

BGE S1-S3



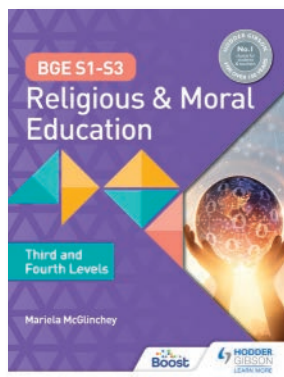
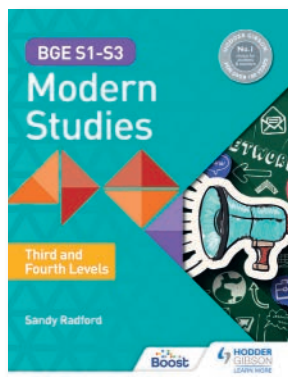
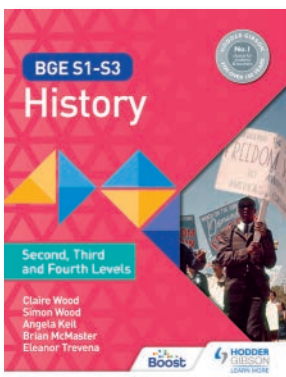
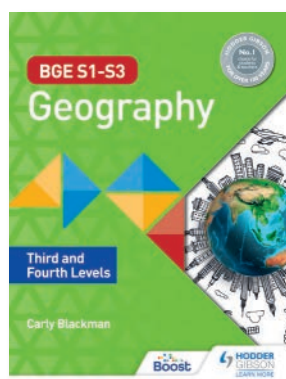
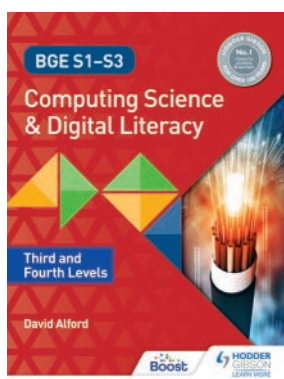
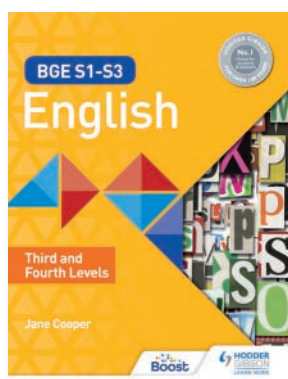
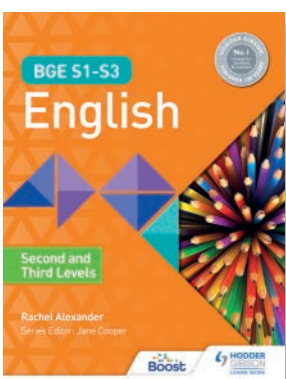
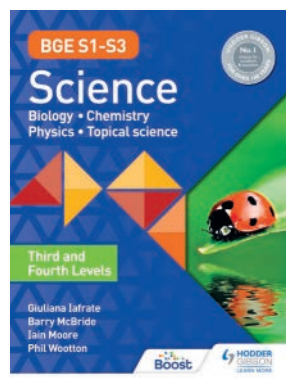
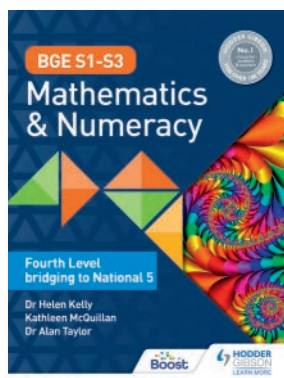
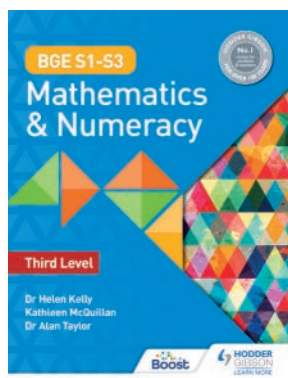
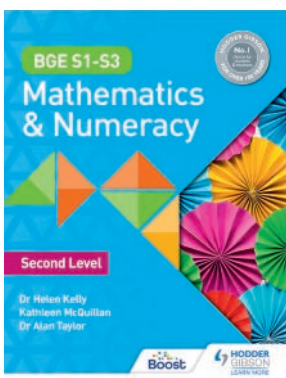
Mathematics & Numeracy

Second Level

Dr Helen Kelly
Kathleen McQuillan
Dr Alan Taylor



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Contents

Introduction	1		
1 Whole numbers	2	5 Angles	60
Place value	2	Types of angles	60
Adding whole numbers	4	Measuring angles	62
Subtracting whole numbers	6	Drawing angles	67
Multiplication and division facts	8	Calculations with angles	69
Multiplying whole numbers by a single digit	10	Angles in triangles	72
Dividing whole numbers by a single digit	12	Compass points and directions	74
Multiplying and dividing whole numbers by 10, 100 and 1000	14	Using scale	76
Multiplying and dividing by multiples of 10, 100 and 1000	16	Check-up	78
Rounding whole numbers	18	6 Measurement	80
Multiplying by a two-digit number	20	Reading scales	80
Estimating	21	Estimate and measure	82
Order of operations	22	Conversion between units of length	84
Check-up	24	Conversion between units of weight	86
2 Negative numbers	26	Conversion between units of volume	87
Negative numbers	26	Adding and subtracting different metric units	88
Adding and subtracting	28	Check-up	90
Check-up	32	7 2D shape and 3D objects	92
3 Decimals	34	Perimeter	92
Place value	34	Area of squares and rectangles	94
Ordering decimals	36	Area of right-angled triangles	96
Adding and subtracting decimals	38	Drawing squares and rectangles	98
Single digit multiplication	40	Circle	99
Single digit division	42	Quadrilaterals and polygons	100
Multiplying and dividing decimals by 10, 100 and 1000	44	3D objects	102
Rounding decimals	46	Drawing prisms	104
Check-up	48	Nets	105
4 Multiples, factors and sequences	50	Volume of cubes and cuboids	106
Multiples	50	Check-up	108
Factors	52	8 Fractions and percentages	110
Sequences	54	Fractions of an amount	110
Square numbers and triangular numbers	56	Equivalent fractions	112
The Fibonacci sequence	57	Simplifying fractions	114
Check-up	58	Percentages	115
		Percentages of an amount	116
		Percentages of an amount (calculator)	119
		Check-up	120

9 Time	122	12 Coordinates and symmetry	154
12- and 24-hour clock	122	Coordinates	154
Units of time	125	Lines of symmetry	158
Time intervals	128	Check-up	162
Timetables	130	13 Data	164
Journeys	132	Gathering data	164
Check-up	134	Frequency tables	165
10 Money	136	Bar graphs	166
Money calculations	136	Line graphs	169
Profit and loss	138	Pie charts	172
Budgeting	140	Using technology	174
Money: making choices	142	Misleading statistics	175
Check-up	144	Probability	176
11 Algebra	146	Check-up	178
Simplifying expressions	146	14 Project	180
Evaluating expressions	148	Mathematical advances and inventions: codes and ciphers	180
Solving equations	150	Answers	183
Check-up	152		

Introduction to BGE Mathematics

► How to get the most from this book

Mathematics is the richest language in the world. Learning mathematics is one of the most important things you can do to boost your brain power, now and throughout your life. Mathematicians understand, describe and influence the world around us. This book covers all the BGE Benchmarks for Mathematics at Second Level.

The chapters take you on a journey which will both support and challenge you. As you focus and work hard on each section you will gain knowledge, understanding and the ability to solve problems and communicate your solutions to others.

Working through this book will equip you to be the best mathematician you can be. Every topic is explained with rigour, taking no short cuts, and has an abundance of practice and challenge to suit every learner. The book is ambitious, encouraging you to aim high and build the skills you need for future success.

The book is enjoyable and easy to read. Every topic includes a clear, 'straight-to-the-point' method set out using bullet points in concise and simple language. It is full of worked examples and helpful hints and contains proven methods for mastering difficult concepts. This book has been designed both as a classroom aid and for your personal study.

Each lesson starts with an explanation and a memorable method to which you can refer.

Each lesson has planned and progressive worked examples which prepare you to tackle the problem set.

13 Data

► Bar graphs

A bar graph displays the frequency of items using bars of different heights. To draw a bar graph:

- Choose an appropriate and consistent scale.
- Draw bars of the correct height. Use a ruler.
- Label the axes and each bar. Add a title.

Worked example

A class carry out an experiment with mentos and fizzy drinks. The results are shown.

a) Draw a bar graph to display the results.

You must use a ruler.

Label the grid lines with tick marks not the spaces between them.

Label the y-axis to go up in 10s. You would need 125 boxes to go up in 1s!

Use a pencil at first and count out your scale to check you have space.

Fizzy drink	Height of explosion (cm)
Coke	75
Diet Cola	110
Lemonade	90
Orange Fizz	125
Tropical	70

Each bar must be the same width.

Each space between the bars must be the same width. You must use a ruler and label each bar.

Remember to add labels to both axes and give your graph a title.

b) List the drinks from highest to lowest explosion.
Orange Fizz, Diet Cola, Lemonade, Cola, Tropical.

c) What was the difference in height between the highest and lowest explosions?
Orange Fizz – Tropical = 125 – 70 = 55 cm

Exercise 13C

1. The results of a trial of different plant foods are shown.

a) Draw a bar graph to display the results.

b) Which plant food would you recommend?

c) Find the difference between the largest and smallest number of saplings.

d) Sprout claims to 'double the number of saplings'. Do you agree with this claim? Explain your answer.

Plant food used	Number of saplings
Water only	5
Bioforce	13
Groen F2	10
Senor	8
Reader	15

2. Five house groups raise money for charity. The table shows the totals raised.

a) Draw a bar graph to display the results. Choose a scale to display up to £800 easily. For example, go up in 50s.

b) Which house group raised the most money?

c) List the house groups from most money raised to least.

d) How much more than Jordan house did Napier house raise?

e) Find the total amount of money which all five houses raised for charity.

House group	Total raised
Somerhill	£300
Warr	£500
Napier	£600
Jordan	£400
Barbour	£800

3. The bar graph shows the total number of medals won by some of the countries in the 2014 Glasgow Commonwealth Games.

a) Write out the countries shown in order from the most medals won to the least.

b) Scotland won 53 medals in total. How many more than New Zealand was this?

c) How many medals did Kenya and South Africa win altogether?

d) Australia won 137 medals at the games. Do you think this graph is misleading? Explain why.

Work through the exercise to practise and consolidate your skills. There are solutions at the end of the book, so check your work as you go to boost your confidence.

Each exercise gets progressively harder. Try to finish the exercises and test your skills with the most challenging problems.

Every chapter has a check-up exercise. Use these to bring your ideas together and boost your memory of key methods.

We hope that you enjoy using this book as much as we have enjoyed creating the content, questions and activities for you!

► Multiplying whole numbers by a single digit

To multiply whole numbers by a single digit:

- Set out the calculation neatly as shown here.
- **Multiply** the digits in each place value in turn. Start from the units on the right.
- If the result is 10 or greater, set down the units digit and **carry** the tens digit into the next column. See the Worked examples below.

The **product** of two numbers is the result of multiplying them together.

Worked examples

1 Calculate:

a) 21×4

$$\begin{array}{r} 21 \\ \times 4 \\ \hline 84 \end{array}$$

b) 624×8

$$\begin{array}{r} 624 \\ \times 8 \\ \hline 4992 \end{array}$$

c) 8596×9

$$\begin{array}{r} 8596 \\ \times 9 \\ \hline 77364 \end{array}$$

2 A venue sells 4424 tickets each costing £7.

Calculate the total takings.

The total takings are £30968.

$$\begin{array}{r} 4424 \\ \times 7 \\ \hline 30968 \end{array}$$

Look at example 1a). There is no need to carry any digits.

Step 1 $4 \times 1 = 4$ Step 2 $4 \times 2 = 8$

Look at example 1b). You have to carry twice.

Step 1 $8 \times 4 = 32$. Set down the 2 units and carry the 3 (tens) into the next column.

Step 2 $8 \times 2 = 16$ and add the 3 (tens) you carried, $16 + 3 = 19$ (tens). You set down the 9 (tens) and carry the 1 (hundred) into the next column. Remember 10 tens is 100.

Step 3 $8 \times 6 = 48$ and add the 1 you carried, $48 + 1 = 49$ (hundreds). As this is the last place value you set down both digits.

Exercise 1E

1 Set down and multiply:

a) $\begin{array}{r} 34 \\ \times 2 \\ \hline \end{array}$

b) $\begin{array}{r} 23 \\ \times 3 \\ \hline \end{array}$

c) $\begin{array}{r} 16 \\ \times 4 \\ \hline \end{array}$

d) $\begin{array}{r} 47 \\ \times 5 \\ \hline \end{array}$

e) $\begin{array}{r} 241 \\ \times 2 \\ \hline \end{array}$

f) $\begin{array}{r} 152 \\ \times 3 \\ \hline \end{array}$

g) $\begin{array}{r} 412 \\ \times 8 \\ \hline \end{array}$

h) $\begin{array}{r} 784 \\ \times 6 \\ \hline \end{array}$



2 Calculate:

a) 43×7

b) 27×8

c) 642×3

d) 385×5

3 Maxine sells 246 pens online and makes a profit of £8 on each one.

Calculate Maxine's total profit.

4 Set down and multiply:

a)
$$\begin{array}{r} 2 \quad 6 \quad 3 \quad 4 \\ \times \quad \quad \quad 2 \\ \hline \end{array}$$

b)
$$\begin{array}{r} 1 \quad 0 \quad 8 \quad 5 \\ \times \quad \quad \quad 3 \\ \hline \end{array}$$

c)
$$\begin{array}{r} 8 \quad 7 \quad 1 \quad 6 \\ \times \quad \quad \quad 4 \\ \hline \end{array}$$

d)
$$\begin{array}{r} 4 \quad 5 \quad 3 \quad 2 \\ \times \quad \quad \quad 6 \\ \hline \end{array}$$

5 Calculate:

a) 1432×5

b) 6241×9

c) 7038×6

d) 9876×7

6 A band sells 6824 T-shirts and makes a profit of £7 on each one.

Calculate the band's total profit.

7 Here are some attempted calculations. They are all wrong! Describe the mistakes in each one.

a)
$$\begin{array}{r} 1 \quad 8 \quad 5 \\ \times \quad 5 \quad 3 \quad 7 \\ \hline 1 \quad 2 \quad 6 \quad 5 \end{array}$$

b)
$$\begin{array}{r} 2 \quad 7 \quad 8 \quad 5 \\ \times \quad 6 \quad 6 \quad 4 \quad 8 \\ \hline 1 \quad 6 \quad 2 \quad 8 \quad 0 \end{array}$$

c)
$$\begin{array}{r} 4 \quad 0 \quad 8 \quad 9 \\ \times \quad \quad 8 \quad 8 \quad 9 \\ \hline 3 \quad 2 \quad 8 \quad 0 \quad 1 \end{array}$$

8 Mrs Dunlop takes a delivery for the mathematics department.

Textbooks



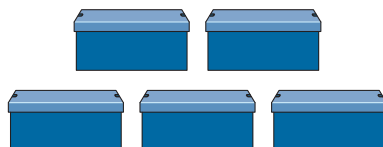
Three boxes of textbooks.

Each box contains 48 textbooks.

Calculate the total number of:

a) textbooks

Pencils

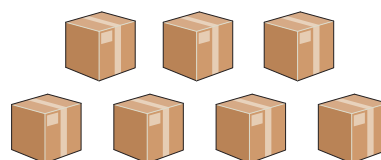


Five boxes of pencils.

Each box contains 189 pencils

b) pencils

Jotters



Seven boxes of jotters.

Each box contains 228 jotters.

c) jotters

9 A 3D printer is making pencil pots. It takes 1263 seconds to print one pot.

How long would it take to print 9 pots?

10 The table shows prices for a week at a holiday resort.

a) Calculate the cost for 4 adults staying all-inclusive.

b) Calculate the cost for 7 adults staying self-catering.

c) Calculate the cost for 4 adults and 5 children staying all-inclusive.

d) The family in part c) decides they would prefer self-catering. Calculate the cost for 4 adults and 5 children self-catering.

e) How much does the family of 4 adults and 5 children save by choosing self-catering over all-inclusive?

	Self-catering	All-inclusive
Adult	£315	£632
Child	£148	£243

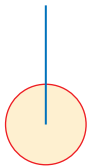
11 An empty crate weighs 400 g. Six identical tins are added to the crate. Each tin weighs 285 g. Calculate the total weight of the crate and the tins.

5 Angles

► Types of angles

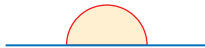
Whenever two straight lines meet, an **angle** is formed. An angle is a measure of the turn between two straight lines. The units we use to measure angles are called **degrees** and the instrument we use is called a **protractor**. We use the symbol $^{\circ}$ as a shorthand for degrees.

A **full turn** is 360° .



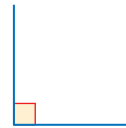
A half turn is 180° .

$\frac{1}{2}$ of $360^{\circ} = 180^{\circ}$. We call this a **straight angle**.

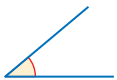


A quarter turn is 90° .

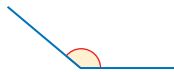
$\frac{1}{4}$ of $360^{\circ} = 90^{\circ}$. We call this a **right angle**.



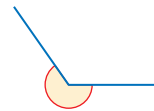
Any angle smaller than 90° is called an **acute** angle.



Any angle between 90° and 180° is called an **obtuse** angle.

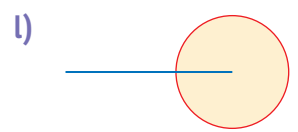
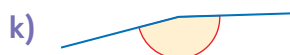
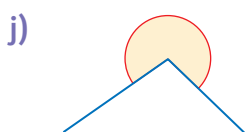
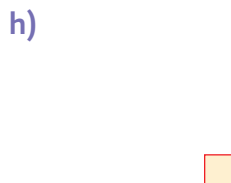
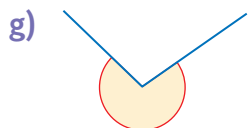
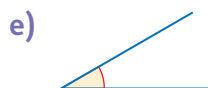
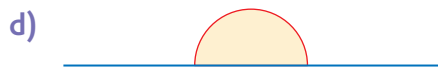
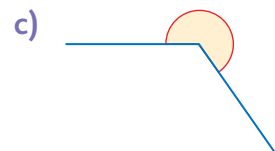
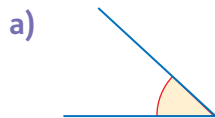


Any angle between 180° and 360° is called a **reflex** angle.



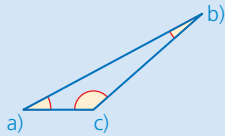
Exercise 5A

- 1 Choose a word from the following list to describe each angle.
acute, right, obtuse, straight, reflex, full turn



Worked examples

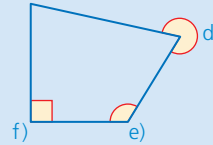
- 1 Choose the correct word to describe each marked angle in these diagrams.



The angle at a) is less than a right angle, so it is **acute**.

The angle at b) is **acute**.

The angle at c) is between 90° and 180° so it is **obtuse**.



The angle at d) is a **reflex** angle.

The angle at e) is an **obtuse** angle.

The angle at f) is a **right angle**.

- 2 Choose the correct word to describe each angle.

a) 70°

70° is less than 90° , so it is an **acute** angle.

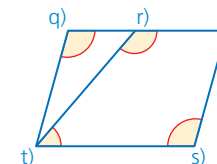
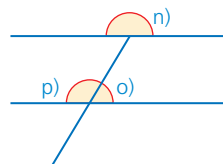
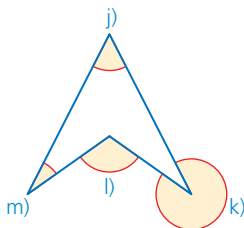
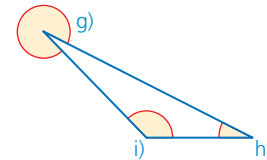
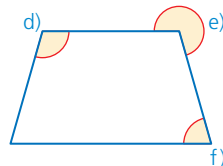
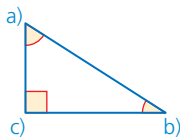
b) 219°

219° is greater than 180° , so it is a **reflex** angle.

c) 104°

104° is between 90° and 180° , so it is an **obtuse** angle.

- 2 Choose the correct word to describe each labelled angle in these diagrams.



- 3 Choose the correct word from the following list to describe each angle.

acute, right, obtuse, straight, reflex, full turn

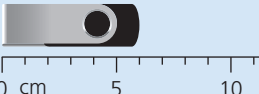
- | | | | | |
|----------------|----------------|----------------|----------------|----------------|
| a) 40° | b) 120° | c) 100° | d) 90° | e) 250° |
| f) 145° | g) 75° | h) 315° | i) 205° | j) 85° |
| k) 107° | l) 3° | m) 219° | n) 141° | o) 180° |
| p) 58° | q) 1° | r) 183° | s) 136° | t) 314° |
| u) 155° | v) 360° | w) 91° | x) 89° | y) 280° |

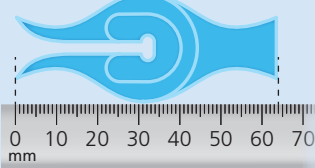
6 Measurement

► Reading scales

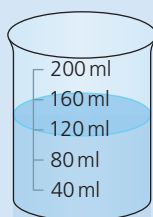
When reading scales, you may have to work out the value of each space first.

Worked examples

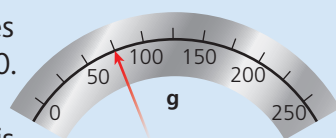
1  Each space is 1 cm.
The USB stick is 6 cm long.

2  Each small space is 1 mm.
The clothes peg is 64 mm long.

3 The beaker has 120 ml of liquid in it.
 $80 - 40 = 40$ so each space on the scale is 40 ml.

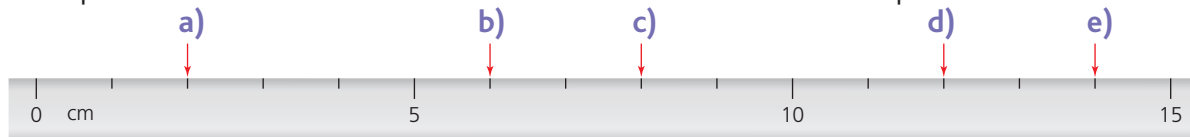


4 There are two spaces between 50 and 100.
If two spaces are 50 g then one space is $50 \div 2 = 25$ g.
The scale measures $50 + 25 = 75$ g.

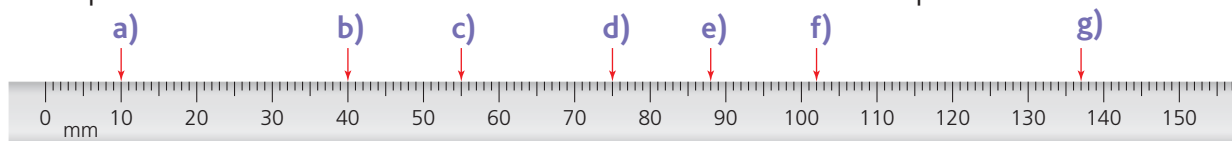


Exercise 6A

- 1** Each space on this ruler is 1 cm. Write down the measurement of each pointer.

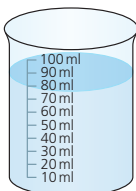


- 2** Each space on this ruler is 1 mm. Write down the measurement of each pointer.

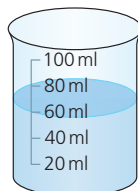


- 3** Write down how much liquid is in each beaker.

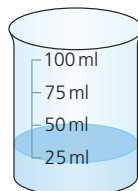
Beaker A



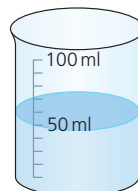
Beaker B



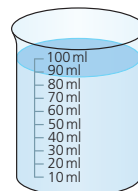
Beaker C



Beaker D

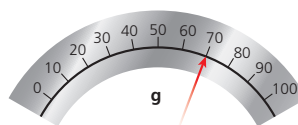


Beaker E



- 4** For each scale, write down the weight measured.

Scale A



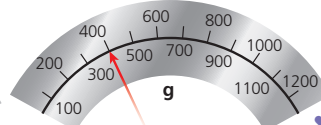
Scale B



Scale C

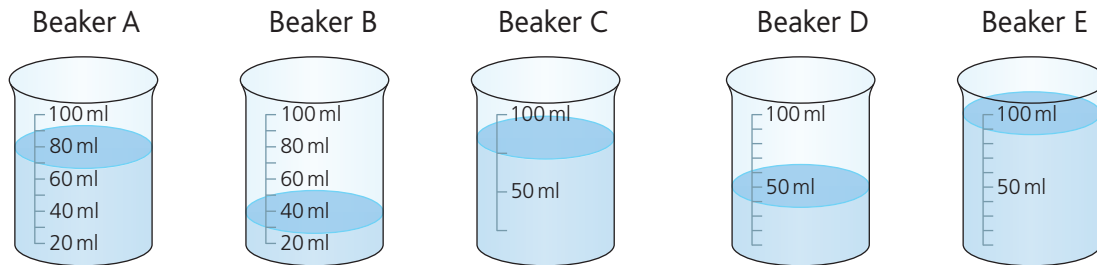


Scale D



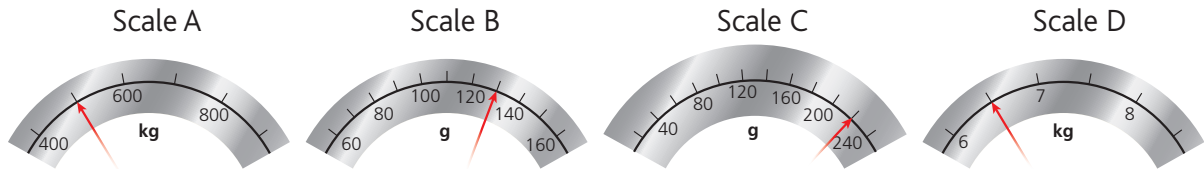
5 For each beaker:

- a) work out the size of each space on the scale b) write down how much liquid is in it.

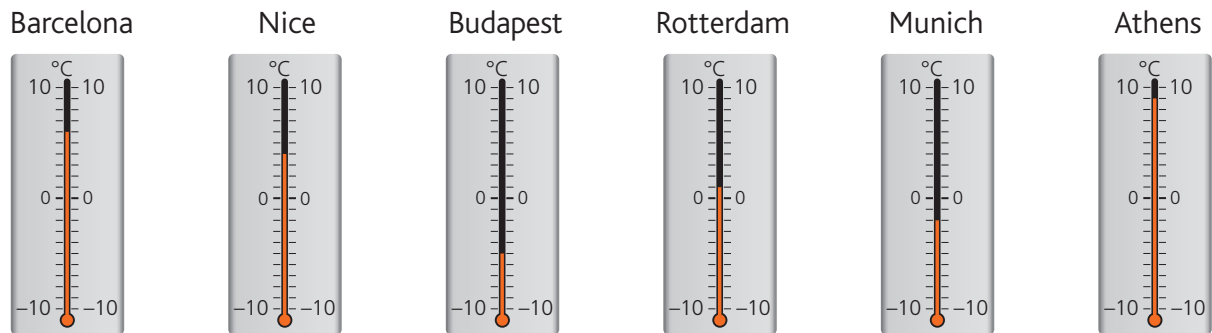


6 For each scale:

- a) work out the size of each space b) write down the weight measured.

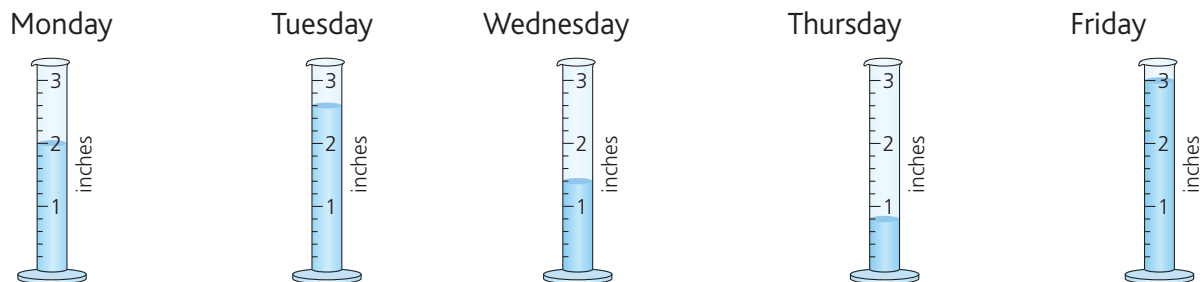


7 These thermometers show the temperature in different cities at a given time.



- a) Write down the temperature in each city.
b) What is the difference in temperature between the warmest and the coldest city?

8 As part of a geography project, Anne has a beaker in her garden to measure the amount of rainfall every day for five days. Here are Anne's results:



- a) On which day was there 1.4 inches of rainfall?
b) How much rainfall was there on Tuesday?
c) How much more rainfall was there on Friday compared to Thursday?
d) Order the days from the most amount of rainfall to the least amount of rainfall.

► Quadrilaterals and polygons

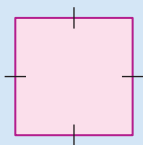
A **quadrilateral** is a shape with 4 straight **edges** (or sides). The edges meet at a **vertex** (or corner). The plural of vertex is **vertices**. A straight line from one vertex to another vertex which is not an edge is called a **diagonal**.

More generally, any 2D shape with straight edges is a **polygon**. When all sides of a polygon are the same length, it is a **regular** polygon. When the sides are not the same length, the polygon is **irregular**.

Worked examples

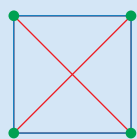
Copy and complete the tables.

1



Name	
Number of edges	
Number of vertices	
Number of diagonals	

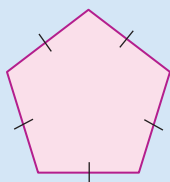
The small lines tell you that each edge is the same length so the quadrilateral is a square.



Name	Square
Number of edges	4
Number of vertices	4
Number of diagonals	2

There are four edges (shown in blue).
There are four vertices (shown in green).
There are two diagonals (shown in red).

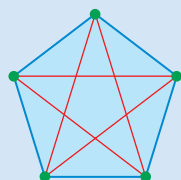
2



Name	
Regular?	
Number of edges	
Number of vertices	
Number of diagonals	

A polygon with 5 edges is a pentagon.

The small lines tell you that each edge is the same length so the polygon is regular.



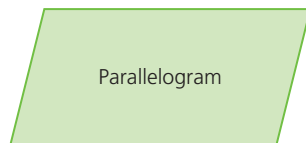
Name	Pentagon
Regular?	Yes
Number of edges	5
Number of vertices	5
Number of diagonals	5

There are five edges (shown in blue).
There are five vertices (shown in green).
There are five diagonals (shown in red).

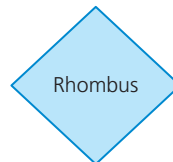
Other quadrilaterals and polygons include:



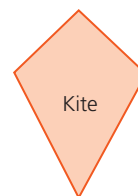
Rectangle



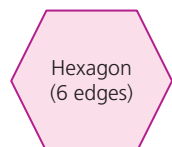
Parallelogram



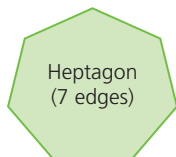
Rhombus



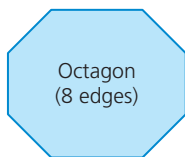
Kite



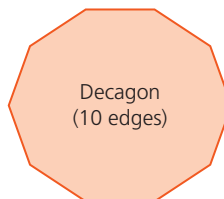
Hexagon
(6 edges)



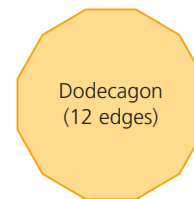
Heptagon
(7 edges)



Octagon
(8 edges)



Decagon
(10 edges)

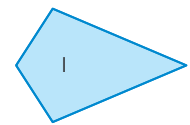
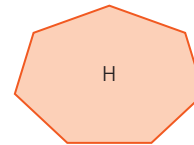
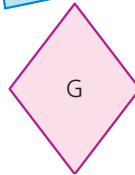
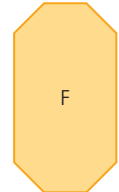
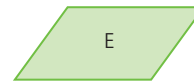
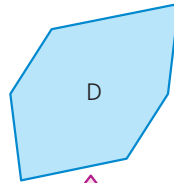
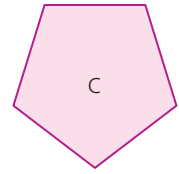
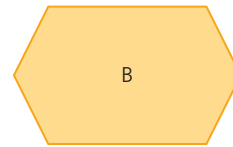
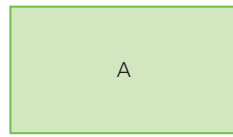


Dodecagon
(12 edges)

Exercise 7F

- 1 Copy and complete the table to show which of the following shapes are quadrilaterals and which are examples of other polygons. The first two have been done for you.

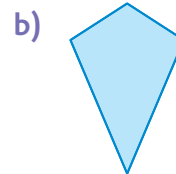
Shape	Quadrilateral	Other Polygon
A	✓	
B		✓
C		
D		
E		
F		
G		
H		
I		



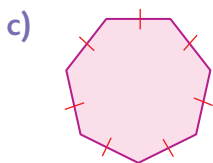
- 2 Name each of the shapes in Q1. Choose from kite, octagon, rhombus, hexagon, rectangle, pentagon, heptagon, parallelogram.
- 3 Copy and complete the following tables for the shapes given. Draw a sketch of the shape and mark the diagonals if this helps you.



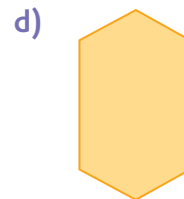
Name	
Number of edges	
Number of vertices	
Number of diagonals	



Name	
Number of edges	
Number of vertices	
Number of diagonals	

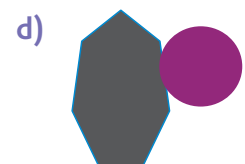


Name	
Regular?	
Number of edges	
Number of vertices	
Number of diagonals	



Name	
Regular?	
Number of edges	
Number of vertices	
Number of diagonals	

- 4 Each diagram below is produced by joining two shapes together. Write down the two shapes used in each diagram.



- 5 The shaded area in each diagram below is produced by removing one shape from the inside of another shape. Write down the two shapes used in each diagram.



Check-up



- 1 Bill is doing a survey to find out about sleep habits. He plans this question:

Q. Do you get lots of sleep?

- Do you think Bill's question will produce good data? Explain your answer.
- Write a better question for Bill. Include options for the answer.

- 2 Kaiwan carries out a traffic survey. He records the data shown here.

car, bike, van, car, car, bus, van, bike, car, van, bike, scooter, car, bike, car, car, bus, van, bike, car, scooter, bike, car, bus, bike, bus, car, bike, car, bike, van, car, scooter, bike

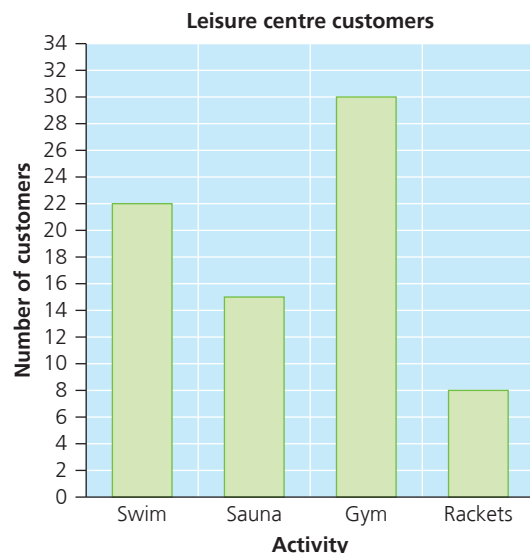
- Copy and complete the frequency table to organise the data.

Vehicle	Tally	Frequency
Car		
Bus ...		

- List the vehicle types from most to least common.
- Find the total number of bikes and scooters.
- Find the total number of vans, buses and cars.

- 3 A leisure centre records data on customer visits one Sunday. The bar graph shows the results.

- List the activities from most to least popular.
- How many customers used the sauna?
- The manager thinks swimming is three times more popular than rackets. Do you agree? Give evidence.
- Find the difference between the number of customers using the gym and the number going for a swim.
- All the visitors only did one activity. Calculate the total number of visitors that Sunday.



- 4 The table shows the number of goals scored at the 2018 FIFA World Cup by players from different leagues around the world.

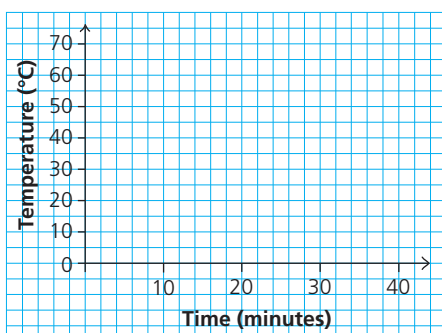
- Draw a bar chart to display the data.
- List the leagues from the most goals scored to the least.
- How many more goals were scored by players from La Liga than by players from Serie A?
- Jen thinks the Premier League players scored four times as many goals as the Ligue 1 players. Is Jen correct? Give evidence for your answer.

League	Number of goals scored
Bundesliga	13
Serie A	8
Ligue 1	14
Premier League	46
La Liga	36



- 5 The table shows the results of a test on a disposable coffee cup.

- a) Draw a line graph to display the results.
Set up your axes as shown.



Disposable coffee cup	
Time (minutes)	Temperature (°C)
0	60
10	40
20	35
30	25
40	20

- b) It is claimed that the cup 'keeps 50% of heat for 30 minutes'. Do you agree with this claim? Give evidence for your answer.
c) Estimate the temperature of the coffee in the disposable cup after 35 minutes.

A new **reusable** coffee cup is tested. The table shows the results.

- d) Add a new line to your graph which shows the temperature of the coffee in the new reusable cup.
Label the lines clearly. Add colour and a key like this.

— Disposable cup

— Reusable cup

- e) Which cup would you recommend? Give two reasons for your answer.

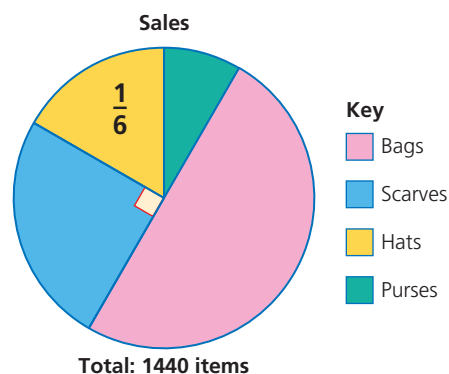
Reusable coffee cup	
Time (minutes)	Temperature (°C)
0	60
10	50
20	45
30	40
40	38

- f) Copy and complete the claim for the reusable cup: 'Keeps 75% of heat for _ minutes'.

- 6 A Scottish fashion brand sold 1440 items.

The pie chart shows the different items sold.

- a) How many bags did the brand sell?
b) How many scarves did they sell?
c) How many hats did they sell?
d) How many purses did they sell?



- 7 A bag contains 10 discs. Each disc is labelled from 1 to 10.

Calculate the probability that the first disc picked will be:

- a) a three b) an even number c) six or less d) at least three
e) a multiple of three f) a twelve g) a factor of 24 h) a prime number

BGE S1-S3

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