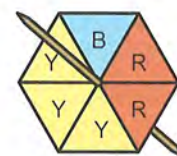
iv $P(\text{red or yellow})$

vi $P(\text{not yellow})$



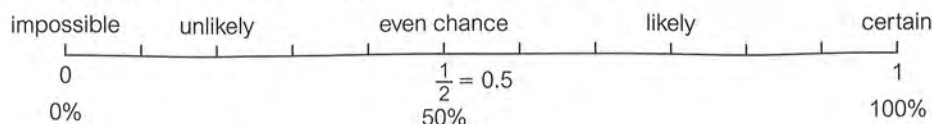
$P(\text{blue}) = \frac{1}{6}$

$P(\text{not blue}) = 1 - \frac{1}{6} = \frac{\square}{\square}$



How many edges are there?

- ☐ 5 Kate rolls an ordinary dice, numbered 1 to 6.
Mark each event on the probability scale with its letter.



Decide whether each event is impossible, unlikely, even chance, likely or certain.

The dice lands on

- A the number 1
- B an even number
- C the number 8
- D a number less than 4
- E a number greater than 0

Probability problems

- ☐ 6 Freya is a goalkeeper. The probability that she saves a penalty is 0.1.
What is the probability that Freya will not be able to save a penalty?

To find the probability of something not happening, subtract the probability of it happening from 1.

- ☐ 7 Weather forecasters predict that there is a 35% chance of rain tomorrow.
What is the probability that there will not be rain tomorrow?

Subtract the probability of the event happening from 100%

- ☐ 8 The computer hard drives made on a production line are either scrapped, repaired or passed.
2% are scrapped, 5% are repaired.
What is the probability that a hard drive is passed?

The sum of the probabilities of all possible outcomes is 100%.

- ☐ 9 Sarah has 4 orange sweets, 3 green sweets and 2 red sweets in a packet.
She takes one out at random.
What is the probability that the sweet is

Literacy hint

Picking an item at random means that each item has exactly the same chance of being picked.

Guided

- a orange or green $\frac{\square}{9}$
- b green or red
- c pink
- d orange or green or yellow

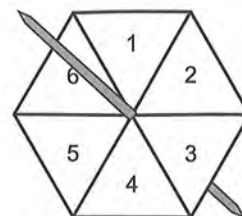
There are $4 + 3 + 2 = 9$ sweets altogether. There are $4 + 3$ sweets that are either orange or green.

Use equivalent fractions to help you.

- ☐ 10 Chan places 20 coloured marbles in a bag.
Five are green, six are blue and the rest are yellow.
Chan thinks that the probability of randomly picking up a yellow marble is the same as the probability of randomly picking a green marble.
Is he correct? Explain your answer.

- 1 Cara spins this six-sided spinner once.
Describe a possible event with each of these probabilities.

- a certain
b $\frac{1}{6}$
c 0
d likely



- 2 Ian has a biased dice. It has a 30% chance of landing on a 6.
What is the probability that the dice will *not* land on a 6?

Literacy hint

A biased dice is a dice that is not fair.

- 3 **Real** About 100 gannets are tagged each year on the island of Grassholm.
The island has a population of 80 000 gannets.

- a What is the probability that a particular gannet will be tagged next year?
Write your answer as a fraction in its simplest form.
b Describe this probability using words.
c What is the probability that a particular gannet will *not* be tagged?
Write your answer as a fraction.

Literacy hint

A gannet is a large sea bird.



- 4 Order these events from most likely to least likely.

Event		Probability
A	The school football team wins their next match by one goal.	0.25
B	The school football team wins their next match by more than one goal.	$\frac{1}{2}$
C	The school football team loses their next match.	20%
D	The school football team draws their next match.	$\frac{1}{20}$

- 5 Design a spinner that has three possible outcomes, red, blue and green, such that $P(\text{red}) = 0.4$ and $P(\text{blue}) = P(\text{green})$.

- 6 **Reasoning** Munmun has a set of 40 cards. Ten are green, ten are red, ten are blue and ten are yellow. Each colour contains cards numbered from 1 to 10.

Munmun selects a card at random. Write down the probability that the card is

- a a 6 or a 7
b a red 3
c not a green card.

- 7 Reasoning** Every lunch break Raj buys one healthy snack from the school shop. He chooses sliced apple, carrot sticks or a banana.

The probabilities of each snack are shown in the table.

Snack	sliced apple	carrot sticks	banana
Probability	0.2	x	x

The probability of Raj buying carrot sticks is the same as him buying a banana.

- a** Calculate the probability of Raj buying carrot sticks.

The cost of each snack is shown in this table.

Snack	sliced apple	carrot sticks	banana
Cost (cents)	90	80	90

- b** Find the probability that, on a randomly chosen day, Raj will spend 90 cents on a healthy snack.

- 8 STEM** The table shows the percentage of breakdowns caused by different types of fault in a certain type of car.

Car part	Probability (%)
steering	5
engine	28
ignition	13
transmission	33
fuel system	12
CPU	

A car breaks down.

Find the probability that

- a** it has a faulty CPU
- b** it does not have a faulty engine or transmission.

- 9** Kobi's local weather forecasting station predicts that there is a 60% chance of thundery showers tomorrow.

Kobi says that he doesn't need to take an umbrella with him when he goes out.

Do you agree with Kobi? Give a reason for your answer.

1 An ordinary fair dice numbered 1 to 6 is rolled once.
Write down the probability of rolling

- a a 2
- b a number less than 3
- c a number that is not a factor of 4.

2 Hind puts the letters of his name in a box and picks one letter at random.

- a Find the probability that Hind picks a vowel letter.
Abdullah does the same thing using his own name and a new box.
- b Find the probability that Abdullah picks a consonant letter.
- c Write down which of them is more likely to pick a vowel letter.

3 These cards are shuffled and placed face down.

1 1 1 2 2 4 4 5 5 6

The top card is then turned over.

- a List the possible outcomes
- b Work out the probability that the top card is
 - i 6
 - ii odd
 - iii not 3.

4 This table shows the probabilities of picking different colour marbles from a bag.

Colour	red	blue	green	white
Probability	0.1		0.2	

There are twice as many white marbles in the bag as green ones.
Work out

- a $P(\text{white})$
- b $P(\text{blue})$.

5 Nazeer rolls a fair 10-sided dice. Rekha rolls a fair 20-sided dice.

Rekha says, 'I am more likely than Nazeer to roll a multiple of 3 because my dice has more numbers that are in the 3-times table'.

Is Rekha correct? Give a reason for your answer.

.....

Progression charts

Progression is all about checking your confidence in the maths that you're learning.

- For each Unit test, tick the questions you answered correctly.
- Then rate your confidence by ticking a smiley face.

1 Analysing and displaying data

I can...	Unit 1: Unit test
Find the mean, median, mode and range of a set of data.	Q2 ☐ Q3 ☐
Use two-way tables and interpret compound bar charts.	Q1 ☐
Group continuous data and draw grouped frequency diagrams.	Q4 ☐
Analyse and present data using spreadsheets in a computer software program.	Q5 ☐
My confidence	

2 Number

I can...	Unit 2: Unit test
Use rules for divisibility by 2, 3, 4, 5, 9 and 10.	Q1 ☐
Find the HCF and LCM of two numbers.	Q2 ☐ Q3 ☐
Compare and order positive and negative numbers.	Q4 ☐
Add and subtract positive and negative numbers.	Q5 ☐
Calculate with squares and square roots.	Q6 ☐ Q7 ☐ Q9 ☐
Carry out calculations involving squares, cubes, square roots and cube roots.	Q8 ☐ Q10 ☐
My confidence	

3 Equations, functions and formulae

I can...	Unit 3: Unit test
Simplify expressions by collecting like terms.	Q8 ☐ Q9 ☐ Q10 ☐
Write expressions and formulae using four operations.	Q5 ☐ Q6 ☐
Substitute into formulae and expressions.	Q1 ☐ Q2 ☐ Q3 ☐ Q7 ☐ Q12 ☐ Q13 ☐
Expand expressions involving brackets.	Q4 ☐ Q11 ☐
My confidence	

4 Fractions

I can...	Unit 4: Unit test
Compare and simplify fractions.	Q1 Q2
Work out simple fractions of amounts.	Q3 Q4
Add and subtract fractions and mixed numbers.	Q5 Q10 Q11
Work with equivalent fractions, decimals and percentages.	Q9
Convert between improper fractions and mixed numbers.	Q6 Q7
Multiply by a fraction or mixed number.	Q8 Q12 Q13
My confidence  ☐  ☐  ☐	

5 Angles and shapes

I can...	Unit 5: Unit test
Solve problems involving angles.	Q1
Use properties of a triangle to work out unknown angles.	Q2 Q3 Q4
Solve problems involving quadrilaterals.	Q6 Q7
Draw diagrams to scale.	Q5 Q8
My confidence  ☐  ☐  ☐	

6 Decimals and percentages

I can...	Unit 6: Unit test
Round decimals to 1 decimal place.	Q7
Write decimals in ascending and descending order.	Q6 Q11
Add and subtract decimals.	Q2
Multiply and divide decimals.	Q5 Q8
Convert between percentages, decimals and fractions.	Q3 Q4
Mentally calculate a percentage of an amount.	Q1 Q9 Q10
My confidence  ☐  ☐  ☐	

7 Ratio and proportion

I can...	Unit 7: Unit test
Write a ratio in its simplest form.	Q1 Q3 Q8
Share a quantity into two parts in a given ratio.	Q2 Q4
Understand the relationship between ratio and proportion.	Q5 Q9 Q10
Solve simple word problems involving ratio and direct proportion.	Q6
Solve simple word problems involving ratio and inverse proportion.	Q11
Solve best-buy problems.	Q7
My confidence  ☐  ☐  ☐	

8 Measure and shapes

I can...	Unit 8: Unit test
Convert between metric units of measures of length, mass and capacity.	Q3
Find the perimeter of regular polygons with one side given.	Q1
Calculate the area and perimeter of squares, rectangles and compound shapes.	Q2 Q6
Solve perimeter and area problems.	Q4
Identify properties and 3D symmetry of 3D solids, including cubes, cuboids, pyramids and prisms.	Q5 Q7
My confidence  ☐  ☐  ☐	

9 Sequences and graphs

I can...	Unit 9: Unit test
Work out a given term in a simple arithmetic sequence.	Q2
Work out and use expressions for the n th term in an arithmetic sequence.	Q4
Generate sequences and predict how they will continue.	Q1
Recognise geometric sequences.	Q3
Work out the midpoint of a line segment.	Q5
Draw straight-line graphs using a table of values.	Q6 Q8
Solve problems involving coordinates and straight lines.	Q7
My confidence  ☐  ☐  ☐	

10 Transformations

I can...	Unit 10: Unit test
Identify congruent shapes.	Q1
Enlarge shapes using given scale factors.	Q6
Recognise and carry out reflections in a mirror line.	Q4
Recognise and carry out rotations.	Q3
Translate 2D shapes.	Q2
Reflect, rotate and translate a shape on a coordinate grid.	Q5
My confidence  ☐  ☐  ☐	

11 Probability

I can...	Unit 11: Unit test
Calculate and compare probabilities.	Q1 Q2 Q5
Calculate more complex probabilities.	Q3 Q4
My confidence  ☐  ☐  ☐	

Maths Progress 7

International 11–14

Progress with confidence

Our innovative Workbooks focus on building your confidence in maths and letting you take control of your learning.

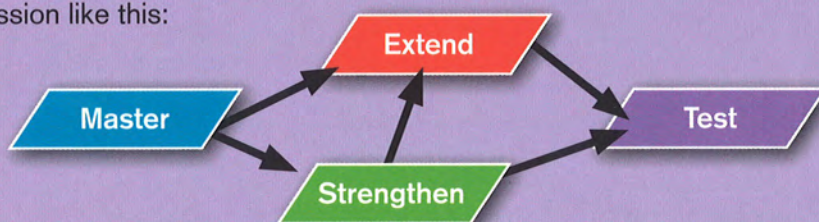
- Chart how well you're doing against specific learning objectives with progression charts for each unit.
- Keep track of your strengths and weaknesses with confidence checkers at the end of each lesson.
- Take control of your work and progression with loads of write-in practice.

The Workbooks also offer plenty of dynamic support to help build your confidence in maths.

- Get direct access to worked example videos on your phone or tablet using the QR codes, providing crucial support for tricky questions.
- Help structure your answers with guided questions and partially worked solutions.
- Break down any barriers to learning with hints and key learning points for each topic.

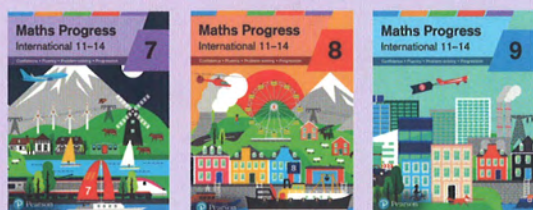
Our unique unit structure

Each unit of the course enables progression like this:



Also available in the series:

Student books



Workbooks



ActiveLearn provides online planning, teaching, homework and assessment resources, including a free interactive Scheme of Work.