

CAMBRIDGE

Foundation

# MATHEMATICS

GCSE for AQA

Student Book Answers

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# Answers

## 1 Working with integers

The answers to past paper questions are the work of the publisher and authors and have been neither seen or verified by AQA.

### BEFORE YOU START ...

- 1 a  $>$       b  $>$       c  $=$       d  $<$   
 2 a Mistake is just working left to right not doing operations in order. Correct answer is 23.  
 b Mistake is adding before multiplying. Correct answer is 31.  
 c Order of operations is correct, but calculation is wrong. Correct answer is 132.  
 3 a C                      b B                      c B

### LAUNCHPAD

- 1 a 1433      b 1117      c 855      d 18  
 2 a C      b D      c D      d B      e D  
 3  $\frac{128}{4} = 32$  cm  
 4 208  
 5 1350

### EXERCISE 1A

- 1 a i £19.50                      ii £1.30  
 b 5 packs. We need to know this so we can work out the total cost.  
 c Multiplication or repeated addition, because there are 5 packs which each cost £3.90.  
 d Divide the cost of one pack by 3 as there are 3 pens in each pack.  
 e £1.50 per pen is not correct because  $3 \times £1.50 = £4.50$  not £3.90. So £1.50 is too expensive.  
 2 £36.50  
 3 64  
 4 a 4320      b 42 mins  
 5 56539  
 6 a 222 km      b 6094 km  
 7 4803  
 8  $5678 + 67 = 5745$

### EXERCISE 1B

- 1 a 15      b -15      c 2      d -5  
 e 2      f 2      g -28      h -36  
 i -2      j 7      k 8      l 17  
 m 17      n -2      o 0  
 2 a -32      b 72      c 36      d 96  
 e -72      f -72      g -10      h 216  
 i 8      j -8      k -14      l 8  
 m 30      n -10      o -6      p 1  
 q -3      r 9      s -5      t 8

- 3 a -8      b 7      c -6      d -6  
 e -13      f 8      g 33      h -10  
 i -9      j 3      k -10      l -6

- 4 a option C                      b option B

5 a

	-10	$\times -2$	+4	$\div -2$	-8	+1
-5	-15	10	-1	$\frac{5}{2}$	-13	-4

b

	$\times -4$	$\div -5$	+8	-3	$\times 2$	-9
10	-40	-2	18	7	20	1

c

	-10	$\times -2$	+4	$\div -2$	-8	+1
0	-10	0	4	0	-8	1

- 6 a £130      b -£49.50      c £150      d £1350  
 7 a -13 000 ft                      b 18 000 ft  
 c i -\$105 000 000                      ii -\$1 365 000 000  
 8 a -8 and 1 or -6 and 3      b -3, 3 and 1  
 c -3 and 1      d -6 and 1  
 9 -26  
 10 a  $-8^{\circ}\text{C}$                       b  $-1.71$  degrees      c  $15^{\circ}\text{C}$

### WORK IT OUT 1.2

- 1 Option A is correct. The mistake in option B is doing the addition first.  
 2 Option B is correct. The mistake in option A is not doing the calculation in brackets first.  
 3 Option B is correct. The mistake in option A is calculating  $20 + 1$  not  $20 \times 1$ .  
 4 Option B is correct. The mistake in option A is doing the subtraction before the division.  
 5 Option B is correct. The mistake in option A is not calculating  $18 - 4$  in the numerator.  
 6 Option A is correct. The mistake in option B is doing the addition before the division.

### EXERCISE 1C

- 1 a D      b D  
 2 a 53      b 65      c 32      d 36      e 37      f 2  
 g -10      h 11      i 13      j 29      k -22      l 8  
 m 1      n 4      o 4      p 80      q 38      r 16  
 s 31      t 21      u 6  
 3 a, c and d are correct  
 b 608                      e 368                      f 10  
 4 a  $2 - 10 \div 5 = 0$       or  $5 - 10 \div 2 = 0$   
 b  $13 - 18 \div 9 = 11$   
 c  $8 \div (16 - 14) - 3 = 1$  or  $8 \div (16 - 14) - 1 = 3$   
 d  $(9 + 5) - (6 - 4) = 12$  or  $(9 + 5) - (12 - 4) = 6$  or  $(4 + 5) - (12 - 9) = 6$  (there are other combinations)

**EXERCISE 1D**

- 1 a -5    b -2    c -100    d 3    e 16    f 12  
 2 a  $\frac{1}{5}$     b  $\frac{1}{10}$     c  $-\frac{1}{3}$     d 3    e  $\frac{1}{9}$     f 9  
 3 (There is more than one way to correct each calculation. Other answers may also be correct.)  
 a correct    b  $488 - 156 = 332$     c correct  
 d  $264 + 469 = 733$     e  $4019 + 217 = 4236$     f correct  
 g  $512 \div 4 = 128$     h correct    i  $1275 \div 15 = 85$   
 j correct    k  $30 \times 125 = 3750$     l  $214 \times 8 = 1712$   
 m correct    n  $\sqrt{15\,625} = 125$     o  $4002 = 160\,000$   
 4 a 312    b 102    c 400  
 d -5    e -145    f 216\,000  
 5 C

**CHAPTER REVIEW**

- 1 a option B    b option d  
 2 Students' own answers  
 3 Students' own answers. Some possible solutions are:  
 $-19 + 2$ ;  $-7 + -10$ ;  $-34 + 17$ ,  $51 \div -3$ ;  $17 \times -1$ , and so on.  
 4 4032  
 5 256  
 6
- |    |    |    |    |
|----|----|----|----|
| 4  | 12 | 10 | 26 |
| 15 | 5  | 6  | 26 |
| 60 | 60 | 60 |    |
- 7 -20 and 5  
 8 -4 and 5  
 9 £568

**2 Collecting, interpreting and representing data**

**BEFORE YOU START ...**

- 1 1.35-1.45 m, 1.45-1.55 m, 1.55-1.65 m, 1.65-1.75 m, 1.75-1.85 m  
 2 a 25    b 25, 50, 75, 100  
 3 a  $120^\circ$ ,  $30^\circ$ ,  $18^\circ$   
 b Check angle  $72^\circ$  has been drawn accurately

**LAUNCHPAD**

- 1 Choose a representative sample, using a random selection method to obtain a mix of male and female students from different years, and small enough so that you have time to ask everyone in your sample.  
 2 a Croatia, Greece    b Croatia & Greece; Russia & Portugal  
 c Germany, Holland, Bosnia, England  
 3 a 31 to 40    b 18

**WORK IT OUT 2.1**

- a D

- b A - does not include male shoppers. B - people who are out at those times in the morning are not typical of the whole population. C - does not include people who do not use the bookshop.

**EXERCISE 2A**

- 1 D and E are likely to give random results.  
 D - a person's name does not determine any other characteristic of that person  
 E - the chance of picking a given name is the same as picking any other name  
 A, B and C are likely to give non-random results.  
 A - might be a very wealthy street.  
 B - excludes people who work or are out during the day.  
 C - young people are more likely to wear trainers.  
 2 a Any sensible suggestion where parents may be found e.g. soft play area; a park; nursery; baby food section of a supermarket.  
 b Approximately 700.  
 3 a  $\frac{15}{28}$  would mean about 160 machines.  
 b No, because not all the members are likely to be there at once.  
 c Sample the members present at different times of the week.  
 4 a 1.72 million    b 574 000    c 2.30 million

**WORK IT OUT 2.2**

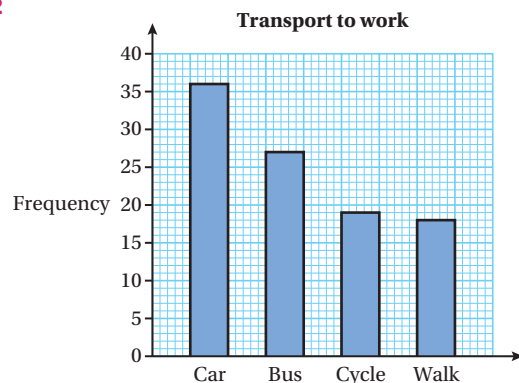
C shows the data best. A - the data is discrete so the points should not be joined together. B - has a bar for each test but the data is better illustrated if grouped together.

**EXERCISE 2B**

1

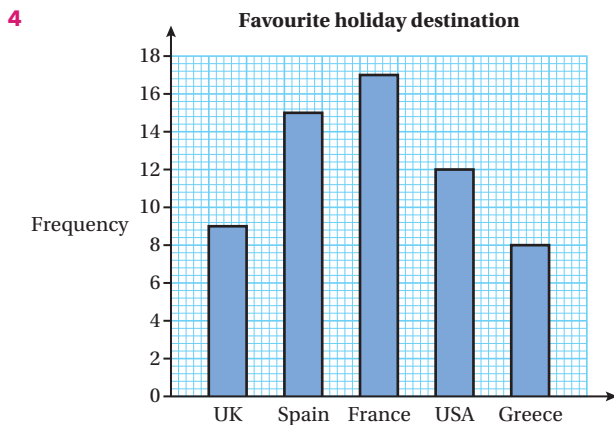
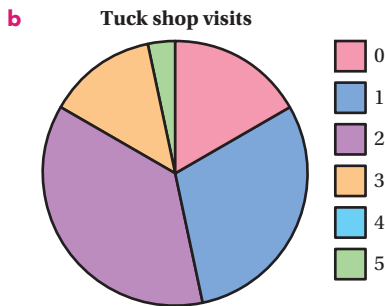


2



**3 a**

Visits to the tuck shop	Frequency
0	5
1	9
2	11
3	4
4	0
5	1
Total	30



- 5** Any pictogram of the data, including a key.  
**6** C  
**7 a** April      **b** 110mm      **c** February  
**d** Approx 220 mm    **e** Wetter, 2012 saw over 775mm of rain  
**8 a** She could have made a list of snacks available so she could have recorded the results on a tally chart.

**b**

Chocobar	10
Juice bar	7
Apple	3
Crisps	10
Cheese puffs	9
Gum	6
Fruit chews	8
NRG drink	10

- c** Check that the data has been categorised in a suitable way.

### EXERCISE 2C

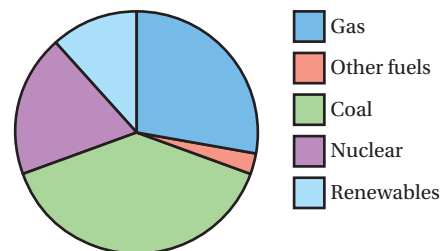
- 1 a** Time spent watching television and time spent doing homework  
**b** It decreases  
**c** It increases  
**d i** 90 mins      **ii** 45 mins  
**2 a** True10      **b** Datalink & G-Commerce  
**c** True10      **d** G-Commerce  
**e** G-Commerce    **f** Speedlink; costs > income  
**g** £35 000  
**3 a** No. Only the proportions are given.  
**b** C      **c** C      **d** C      **e**  $\frac{1}{3}$   
**f** Almost half of sales are done over the internet, about a quarter are direct sales and the remaining sales are shared approx. equally between catalogues and agents.  
**4 a** Willhelm      **b** Susan      **c** Trevor  
**d** Their score for the actual exam was worse than for their mock.

### WORK IT OUT 2.3

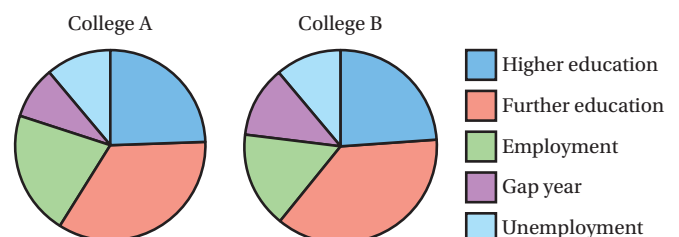
B. A - there are too many sectors. C - the categories do not correspond to the data.

### EXERCISE 2D

- 1** Electricity generation



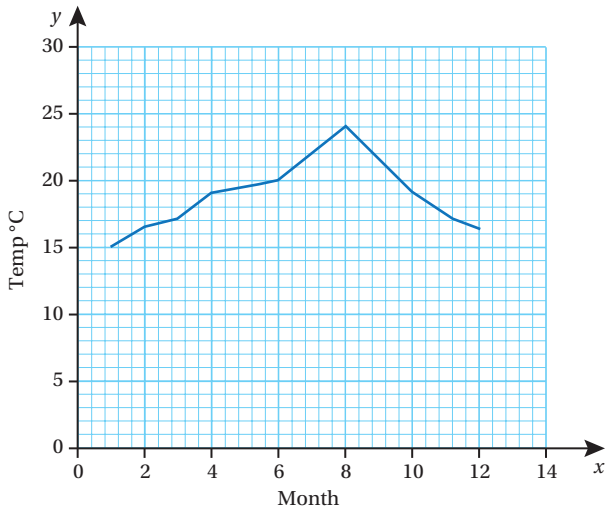
- 2 a** Any two proportional responses, such as Ireland has a smaller proportion of under 15s than Greece  
**b** It isn't possible to say, as we don't know the relative populations  
**c** No - we don't know the numbers only the proportions  
**3 a** Proportion of light goods vehicles has increased. Proportion of motorbikes has increased. Proportion of heavy goods vehicles has slightly decreased. Proportion of buses and coaches has slightly decreased.  
**b** 3.55 million      **c** 20%      **d** B  
**4 a** 18      **b** TV      **c** 30%; 6 students  
**5** College B has a larger proportion of students who go on to further education. A larger proportion of College A students go on to employment. Similar proportions go on to higher education



**EXERCISE 2E**

**1 a**

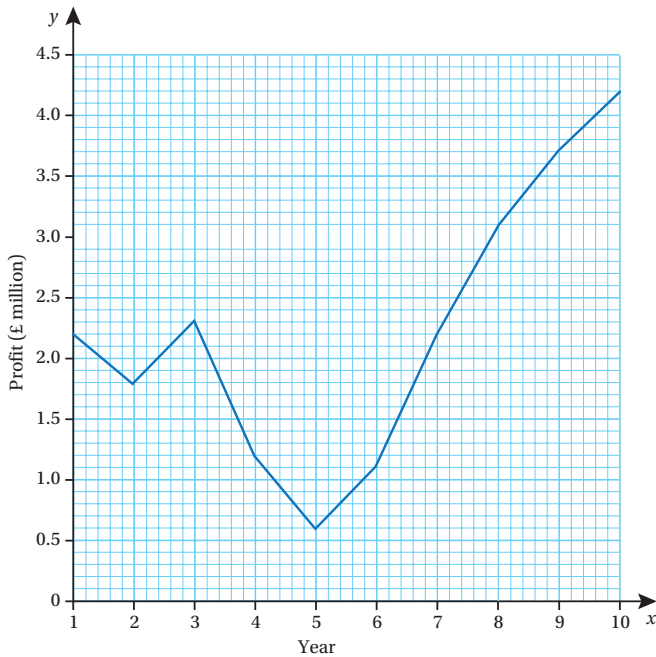
**Average temperature**



**b** The temperature gradually rises from a low point in January (month 1) to a high in August (month 8). It then falls more quickly until the end of the year.

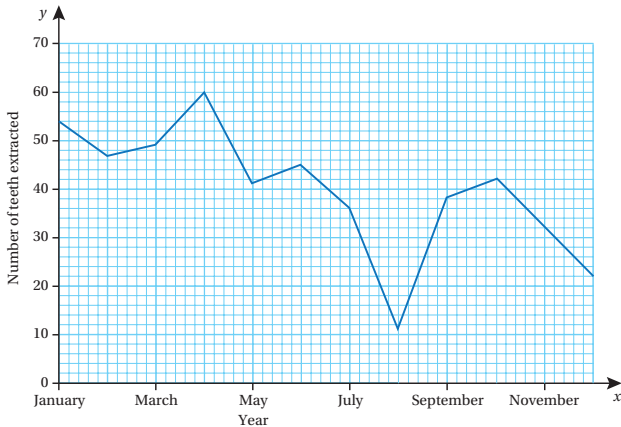
**2**

**Annual profit**



**3 a**

**Teeth extracted**

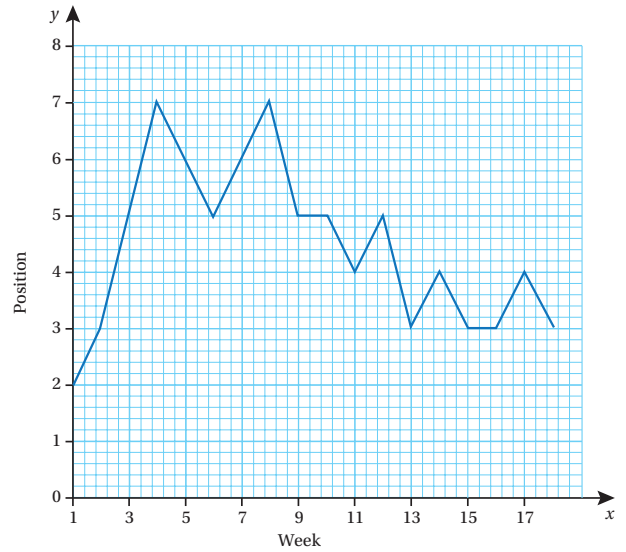


**b** April was the month with the most teeth extracted, with a sharp decline in August. December was also a quiet month. Otherwise the numbers of teeth extracted do not change much.

**c** The dentists might have been on holiday for at least part of August.

**4 a**

**League position**

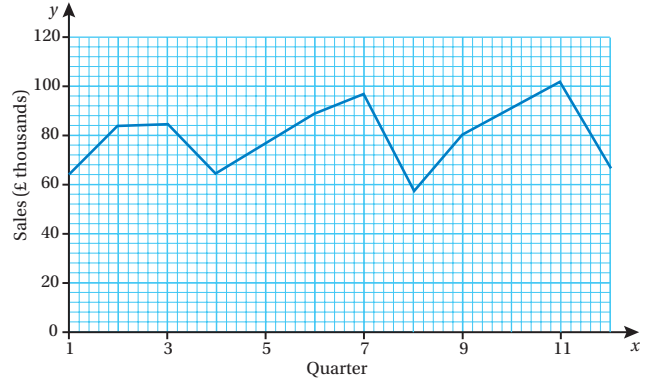


(Note students may draw the vertical scale the other way around.)

**b** The team started well in second place but quickly dropped down to 7th. They were between 5th and 7th for the early part of the season before improving after week ten, when they stayed between 5th and 3rd, where they eventually finished.

**5 a**

**Quarterly sales figure**

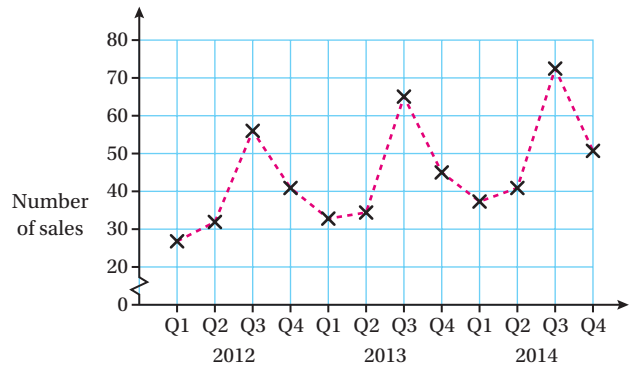


Quarter 3

**b** Quarter 4

**c** In Quarter 1 they were £64 000, Quarter 5 £77 000, Quarter 9 £79 000. It is fair to say that sales are improving.

**6 a**



**b** Shed sales per quarter have shown a general upward trend, with major fluctuations.

**c** It seems that the retailer is able to sell more sheds in the third and fourth quarters each year than in the first and second quarters.

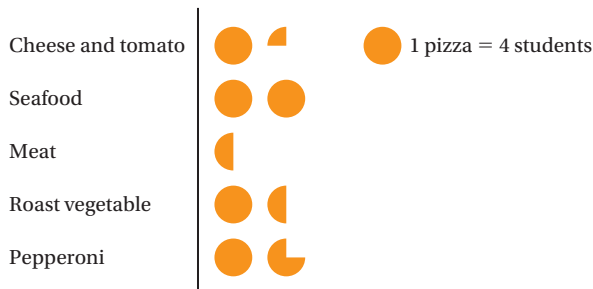
- 7 a** The number of light vans has increased  
**b** The number of vehicles has remained largely the same  
**c** The number of heavy goods vehicles might have decreased because they are now larger, and each one carries more goods or the freight is being carried by the smaller light vans.
- 8 a** June and August    **b** It rained    **c** February  
**d** 35 mm    **e** 10 mm

### CHAPTER REVIEW

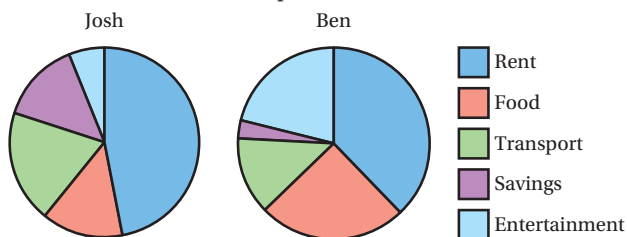
**1 a** Taking the students whose names begin with a certain letter, choosing students whose birthday is in a particular month, or any other suitable method.

**b** 204

**2** Favourite pizza



**3 a** Pie charts are best for comparison



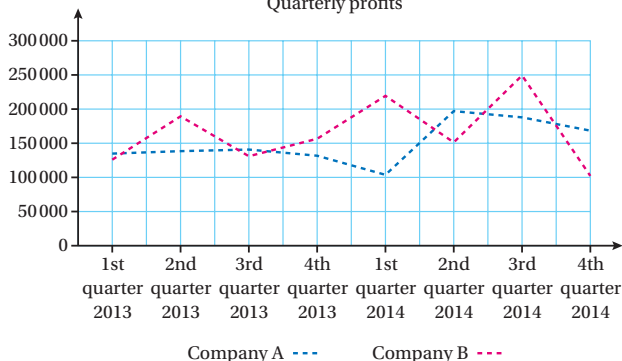
- b** Josh spends a larger proportion of his money on rent  
 Ben spends a larger proportion of his money on food  
 Josh saves a greater proportion of his money  
 Ben spends a greater proportion of his money on entertainment  
 Josh spends a greater proportion of his money on transport

**4 a**  $90^\circ = \frac{1}{4}$  or 25% of  $360^\circ$

**b** Twice as many magazines are sold in England than Scotland or half of all sales are in England.

**c** 180 000 magazines

**5 a** Quarterly profits



- b** Generally Company B makes higher profits.  
**c** The drop in profits for company B between the 3rd quarter and 4th quarter 2014  
**d** B

### 3 Analysing data

#### BEFORE YOU START ...

**1 a** 3.3, 3, 2, 6    **b** 35, 35, no mode, 50

**2**  $(-1, \frac{1}{2})$   $(1, -\frac{1}{2})$   $(2, -1)$

**3 a**  $\frac{1}{2}$     **b**  $y = -\frac{1}{2}x$

#### LAUNCHPAD

- 1 a** 11    **b** A    **c** B    **d** C  
**e** Mode the same, median stay the same, mean increase
- 2 a** 14    **b** 15.13 years    **c** 3 years
- 3** Scale is misleading as it doesn't begin at zero
- 4 a** A negative correlation  
**b** Increasing smoking decreases your life expectancy

#### EXERCISE 3A

**1** C

**2 a**

Days absent ( <i>d</i> )	Frequency	Midpoint	Midpoint × frequency
$0 \leq d < 5$	15	2.5	37.5
$5 \leq d < 10$	23	7.5	172.5
$10 \leq d < 15$	19	12.5	237.5
$15 \leq d < 20$	12	17.5	210
$20 \leq d < 25$	6	22.5	135
Total	75		792.5

**b**  $5 \leq d < 10$     **c** mean: 10.57, median:  $5 \leq d < 10$ , range: 25

**3 a**

$0 \leq s < 20$	8
$20 \leq s < 40$	12
$40 \leq s < 60$	9
$60 \leq s < 80$	7
$80 \leq s < 100$	6

- b** 45.7,  $40 \leq s < 60$ , 100  
**c** No, as we have the data and can calculate it  
**d**  $20 \leq s < 40$

4 a	$1.45 \leq h < 1.50$	1
	$1.50 \leq h < 1.55$	3
	$1.55 \leq h < 1.60$	11
	$1.60 \leq h < 1.65$	4
	$1.65 \leq h < 1.70$	13
	$1.70 \leq h < 1.75$	2
	$1.75 \leq h < 1.80$	6
	$1.80 \leq h < 1.85$	6
	$1.85 \leq h < 1.90$	3

Mean = 1.68,  $1.65 \leq h < 1.70$       **b**  $1.65 \leq h < 1.70$

**c** Mean is 1.67, median is  $1.60 \leq h < 1.70$  The new group intervals are wider so the estimates are not as accurate.

**5 a** Grouped in half hours from 2 hrs 30. Midpoint of each group is a quarter or three quarter hour. Estimated mean is 237 mins, or 3 hours 57 mins. Median group is  $4:00 \leq t < 4:30$   
 $2h 30 \leq t < 3h 00$ ,  $3h 00 \leq t < 3h 30$ ,  $3h 30 \leq t < 4h 00$ ,  
 $4h 00 \leq t < 4h 30$ ,  $4h 30 \leq t < 5h 00$ ,  $5h 00 \leq t < 5h 30$

**b** Modal class =  $4h 00 \leq t < 4h 30$

**c** Mean = 3h 57, median =  $4:00 \leq t < 4:30$ , range = 3 hours

**6 a** 309.6 kg

**b**  $250 \leq m < 300$  or  $300 \leq m < 350$  as the median lies at the boundary of two classes

### EXERCISE 3B

**1 A:** Mean 54, Median 54, Mode 35, Range 34.

**B:** Mean 55.9, median 58.5, no mode, range 40

B has the higher average (both mean and median) but also a greater range

**2 a** Ahmed: mean 36.7, median 39.5, mode 27, range 48.

Bill: mean 26.3, median 28, mode 44, range 46.

**b** Ahmed has had a better season as his mean and median are higher, as is the total number of runs scored

**3** Bus 127 mean 19.9, median 20, mode 21, range 6. Bus 362 mean 19.4, median 19, mode 15, range 11. Bus 362 is better on most measures, but it has the greatest range so is potentially less reliable. It does not matter that there is less data as averages used.

**4** mean machine A = 321.2, machine B 328.9. Both have same range (250), median ( $300 \leq b < 350$ ) and modal group ( $350 \leq b < 400$ ). Machine B is the sensible choice.

**5** One example would be 40, 60, 80, 80, 90 kg.

**6 a** The median is the best way to measure house prices as there is a big range of data and some extreme values.

**b** Any example when the spread of data is quite small, for example mean height of men or women.

**c** For example, shoe sizes, or dress sizes (when the data is discrete rather than continuous).

### EXERCISE 3C

**1** No vertical scale, no label on horizontal scale

**2** The horizontal scale is not consistent. This is probably to make growth look better than it is.

**3** The width of the bars change exaggerating the later sales

**4 a** Vertical scale does not start at zero

**b** To emphasise the changes

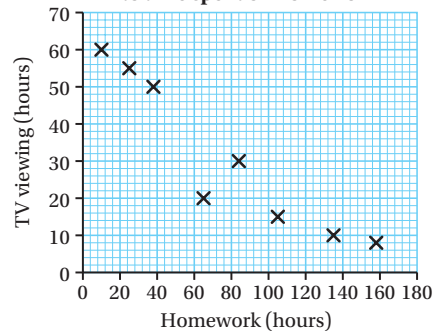
**5 a** They are both the same

**b** The 3D effect makes the scale difficult to read

**6** Either a bar chart or a time series graph would be best.

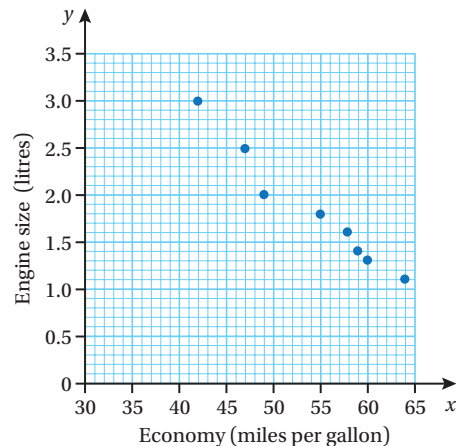
### EXERCISE 3D

**1** Scattergraph comparing time spent viewing TV to time spent on homework

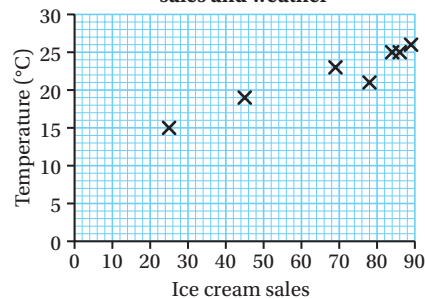


Graph shows a strong negative correlation

**2** Scattergraph comparing fuel economy to engine size

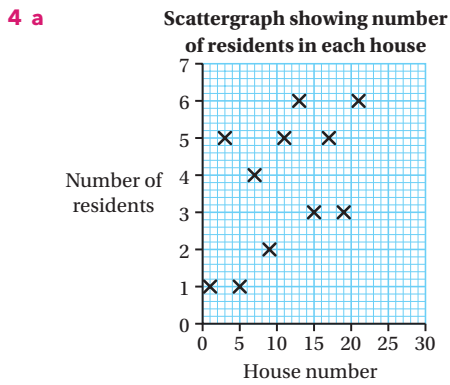


**3 a** Scattergraph comparing ice cream sales and weather

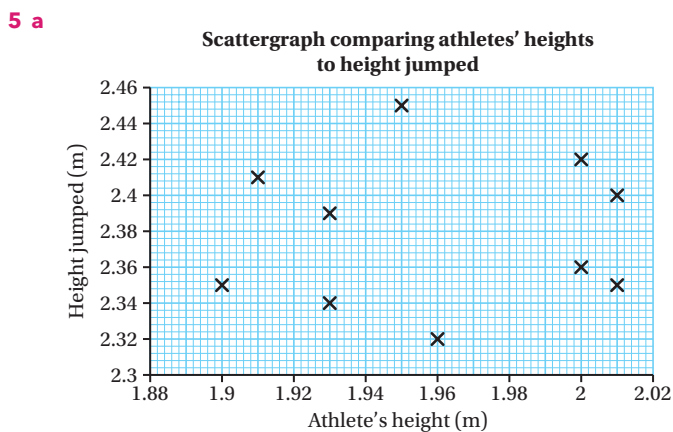


**b** Sales might also be affected by location, day of the week or time of day





**b** No correlation



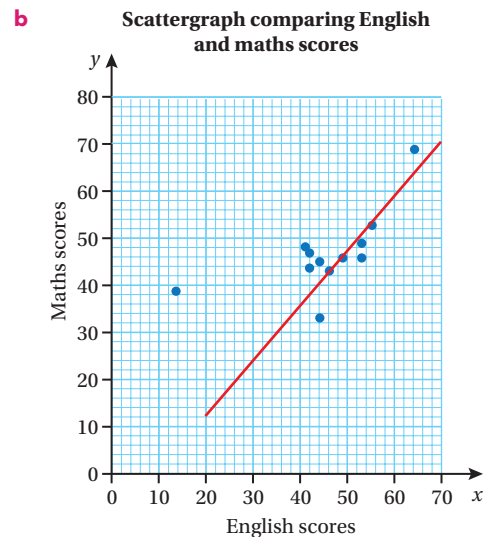
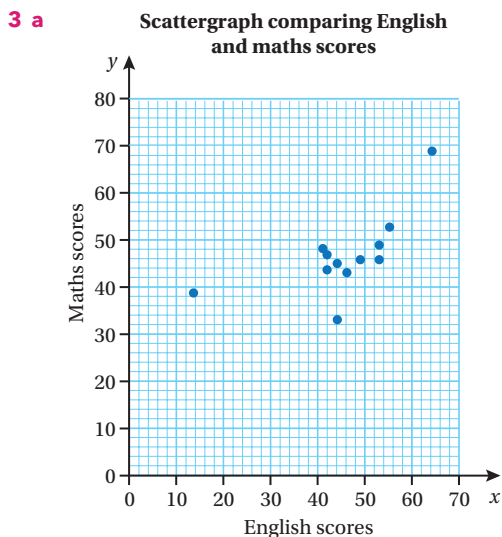
**b** No definite correlation

**c** D

**EXERCISE 3E**

**1** B

**2 a** 48.7    **b** 49    **c** 47    **d** 46    **e** 46.1



**c** The point (14, 39)

**4 a** 113 mins

**b** Yes. The time of 156 minutes is an outlier (maybe due to an accident) so the company has calculated the mean from the remaining 19 data to give 110.63 minutes.

**CHAPTER REVIEW**

Lake A	
Mean	20.22727
Median	21
Mode	5 modes: 3, 19, 21, 26, 40
Range	40
Lake B	
Mean	16
Median	15.5
Mode	10
Range	15

Lake A is better for experts as the wind speed is more often higher, and if the one day of zero wind is discounted all measures of central tendency are close to preferred speed.

Lake B is better for beginners with a slower wind speed and less variability of wind speed.

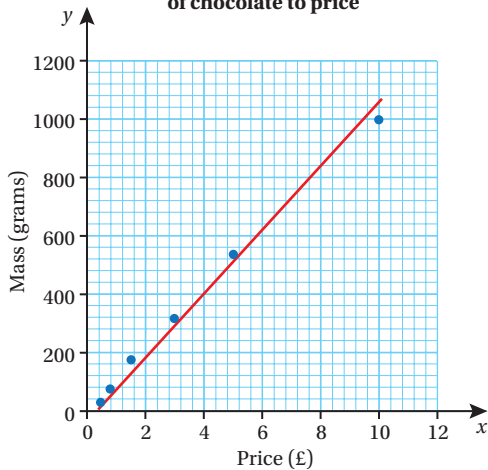
**b** C

**2 a** The vertical scales are different

**b** Graph A makes the growth look bigger

**c** If you wanted to get a sense of the number of subscribers compared to a potential number of subscribers

**3 a** Scattergraph comparing mass of chocolate to price



- b** A strong positive correlation  
**4 a**  $1 + 2 + 4 + 6 = 13$   
**b** Cannot tell, as there are 2 people paid less than £10 but we don't know how much  
**c**  $20 < x \leq 30$

## 4 Properties of integers

### BEFORE YOU START ...

- 1 a** 25      **b** 6      **c** 11  
**2 a** 2      **b** 3      **c** 5  
**3 a** 2, 3, 5, 7, 11, 13, 17, 19      **b** 1, 4, 9, 16      **c** 1, 8  
**4 a** D      **b** C      **c** B      **d** A

### LAUNCHPAD

- 1 a** false   **b** false   **c** true   **d** true   **e** false   **f** false  
**2 a** multiples of 2; 29 is incorrect  
**b** multiples of 11, 56 is incorrect  
**c** factors of 12; 8 is incorrect  
**d** multiples of 3, 41 is incorrect  
**e** factors of 36, 24 is incorrect  
**f** multiples of 12; 86 is incorrect  
**g** primes to 20, 9 is incorrect  
**3 a** B      **b** A  
**4 a** C (24)      **b** D (360)

### EXERCISE 4A

- 1 a** 1, 3, 5, 7, ..., 29      **b** 2, 4, 6, 8, ..., 30  
**c** 2, 3, 5, 7, 11, 13, 17, 19, 23, 29      **d** 1, 4, 9, 16, 25  
**e** 1, 8, 27      **f** 1, 2, 3, 4, 6, 8, 12, 24  
**g** 3, 6, 9, 12, ..., 30      **h** 1, 2, 4  
**i** 12, 24  
**2** option A  
**3 a** 209, 211, 213, 215  
**b** various options, for example, 502, 504, 506, 508  
**c** 25, 36, 49, 64  
**d** 1, 23  
**e** 17, 19, 23, 29, etc. (selection is technically infinite)  
**f** 1, 8, 27, 64, 125, 216, 343, 512, 729, 1000

- g** 8, 16, 24, 32, 40  
**h** 1, 2, 3, 4, 6, 9, 12, 18, 36  
**4 a** even   **b** even   **c** even   **d** odd   **e** even   **f** odd

### EXERCISE 4B

- 1 a** 348, 432, 456, 654, 843      **b** 606, 607, 660, 670, 706  
**c** 123, 231, 312, 1231, 1321      **d** 12 700, 21 007, 21 700, 71 200  
**2 a** 5      **b** 500      **c** 50  
**d** 5000      **e** 50 000 000      **f** 500 000  
**g** 5 000 000      **h** 50 000      **i** 50 million  
**3** option B  
**4 a** **i** 640   **ii** 406      **b** **i** 7531   **ii** 1357  
**c** **i** 643210   **ii** 102346

### EXERCISE 4C

- 1 a** 2, 3, 5, 7      **b** 53, 59      **c** 97, 101, 103  
**2** option B  
**3 a**  $2^2 \times 3^2$       **b**  $5 \times 13$       **c**  $2^6$       **d**  $2^2 \times 3 \times 7$   
**e**  $2^4 \times 5$       **f**  $2^3 \times 5^3$       **g**  $2 \times 5 \times 127$       **h**  $13 \times 151$   
**4 a** 1080  
**b** No. The product of prime factors is unique for each whole number.

### EXERCISE 4D

- 1 a** option A      option C  
**2 a** 18      **b** 36      **c** 90      **d** 24  
**e** 36      **f** 24      **g** 72      **h** 96  
**3 a** 6      **b** 18      **c** 9      **d** 3  
**e** 10      **f** 1      **g** 12      **h** 80  
**4 a** LCM = 378, HCF = 1      **b** LCM = 255, HCF = 5  
**c** LCM = 864, HCF = 3      **d** LCM = 848, HCF = 1  
**e** LCM = 24 264, HCF = 2      **f** LCM = 2574, HCF = 6  
**g** LCM = 35 200, HCF = 2      **h** LCM = 17 325, HCF = 5  
**5** 18m  
**6** 120 shoppers  
**7** 20 students  
**8** 20 minutes  
**9 a** 60 days      **b** six times  
**10** 6 cm  
**11** 4.31 pm

### CHAPTER REVIEW

1

			<sup>a</sup> C										
<sup>1</sup>	M	U	L	T	I	P	L	E	S				
		B				R							
<sup>2</sup>	E	V	E	N		<sup>3</sup> D	I	V	I	S	<sup>c</sup> O	R	
					<sup>d</sup> F	M						D	
	<sup>4e</sup> S	Q	U	A	R	E							D
	I					<sup>d</sup> C							
	X					<sup>5</sup> T	W	O					
						<sup>d</sup> O							
					<sup>6</sup> P	R	O	D	U	C	T		

2 Yes. You can decide by trial division of prime numbers up to half the size of the number in question.

3 option A

4 F20: 1, 2, 4, 5, 10, 20

F35: 1, 5, 7, 35

HCF = 5

M20: 20, 40, 60, 80, 100, 120, 140

M35: 35, 70, 105, 140

LCM = 140

5 a  $2^2 \times 3^2$  b 9

6  $800 = 2^5 \times 5^2$

7 a  $72 = 2 \times 2 \times 2 \times 3 \times 3$

$108 = 2 \times 2 \times 3 \times 3 \times 3$

HCF = 36, LCM = 216

b  $84 = 2 \times 2 \times 3 \times 7$

$60 = 2 \times 2 \times 3 \times 5$

HCF = 12, LCM = 420

8 12th step

## 5 Working with fractions

### BEFORE YOU START ...

1 a 18, 27 and 36 b 18, 24, 30 and 36

c 24 and 36 d 18, 24, 30 and 36

2 a option C b option D c option B

3 a Student A b Student B c Student B

### LAUNCHPAD

1 a  $\frac{5}{35}$  b  $\frac{9}{16}$  c  $\frac{22}{10}$

2 a  $\frac{17}{12} = 1\frac{5}{12}$  The mistake was adding the numerators and denominators.

b  $-\frac{1}{10}$  The mistake was to subtract the first fraction from the second.

c  $\frac{8}{35}$  The mistake was to add the numerators rather than multiplying them.

d 60 The mistake was to multiply rather than divide.

3 a  $\frac{3}{5}$  of 60 b  $\frac{7}{10}$  of 300 c  $\frac{1}{2}$  of  $\frac{3}{4}$

### EXERCISE 5A

1 a 33 b 3000 c 150 d 45

e 70 f 9 g 21 h 70

2 student's own answers

3 a  $\frac{7}{3}$  b  $\frac{10}{3}$  c  $\frac{21}{4}$  d  $\frac{9}{2}$

e  $\frac{8}{3}$  f  $\frac{4}{3}$  g  $\frac{13}{5}$  h  $\frac{34}{9}$

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

e  $1\frac{1}{11}$  f  $1\frac{4}{9}$  g  $2\frac{1}{4}$  h  $2\frac{1}{3}$

5 a option B b option C c option C

6 a  $\neq$  b  $\neq$  c  $\neq$  d  $\neq$

e  $=$  f  $=$  g  $=$  h  $=$

7 a  $\frac{1}{5}$  b  $\frac{2}{3}$  c  $\frac{1}{4}$  d  $\frac{1}{2}$  e  $\frac{1}{3}$  f  $\frac{1}{3}$

g  $1\frac{1}{2}$  h  $\frac{3}{5}$  i  $-\frac{2}{3}$  j  $\frac{2}{3}$  k  $\frac{5}{7}$  l  $\frac{3}{7}$

8 a  $\frac{1}{4}, \frac{4}{7}, \frac{3}{5}, 1\frac{3}{4}, \frac{9}{4}$  b  $\frac{3}{4}, \frac{19}{24}, \frac{5}{6}, 2\frac{2}{3}, \frac{11}{3}$

c  $\frac{1}{7}, \frac{10}{21}, \frac{8}{14}, \frac{7}{7}, \frac{13}{7}, 2\frac{3}{7}$

### EXERCISE 5B

1 a  $\frac{3}{10}$  b  $\frac{1}{45}$  c  $\frac{1}{7}$  d  $\frac{7}{15}$

e  $\frac{3}{14}$  f  $-\frac{5}{11}$  g 18 h  $\frac{16}{45}$

i  $\frac{1}{6}$  j  $\frac{21}{100}$  k -15 l  $-\frac{54}{5} = -10\frac{4}{5}$

m  $\frac{9}{2} = 4\frac{1}{2}$  n  $-\frac{1125}{88} = -12\frac{69}{88}$  o  $\frac{49}{225}$  p  $\frac{94}{3} = 31\frac{1}{3}$

2 a  $\frac{1}{24}$  b  $\frac{2}{5}$  c  $\frac{4}{33}$

d  $\frac{5}{28}$  e  $\frac{21}{250}$  f  $\frac{3}{88}$

3 a  $\frac{11}{14}$  b  $\frac{3}{4}$  c  $\frac{5}{8}$  d  $\frac{43}{30} = 1\frac{13}{30}$

e  $\frac{3}{8}$  f  $\frac{4}{9}$  g  $\frac{23}{20} = 1\frac{3}{20}$  h  $\frac{5}{12}$

i  $\frac{7}{15}$  j  $\frac{1}{2}$  k  $\frac{11}{12}$  l  $\frac{7}{36}$

m  $\frac{11}{30}$  n  $\frac{11}{40}$  o  $\frac{1}{20}$  p  $\frac{49}{10} = 4\frac{9}{10}$

4 a  $\frac{21}{4} = 5\frac{1}{4}$  b  $\frac{5}{12}$  c  $\frac{179}{40} = 4\frac{19}{40}$  d  $\frac{717}{110} = 6\frac{57}{110}$

e  $\frac{79}{12} = 6\frac{7}{12}$  f  $\frac{49}{10} = 4\frac{9}{10}$  g  $\frac{87}{20} = 4\frac{7}{20}$  h  $\frac{232}{35} = 6\frac{22}{35}$

i  $\frac{309}{65} = 4\frac{49}{65}$  j  $\frac{13}{20}$  k  $\frac{21}{4} = 5\frac{1}{4}$  l  $\frac{21}{10} = 2\frac{1}{10}$

5 a option C b option B

6 a 1 b 2 c  $\frac{7}{10}$  d  $-\frac{15}{7} = -2\frac{1}{7}$

e  $\frac{9}{56}$  f  $-\frac{10}{33}$  g  $\frac{35}{27} = 1\frac{8}{27}$  h  $\frac{5}{6}$

i  $-\frac{9}{28}$  j  $\frac{25}{4} = 6\frac{1}{4}$  k  $\frac{32}{25} = 1\frac{7}{25}$  l  $\frac{15}{22}$

7 a  $4\frac{2}{9}$  b  $\frac{4}{5}$  c  $\frac{39}{7} = 5\frac{4}{7}$  d  $4\frac{3}{4}$

e  $\frac{5}{12}$  f  $\frac{215}{72} = 2\frac{71}{72}$  g 0 h  $\frac{11}{170}$

i  $\frac{187}{9} = 20\frac{7}{9}$

### EXERCISE 5C

1 option C

2  $2\frac{1}{2}$  kg

3 option B

4  $14 + 8 = 22$  packets

5  $26\frac{5}{12}$  min

6 a  $\frac{5}{48}$  b Britain c Malaysia d  $\frac{13}{16}$

7 a  $\frac{13}{10}$  b  $\frac{7}{20}$

8  $\frac{5}{12}$  litre

9  $\frac{7}{20}$

- 10  $\frac{7}{24}$  cake  
 11  $42\frac{1}{2}$   
 12 40 meals

### EXERCISE 5D

- 1 a 9                      b 15                      c 8                      d 54  
   e 144                    f 32                      g  $\frac{3}{8}$                       h  $\frac{1}{10}$   
   i  $\frac{2}{21}$                     j  $\frac{5}{8}$                       k  $\frac{7}{4} = 1\frac{3}{4}$             l  $\frac{35}{12} = 2\frac{11}{12}$   
 2 a option C            b option D  
 3 a £42                    b £126                    c £12                    d £12  
   e  $1\frac{1}{2}$  cups            f  $2\frac{1}{2}$  cups            g  $\frac{3}{4}$  cup                    h  $\frac{7}{4} = 1\frac{3}{4}$  cups  
   i 1 cup                    j  $\frac{8}{3} = 2\frac{2}{3}$  h            k  $\frac{5}{6}$  h                    l  $\frac{15}{4} = 3\frac{3}{4}$  h  
   m  $\frac{1}{4}$  h                    n  $\frac{7}{3} = 2\frac{1}{3}$  min        o 12 s  
 4 a  $\frac{3}{25}$                     b  $\frac{7}{40}$                       c  $\frac{1}{25}$                       d  $\frac{3}{32}$   
   e  $\frac{1}{12}$                     f  $\frac{3}{20}$                       g  $\frac{1}{40}$                       h  $\frac{23}{160}$   
 5  $\frac{3}{4}$   
 6  $\frac{11}{75}$   
 7  $\frac{1}{9}$   
 8  $\frac{2}{5}$  hour = 24 minutes

### CHAPTER REVIEW

- 1 option D  
 2 a  $\frac{1}{6}$                       b  $\frac{39}{46}$                       c  $4\frac{3}{8}$   
 3 a  $\frac{3}{7}, \frac{4}{5}, \frac{5}{6}, \frac{8}{9}$         b  $1\frac{3}{5}, \frac{16}{9}, 2\frac{2}{5}, \frac{23}{7}$   
 4 a  $\frac{71}{40} = 1\frac{31}{40}$         b  $\frac{21}{40}$                       c  $\frac{56}{15} = 3\frac{11}{15}$         d  $\frac{194}{35} = 5\frac{19}{35}$   
   e  $\frac{22}{15} = 1\frac{7}{15}$             f  $\frac{13}{28}$                       g  $\frac{8}{189}$                     h  $\frac{112}{3} = 37\frac{1}{3}$   
 5 a  $\frac{35}{78}$                     b  $\frac{119}{3} = 39\frac{2}{3}$   
 6  $\frac{17}{100}$   
 7  $16\frac{2}{3}$  bottles (16 full bottles)  
 8 30 plots  
 9 150 g  
 10  $11\frac{2}{3}$  litres  
 11  $3\frac{1}{3}$  cups

## 6 Working with decimals

### BEFORE YOU START ...

- 1 a 300.098    b 0.0398    c 19.308    d 0.98308    e 130.098  
 2 a <            b >            c <            d >            e =  
 3 a  $\frac{4}{16}$         b  $\frac{3}{8}$             c  $\frac{2}{5}$             d  $\frac{3}{4}$             e  $\frac{45}{90}$         f  $\frac{1}{40}$

### LAUNCHPAD

- 1 There are many possible answers. For example:  
 a 2.155            b 2.1555            c 0.67535  
 2 a  $\frac{9}{100}$                 b  $\frac{2}{1000}$                 c  $\frac{8}{10}$   
 3 a  $3\frac{1}{4}$                 b  $\frac{8}{9}$                     c 0.99  
 4 a C                b C                    c C                    d B                    e A                    f C

### EXERCISE 6A

- 1 option B  
 2 a  $\frac{3}{5}$                     b  $\frac{21}{25}$                     c  $1\frac{16}{25}$                     d  $\frac{77}{200}$   
   e  $\frac{1}{8}$                     f  $1\frac{2}{25}$                     g  $\frac{7}{8}$                       h  $\frac{1}{125}$   
   i  $3\frac{8}{125}$                 j  $\frac{333}{1000}$   
 3 a 0.6                    b 0.75                    c 0.72                    d 0.95  
   e 0.68                    f 0.44                    g 0.445                    h 0.152  
   i 9.25                    j 2.9                    k  $1.8\dot{3}$                     l 0.375  
   m 2.25                    n  $0.\dot{8}$                     o 2.375  
 4 a repeating digits of the numerator  
   b recurring non-terminating decimals  
   c 0.16,  $0.\dot{3}$ , 0.5,  $0.\dot{6}$ ,  $0.8\dot{3}$   
   d  $0.\dot{0}9$ ,  $0.\dot{1}\dot{8}$   
   e prediction is  $0.2\dot{7}$  and  $0.3\dot{6}$  based on multiples of 9  
 5 a 8.62, 5.29, 5.2, 4.92, 4.09  
   b 7.42, 3.219, 0.76, 0.742, 0.421  
   c 14.89, 14.72, 14.3, 14.07, 14.009  
   d 0.287, 0.273, 0.26, 0.23, 0.206  
   e  $0.68, \frac{2}{3}, \frac{1}{2}, \frac{5}{11}, 0.45, 0.403$   
   f  $0.88, \frac{7}{9}, 0.718, 0.625, \frac{3}{8}$   
 6 a <                    b <                    c <                    d =                    e >  
   f <                    g >                    h >                    i <

### EXERCISE 6B

- 1 a  $\approx 3$  g                    b  $\approx 32$  g                    c  $\approx 24$  g  
   d  $\approx 50$  g                    e  $\approx 20$  coins                    f more  
   g Estimating by rounding will give no difference.  
   Try  $20 \times 70 = 140$  and  $20 \times 65 = 130$ , which gives an answer of about 10 g.  
 2 a no                    b about 2 litres                    c  $2\frac{1}{2}$  bottles  
   d  $\approx 12$  days                    e  $\approx$  £15                    f more  
   g  $\approx 60$  p  
 3 student's own answers

**EXERCISE 6C**

1 student discussion

**EXERCISE 6D**

1 option B

- 2 a 1.58                      b 1.67                      c 1.7  
 d 13.35                      e 22.714                      f 34.335
- 3 a 66.05    b 23.76    c 3.61    d 22.43    e 332.907  
 f 29.695    g 23.959    h 78.6    i 109 520    j 0.8021  
 k 205.6158    l 0.03    m 0.0895    n 8.15    o 793
- 4 a 0.74 s    b 0.44 s    c 9.21 s  
 d unlikely as the first runner has a stationary start
- 5 yes, Nadia has 1.54 litres
- 6 166.67 mg vitamin C, 7.8 mg boron and 36.85 mg calcium
- 7 a 180.25 kWh    b 9398.75 kWh

**EXERCISE 6E**

- 1 option A
- 2 185.9 km
- 3 42 cups (with some juice left over)
- 4 1800
- 5 72 posts (there are approximately 71 'gaps' of 0.84 m but there will be a post at each end)
- 6 £8.58
- 7 a £78.44 per day    b £392.20 per week  
 c Less because there are 73 five-day weeks in a year (as opposed to 52 seven-day weeks).

**CHAPTER REVIEW**

- 1 a 4.08, 4.2, 4.22, 4.8, 4.97  
 b  $2.12, 2\frac{9}{25}, 2\frac{46}{50}, 2.955, 2.96$   
 c  $\frac{3}{4}, 0.78, \frac{4}{5}, \frac{5}{6}, 0.86, 0.91$
- 2 a 3.4 m    b 6.45 m    c A, B and C
- 3 a >    b >    c <
- 4 a  $\frac{22}{25}$     b  $2\frac{3}{4}$     c  $\frac{1}{125}$
- 5 a 3.15    b 69.67    c 32    d 0.32
- 6 a 7.816    b 1.092    c 876    d 0.01807  
 e 2.884    f 13.6
- 7 Kate, she has £2.39 more
- 8 0.2 or  $\frac{1}{5}$

**7 Basic algebra****BEFORE YOU START ...**

- 1 a B    b A    c A
- 2 a i 19 and -11    ii 27 and -3  
 b 6
- 3 a 6y    b 5x

**LAUNCHPAD**

- 1 a  $3n + 4$     b  $3(n - 4)$     c  $\frac{4n^2 + 3}{2}$
- 2 a  $5a + b$     b  $6x + 4$     c  $-6a^2 + 3ab$

- 3 a  $mn - mp$     b  $7x + 23$     c  $z^2 + 3z$
- 4 a  $3x + 12 = [3](x + 4)$   
 b  $5x + 10y = [5](x + 2y)$   
 c  $x^2 - 3x = [x](x - 3)$   
 d  $ab - ac = a([b] - [c])$   
 e  $-x + 7x^2 = -x([1] - [-][7x])$
- 5 a  $2(x + 2y)$     b  $-3(x + 3)$     c  $5(x + y)$

**EXERCISE 7A**

- 1 a i false    ii true    iii false    iv false  
 b  $n = 2$
- 2 option D
- 3 a  $3x + 7y$     b  $5(x^2 - 4)$     c  $\frac{x^3 + y^2}{4}$   
 d  $4(x + 6) - y$     e  $\frac{1}{2}x^2$  or  $\frac{x^2}{2}$
- 4 a ii    b vii    c v    d i  
 e iii    f iv    g vi
- 5 a 6a    b 20b    c -9d    d 12ab  
 e 10cd    f -12mn    g 6pq    h  $a^2$   
 i  $m^2$     j  $8a^2$     k  $-15a^2$     l  $8m^2$   
 m  $56a^2b$     n  $12cd^2e$     o  $8a^3$
- 6 a 3x    b 9y    c  $3a^2$     d 5p  
 e x    f  $\frac{3y}{2}$     g  $-2x^2$     h  $4a^2$   
 i  $\frac{5}{n^2}$
- 7 a 10n    b pq    c  $a(b + c)$   
 d  $\frac{x + y}{z}$     e  $n^5$     f  $p^4$
- 8 a  $P = 2x + 16, A = 2x + 12$     b  $P = 4x + 16, A = x^2 + 8x + 16$   
 c  $P = 2x + 15, A = \frac{x}{2} + \frac{7}{2}$  or  $\frac{x + 7}{2}$     d  $P = 4x + 2y, A = x^2 + 2y$
- 9 a  $x + 10$     b  $x - 10$     c  $\frac{x}{3}$

**EXERCISE 7B**

- 1 a 24    b 21    c 54    d 15  
 e 24    f -15    g 36    h 9
- 2 a 60    b 24    c 2    d -200  
 e -6    f 9    g 22    h -8
- 3 e.g.  $5x + 9y = 37$  and  $-2x - 3y = 37$   
 a if  $x = 2$  and  $y = 3, 5 \times 2 + 3 \times 9 = 37$   
 b if  $x = -5$  and  $y = -9, -2 \times -5 - 3 \times -9 = 37$

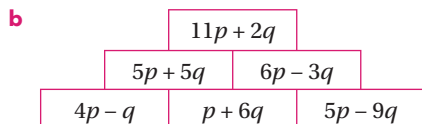
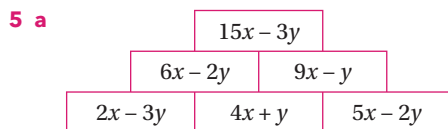
**EXERCISE 7C**

- 1 a unlike    b like    c like  
 d like    e unlike    f unlike  
 g like    h like    i unlike  
 j unlike    k like    l like
- 2 a  $6x + 5y$     b  $2d - 3c$   
 c  $-3xy - y^2$     d  $2a^2 + 2ab^2 + 2ab$   
 e  $2g - f$     f  $6a^2b$   
 g  $12mn^3$     h  $9st^2 + s^2t$
- 3 a  $2a + [5a] = 7a$     b  $5b - [3b] = 2b$   
 c  $8mn + [4mn] = 12mn$     d  $11pq - [5pq] = 6pq$

- e  $4x^2 + [3x^2] = 7x^2$       f  $6m^2 - [5m^2] = m^2$   
 g  $8ab - [10ab] = -2ab$       h  $-3st + [8st] = 5st$   
**4 a** option B      **b** option D      **c** option D  
**5 a**  $8a \times [2] = 16a$       **b**  $9b \times [2] = 18b$   
**c**  $8a \times [2b] = 16ab$       **d**  $5m \times [3n] = 15mn$   
**e**  $3a \times [4a] = 12a^2$       **f**  $6p \times [5p] = 30p^2$   
**g**  $-5b \times [-2b] = 10b^2$       **h**  $4m \times [3mn] = 12m^2n$   
**6 a**  $-28x$       **b**  $16xyz$       **c**  $10a^2$   
**d**  $ab^2c^2d$       **e**  $24x^2y$       **f**  $\frac{-y^2}{x}$   
**g**  $-3x$       **h**  $\frac{-12y}{x}$       **i**  $3x^2$   
**7 a**  $\frac{2x}{3}$       **b**  $\frac{a}{3}$       **c**  $\frac{-2m}{3}$       **d**  $\frac{2p}{3}$   
**e**  $\frac{2x^2}{3}$       **f**  $\frac{3xy}{4}$       **g**  $12b$       **h**  $\frac{1}{3}$

### EXERCISE 7D

- 1** option C  
**2 a** incorrect;  $4a + 4b$       **b** incorrect;  $5a + 5$   
**c** correct      **d** incorrect;  $-3p + 15$   
**e** incorrect;  $a^2 + ab$       **f** correct  
**g** incorrect;  $-6x + 30$       **h** incorrect;  $12a^2 - 21a$   
**i** correct      **j** incorrect;  $6x^2 - 21xy$   
**3 a**  $2c + 5$       **b**  $a + 9$       **c**  $5b + 25$   
**d**  $2e + 5$       **e**  $3f - 18$       **f**  $8a^2 + 13a$   
**g**  $10b^2 - 9b$       **h**  $15a^2 + 6a$       **i**  $2b^2 - 15b$   
**4 a**  $5y + 14$       **b**  $16b - 9$       **c**  $a + 1$   
**d**  $b - 22$       **e**  $x^2 + x - 6$       **f**  $2p^2 - 3p - 5$   
**g**  $10z$       **h**  $4y^2 - 16y$



- 6 a** Let  $a = 1$ :  $1 + 1 = 2$  and  $1 \times 1 = 1$  (note if you use 2, it will be equal)  
**b** Let  $x = 1$ :  $3(1) + 4 - 1 + 2 = 8$  and  $2(1) + 2 = 2 + 2 = 4$   
**c** Let  $m = 1$ :  $(1 + 2)^2 = 9$  and  $1^2 + 4 = 5$   
**d** Let  $x = 1$ :  $\frac{1+4}{3} = \frac{5}{3}$  and  $1 + 1 = 2$

### EXERCISE 7E

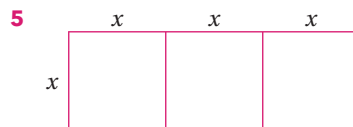
- 1 a**  $2(x + 2)$       **b**  $6(2m - 3n)$       **c**  $3(a - b - 2)$       **d**  $x(y - z)$   
**e**  $5xy(1 - 3z)$       **f**  $7b(2a - 3c)$       **g**  $p(q - r)$       **h**  $x(x - 1)$   
**i**  $6ac(3b - 2)$       **j**  $2x(x - 2y)$       **k**  $2xy(x - 2y)$       **l**  $-6(a + 2)$   
**m**  $-3(a + 3)$       **n**  $-x(y + 5)$       **o**  $-x(x - 6)$   
**2 a**  $x(7 - y + x)$       **b**  $2x(y + 2z + 5)$       **c**  $5(2x - y + 3z)$   
**d**  $(x - 2)(x + 5)$       **e**  $(a - 7)(a - 1)$       **f**  $-2(x - 3)$

### EXERCISE 7F

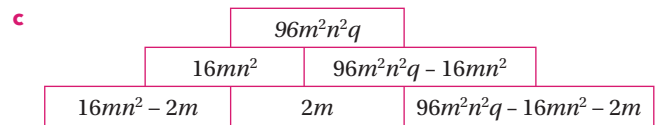
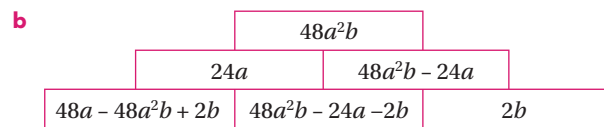
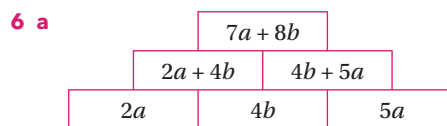
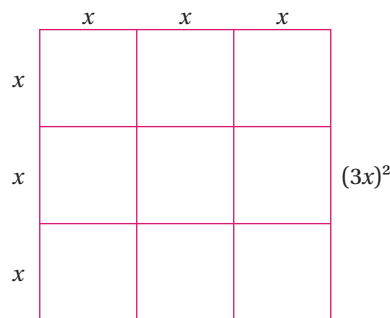
- 1 a** false      **b** true      **c** true      **d** false      **e** true  
**2** all total  $3m$

- 3 a**  $(5a + 4) - (2a + 3) = 3a + 1$   
 $3b + 1 - b = 2b + 1$   
**b**  $P = 10a + 6b + 10$   
**c** 210.25 units<sup>2</sup>

- 4 a**  $(x + 2)$   
**b**  $x^2$



$3x^2$



- 7 a** Let the number be  $x$ . Double is  $2x$ . Add six gives  $2x + 6$ . Halve it gives  $x + 3$ . Subtract the number ( $x$ ) gives 3.  
**b** Student's own idea.

### CHAPTER REVIEW

- 1 a**  $5x$       **b**  $a - 8b$       **c**  $18xyz$   
**2 a**  $5x - 3y$   
**b** largest value = 13, smallest value = 8  
**3**  $a = 2, b = 17$   
**4 a**  $13g + 10$       **d** 6  
**5** option C  
**6 a**  $2n$  is an even number then the next even number is  $2n + 2$   
**b**  $2n + 4$   
**c**  $2n + (2n + 2) + (2n + 4) = 6n + 6$  this is a multiple of 6:  $6(n + 1)$   
**7 a** Let  $x = 1$ :  $5(1 + 3) = 20$  and  $5(1) + 3 = 8$ , not identities.  
**b** Let  $m = 1$ :  $-3(1 - 2) = 3$  and  $-3(1) - 6 = -9$  not identities.  
**c** Let  $y = 1$ :  $4(1 - 3) + 2(1 + 4) = 2$  and  $6(1) - 4 = 2$ , these are identities.




## 8 Properties of polygons and 3D objects

### BEFORE YOU START ...

- 1 a point      b vertex      c edge      d face  
 e right angle      f acute angle      g base      h height
- 2 a rectangle ABCE; triangle ADE; trapezium ABCD  
 b octahedron

### LAUNCHPAD

- 1 a parallelogram      b lines are parallel  
 c  $PQ \parallel SR$       d acute angle  $SPQ$
- 2 2 reflective and 2 rotational
- 3 a right-angled      b isosceles  
 c equilateral      d isosceles
- 4 a parallelogram, rectangle, square, rhombus  
 b rhombus, square  
 c parallelogram, rectangle, square, rhombus  
 d rectangle, square  
 e trapezium  
 f quadrilateral

Solid	Mathematical name	Number of faces	Number of edges	Number of vertices
	cuboid	6	12	8
	cube	6	12	8
	square-based pyramid	5	8	5

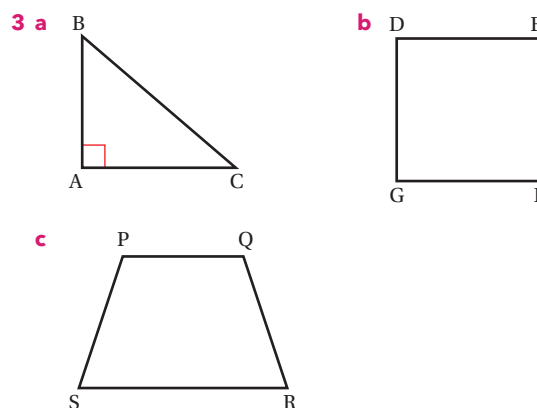
### EXERCISE 8A

- 1 a equilateral triangle      b regular pentagon  
 c regular hexagon      d regular octagon
- 2 many examples could be provided
- a stop sign      b playing dice  
 c sheet of paper      d shape of the side of a house

### EXERCISE 8B

	Column A	Column B
a	A shape that has two fewer sides than an octagon.	hexagon
b	A shape that has two sides more than a triangle.	pentagon
c	A shape with four sides.	quadrilateral
d	A stop sign is an example of this shape.	octagon
e	A figure that has length and height.	two-dimensional
f	A closed plane shape with all sides $x$ cm long and all angles the same size.	regular polygon
g	A 10-sided figure.	decagon
h	Another name for a regular 4-sided polygon.	square
i	The more common name for a regular 3-sided polygon.	equilateral triangle

- 2 a true      b true      c true      d true  
 e false      f false      g true      h true



### EXERCISE 8C

- 1 a none      b all lines (AB, CD, EF, GH)  
 c CD, HG      d AB
- 2 option B

Shape	Number of lines of symmetry	Order of rotational symmetry
square	4	4
rectangle	2	2
isosceles triangle	1	0
equilateral triangle	3	3
parallelogram	0	2
regular hexagon	6	6
regular octagon	8	8
regular decagon	10	10

- 4 a propeller with three props
- 5 H
- 6 Lines of symmetry: vertical and horizontal axes through the centre of the image, rotational symmetry of order 2.
- 7 Students' own answers
- 8 Students' own answers

### EXERCISE 8D

- 1 equilateral triangle
- 2 option D
- 3 a This is possible.  
 b The angles would sum to more than  $180^\circ$ .  
 c Angles do not sum to  $180^\circ$ .  
 d Angles of an equilateral triangle are all  $60^\circ$ .  
 e Isosceles triangle has two sides of equal length.
- 4 option A
- 5 a  $38^\circ$       b isosceles
- 6  $a = 54^\circ$  (sum of angles in a triangle),  $b = 66^\circ$  (base angles in isosceles triangle are equal and sum of angles in a triangle),  $c = 60^\circ$  (sum of angles in a triangle and angles are all the same in an equilateral triangle),  $d = 115^\circ$  (base angles in an

isosceles triangle are equal, sum of angles in a triangle and sum of angles on a straight line),  $e = 115^\circ$

- 7 a 17.5 mm    b  $\sqrt{13}$  mm

**EXERCISE 8E**

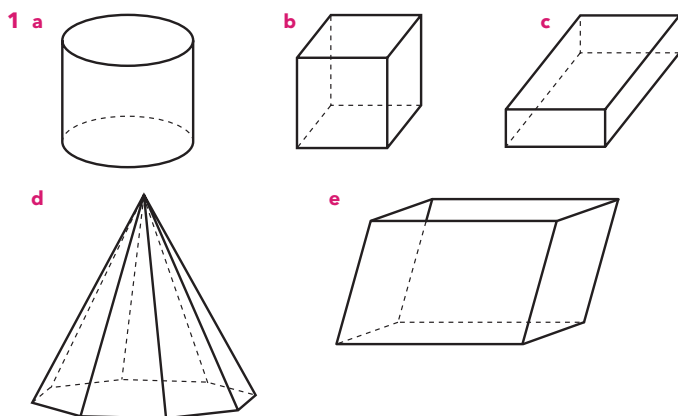
- 1 option A  
 2 a rectangle, square  
 b rectangle, square  
 c parallelogram, rectangle, square, rhombus  
 d quadrilateral  
 e square  
 f parallelogram, rectangle, square, rhombus

3

Shape	Diagonals are equal in length	Diagonals bisect each other	Diagonals are perpendicular
rhombus		✓	✓
parallelogram		✓	
square	✓	✓	✓
kite			✓
rectangle	✓	✓	

- 4 interior angles of a rhombus do not all equal  $90^\circ$ .  
 5 no, it could be a rhombus  
 6 two possibilities:  $90^\circ$  and  $90^\circ$ , or  $47^\circ$  and  $133^\circ$   
 7 a always true (a square is a rectangle with equal sides)  
 b sometimes true (a square is a rectangle with equal sides)  
 c sometimes true (a rectangle can be a rhombus if all sides are equal)  
 d always true (a rhombus is a parallelogram with equal sides)  
 e sometimes true (a parallelogram is a rhombus with equal sides)

**EXERCISE 8F**



- 2 option C  
 3 A circle is a two-dimensional shape defined by a set of points equidistant from a single point, the centre. A sphere is a

three-dimensional object, shaped like a ball with a continuous curved surface.

- 4 Both are three-dimensional objects. A cylinder has two circular faces and a curved surface. A cone has only one circular face and a curved surface.  
 5 cube, cuboid, any prism with a quadrilateral cross section

6

3D shape	Faces	Vertices	Edges
cube	6	8	12
cuboid	6	8	12
triangular pyramid	4	4	6
square pyramid	5	5	8
triangular prism	5	6	9
hexagonal prism	8	12	18

- 7 40 faces, 74 edges and 48 vertices

**CHAPTER REVIEW**

- 1 a false    b true    c false  
 2 Regular hexagon has 6 lines of symmetry (lines connecting opposite vertices and lines connecting midpoints of opposite sides) and rotational symmetry of order 6.  
 3  $b = 117^\circ$ ,  $c = 117^\circ$ ,  $d = 63^\circ$   
 4 no, the missing angle is  $95^\circ$  because angles in a quadrilateral total  $360^\circ$   
 5 a square-based pyramid: 5 faces, 8 edges, 5 vertices  
 b triangular prism: 5 faces, 9 edges, 6 vertices  
 c cube: 6 faces, 12 edges, 8 vertices  
 d sphere: 1 face, 0 edges, 0 vertices  
 6 a parallel  
 b perpendicular  
 c trapezium  
 d right angle  
 e obtuse  
 f reflective symmetry  
 7 a BC and DE are parallel.  
 b BC and CD are perpendicular to each other; CD is perpendicular to DE.  
 c It has one line of reflective symmetry down the middle through A.  
 d It has no rotational symmetry.  
 8 a 2 lines of reflective symmetry  
 b order of rotational symmetry 2  
 c diagonals cross at  $90^\circ$   
 d angles ABC and BCD add to  $180^\circ$   
 9 a Yes    No  
       No    Yes  
 b width = 340 mm, height = 60 mm.



## 9 Angles

### BEFORE YOU START ...

- 1 a  $84^\circ$       b  $64^\circ$       c  $187^\circ$       d  $208^\circ$   
 2 a right-angled isosceles triangle      b rhombus  
 c rectangle  
 3  $x = y$  as the triangle formed by the diagonals is isosceles and base angles of an isosceles triangle are equal  
 4 a  $35^\circ$       b  $120^\circ$

### LAUNCHPAD

- 1 a  $72^\circ$       b  $60^\circ$       c  $108^\circ$   
 2 no, angles on a line are  $180^\circ$   
 3 various combinations as  $a = c = e = g$  and  $b = d = f = h$   
 4  $c = f$  only if the red line is perpendicular to the two parallel lines, ie  $c$  and  $f$  are  $90^\circ$   
 5  $44^\circ$ ; angle  $BCA = 68^\circ$ ; angle  $CAB = \text{angle } BCA = 68^\circ$ , so  $x = 180^\circ - 68^\circ - 68^\circ = 44^\circ$

### EXERCISE 9A

- 1 option A  
 2 option B  
 3 a  $188^\circ$       b  $110^\circ$       c  $95^\circ$   
 d reflex; obtuse; obtuse  
 4 a  $x = 49^\circ, y = 80^\circ$       b  $x = 50^\circ$       c  $p = 60^\circ$   
 5 angle  $ABC = 50^\circ + 65^\circ + 59^\circ = 174^\circ$ ; if  $AE$  is a straight line, angle  $ABE$  must be  $180^\circ$   
 6 a  $y = 43^\circ$  (vertically opposite angles);  $x + y = 180^\circ$  (angle of a straight line);  $z = x$  (vertically opposite angles)  $x = 137^\circ$ ,  $y = 43^\circ, z = 137^\circ$   
 b  $x = 180^\circ - 47^\circ - 84^\circ$  (angles on a straight line);  $y = x$  (vertically opposite angles);  $w = 84^\circ$  (vertically opposite angles);  $z = 47^\circ$  (vertically opposite angles)  $x = 49^\circ, y = 49^\circ, w = 84^\circ, z = 47^\circ$   
 7  $z = 200^\circ$   
 8 a  $30^\circ$       b  $192^\circ$       c  $138^\circ$   
 9  $180^\circ \div 3 = 60^\circ$

### EXERCISE 9B

- 1 option C  
 2  $a = 137^\circ, b = 137^\circ, c = 137^\circ, d = 43^\circ$   
 3 option A  
 4  $x = 80^\circ$   
 5  $a = 125^\circ, b = 55^\circ, c = 35^\circ$   
 6  $x = 135^\circ, y = 135^\circ$   
 7  $a = 138^\circ, b = 42^\circ, c = 138^\circ, d = 138^\circ, e = 42^\circ, f = 138^\circ, g = 42^\circ$   
 8  $\angle CEG = 32^\circ$   
 9  $\angle DCF = 54^\circ$

### EXERCISE 9C

- 1 option B  
 2 a  $x = 55^\circ$       b  $c = 70^\circ$   
 3  $x = 75^\circ, y = 105^\circ$   
 4  $a = 40^\circ, b = 50^\circ$

- 5  $x = 130^\circ, y = 145^\circ, z = 85^\circ$   
 6  $a = 48^\circ$  (equal angles of isosceles triangle),  $b = 84^\circ$  (angles in a triangle sum to  $180^\circ$ ),  $c = 96^\circ$  (exterior angle = sum of two opposite interior angles)  
 7  $x = 18\frac{1}{3}^\circ$   
 8 Either two angles of  $53^\circ$  and one of  $74^\circ$ ; or two angles of  $74^\circ$  and one of  $32^\circ$

### EXERCISE 9D

- 2 8 triangles; 18 triangles

3	Number of sides in polygon	3	4	5	6	7	8	10	20
	Number of triangles	1	2	3	4	5	6	8	18
	Angle sum of interior angles	$180^\circ$	$360^\circ$	$540^\circ$	$720^\circ$	$900^\circ$	$1080^\circ$	$1440^\circ$	$3240^\circ$

- 4 number of triangles is two less than the number of sides  
 5  $n - 2$   
 6 a 180 times two less than  $n$       b  $180(n - 2)$   
 7  $1800^\circ$   
 8 interior angle = sum of interior angles  $\div 12 = 1800^\circ \div 12 = 150^\circ$

### WORK IT OUT 9.1

- Option A is correct.  
 Option B includes interior angles as well.  
 Option C there is no central  $360^\circ$

### EXERCISE 9E

1	Regular polygon	Sum of interior angles	Size of interior angle	Size of exterior angle
	triangle	$180^\circ$	$60^\circ$	$120^\circ$
	quadrilateral	$360^\circ$	$90^\circ$	$90^\circ$
	pentagon	$540^\circ$	$108^\circ$	$72^\circ$
	hexagon	$720^\circ$	$120^\circ$	$60^\circ$
	heptagon	$900^\circ$	$128.57^\circ$ (2 dp)	$51.43^\circ$ (2 dp)

- 2 option C  
 3 a  $1260^\circ$       b  $1800^\circ$       c  $4140^\circ$   
 4 a  $2340^\circ$       b  $360^\circ$       c  $156^\circ$       d  $24^\circ$   
 5 a  $45^\circ$       b  $135^\circ$       c octagon  
 6 a  $x = 100^\circ$       b  $x = 135^\circ$       c  $x = 137.5^\circ$

### CHAPTER REVIEW

- 1 a  $a = 270^\circ$       b  $b = 120^\circ$       c  $c = 61^\circ$   
 d  $d = 55^\circ$       e  $e = 92^\circ$       f  $f = 162^\circ$   
 2 a  $x = 108^\circ$  (corresponding angles)  
 b  $y = 63^\circ$   
 3 no as the angles sum to  $179^\circ$  not  $180^\circ$

4 pentagon

5  $360^\circ$ 6  $x = 64^\circ$  and  $y = 116^\circ$ 7  $54^\circ$ 8  $z = 105^\circ$ 

9 a 10                      b decagon

10  $36^\circ$ 11  $I =$  sum of interior angles,  $E =$  sum of exterior anglesWe know  $I = 180(n - 2)$  (formula for sum of interior angles) $I + E = 180n$  the sum of each interior and exterior angle is  $180^\circ$  and there are  $n$  anglesSo  $E = 180n - I = 180n - 180(n - 2) = 180n - 180n + 360 = 360^\circ$ 12  $x = 55^\circ, y = 30^\circ$ 13  $137^\circ$ 

## 10 Perimeter

### BEFORE YOU START ...

1 a pentagon              b hexagon              c octagon

2 a 5000 m              b 1 200 000 cm

c 8.5 m              d 4800 mm

3 a true              b false              c false

4  $l = \frac{p}{2} - w$ 5  $r = \frac{p}{\pi + 2}$ 

### LAUNCHPAD

1 290 m

2 a 116 mm              b 317 mm

3 42.25 mm

4 35 mm

5 a 38.33 cm              b 43.98 cm

6 12 cm

7 8.23 m (to 2 dp)

### EXERCISE 10A

1 30 cm

2 29.96 m

3 option D

4 a  $3a$               b  $2x + 2y$               c  $8z$ 

5 option C

6 120 cm

7 144 cm

8 360 cm

9 a Because a parallelogram is a pushed rectangle and a rhombus is a pushed square, they both have the same dimensions as each other.

b Because a trapezium is not directly related to any other quadrilateral.

10 a 520 m              b 48 posts with the 4 extra

c £1040.32

### WORK IT OUT 10.1

Option A is correct because there are 16 sides to the perimeter each of 6.5 cm.

### EXERCISE 10B

1 rectangle width 44 mm

parallelogram length 45 mm

rhombus side length and width 3.0625 cm

square length and width 11.82 cm

2 a 66 m              b 37.5 cm              c 4.8 cm

d 44.6 cm              e 280 mm

3 a 11 cm              b 20 cm

c 25 cm              d 19 cm

e 17.5 cm              f 30 cm

4 option C

5 5.7 m

### EXERCISE 10C

1 a 62.83 mm              b 43.98 cm              c 5.65 m

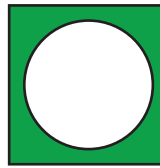
d 6.79 m              e 16.76 cm

2 option C

3 131.95 cm

4 6220.35 mm

5 a



b 25.13 cm              c 26.08 cm

d i 59.13 cm              ii 60.08 cm

6 a 6.37 mm              b 4.84 cm

7 58 mm

8 Plate with side length 24.51 cm

9 47 cm

### EXERCISE 10D

1 a 21.99 cm              b 17.17 cm              c 29.6 cm              d 9.69 m

2 a 16.19 cm              b 22.28 cm              c 7.24 cm              d 16.54 m

e 44.22 cm              f 54.99 m

### WORK IT OUT 10.2

Option B is correct.

Option A is wrong because the whole circumference of each circle was calculated rather than just  $\frac{3}{4}$ .

Option C is wrong because the wrong formula for working out the circumference was used.

**EXERCISE 10E**

- 1 a 208.76 m      b 234.85 m  
 2 a discus      b 7.85 m  
 c 6.71 m inner and 7.34 m outer  
 3 314.61 m  
 4 line A = 10.12 m; line B = 20.25 m  
 5 40 074.78 km  
 6 option B  
 7 351.1 mm

**CHAPTER REVIEW**

- 1 option B  
 2 7 cm  
 3 37.68 cm  
 4 57.46 m  
 5 18 cm  
 6 Yes, the tube has circumference 31.4 cm which leaves 18.6 cm for a bow  
 7 18.5 m  
 8 91.06 m  
 9 112 cm  
 10 61.70 cm  
 11 111.4 cm  
 12 a 32.99 m      b 44.99 m

**11 Area****BEFORE YOU START ...**

- 1 a Parallelogram      b Trapezium      c Rectangle  
 2 a 25      b 200      c 25  
 3 a 12      b 100      c 0.5  
 4 a  $5 \text{ m}^2 = 50\,000 \text{ cm}^2$   
 b  $870 \text{ cm}^2 = 87\,000 \text{ mm}^2$   
 c  $4 \text{ km}^2 = 4\,000\,000 \text{ m}^2$

**LAUNCHPAD**

- 1 a  $A = \frac{4 \times 3}{2}$       b  $A = 4 \times 3$       c  $A = 4 \times 3$   
 d  $A = 4 \times 4$       e  $A = 4 \times 4$   
 2 a Area (A)      b coefficient      c radius  
 3  $4.02 \text{ m}^2$  (2 dp)  
 4  $105 \text{ cm}^2$   
 5  $786 \text{ m}^2$

**EXERCISE 11A**

- 1 Student's own answers but possible suggestions include ...  
 a Rectangles: areas of walls to know how much paint they need.  
 b Triangles and squares: areas to work out how many mosaic tiles they need.

- c Triangles, quadrilaterals, circles, composite shapes: to find out the area of turf for a lawn for example.  
 d Composite shapes: to find out the area of material needed.  
 e Rectangles: to know how much carpet they need.

- 2 a C      b C  
 3 a  $0.495 \text{ m}^2$   
 b  $2437.5 \text{ mm}^2$   
 4 12 m  
 5  $22.5 \text{ cm}^2$   
 6  $0.9 \text{ m}^2$   
 7 100 cm  
 8  $4.32 \text{ m}^2$

**WORK IT OUT 11.1**

Option C is correct.

In Option A both dimensions are incorrect; in Option B the height is incorrect.

**WORK IT OUT 11.2**

Option A is correct.

In Option B the area should be for a rectangle not a triangle; in Option C there are  $10\,000 \text{ cm}^2$  in  $1 \text{ m}^2$ .

**EXERCISE 11B**

- 1 a  $60 \text{ cm}^2$       b  $703 \text{ mm}^2$       c  $308 \text{ cm}^2$       d  $3.78 \text{ m}^2$   
 2 a  $412.5 \text{ mm}^2$       b  $22.5 \text{ cm}^2$       c  $64 \text{ cm}^2$       d  $10.5 \text{ cm}^2$   
 3 12 cm  
 4 B  
 5 a 6 cm      b 17 cm      c 2.86 cm  
 d 5 cm      e 10.22 cm  
 6 a  $308 \text{ m}^2$       b 7700 kg of soil, 3080 kg of compost  
 c 78 m

**EXERCISE 11C**

- 1 A  
 2 a  $254.34 \text{ cm}^2$       b  $514.46 \text{ cm}^2$       c  $153.86 \text{ cm}^2$       d  $356.15 \text{ cm}^2$   
 3 a  $149.85 \text{ mm}^2$       b  $3.67 \text{ cm}^2$       c  $3.91 \text{ m}^2$       d  $384.34 \text{ mm}^2$   
 4  $0.17 \text{ m}^2$   
 5 a  $153.94 \text{ cm}^2$       b  $201.06 \text{ cm}^2$   
 6 a  $64.34 \text{ cm}^2$   
 b 20.11 cm  
 7 a  $1950.3 \text{ m}^2$       b  $4.91 \text{ m}^2$   
 8 Circumference =  $2\pi r = 75.398 \text{ mm}$ . So  $r = 12 \text{ mm}$ .  
 Area =  $\pi r^2 = 452.39 \text{ mm}^2$

**EXERCISE 11D**

- 1 a  $8 \times 5 + 2 \times 5 = 50 \text{ m}^2$   
 b  $7.2 \times 4.5 + 5.1 \times (7.2 - 1.2 - 2.1) = 52.29 \text{ m}^2$   
 c  $2.1 \times 5.4 + 5.4(7.8 - 2.1 - 3.4) + 7.8 \times (7.2 - 5.4) = 37.8 \text{ cm}^2$

- d  $12 \times 2.4 + 1.2 \times 6 = 36 \text{ cm}^2$   
 e  $2 \times 19.1 \times 3.8 = 145.16 \text{ cm}^2$   
 f  $8.53 \times 7.84 - 0.5 \times 3.71 \times (7.84 - 5.82) = 63.13 \text{ cm}^2$   
 g  $0.5 \times \pi \times 4.3^2 + 0.5 \times \pi \times 2.15^2 = 36.31 \text{ cm}^2$   
 h  $\frac{124}{360} \pi \times 15^2 = 243.47 \text{ cm}^2$
- 2 a  $250.47 \text{ cm}^2$       b  $13.73 \text{ cm}^2$       c  $153.96 \text{ cm}^2$   
 d  $149.1 \text{ cm}^2$       e  $30.18 \text{ cm}^2$       f  $77.43 \text{ cm}^2$   
 g  $15.14 \text{ cm}^2$       h  $69.53 \text{ m}^2$
- 3 B

**EXERCISE 11E**

- 1 182.5  
 2  $200.84 \text{ cm}^2$   
 3 a  $706.5 \text{ cm}^2$       b  $678.24 \text{ cm}^2$   
 4  $103.87 \text{ cm}^2$   
 5  $19.24 \text{ m}^2$   
 6  $113.1 \text{ cm}^2$   
 7  $6.93 \text{ cm}$   
 8  $\pounds 56.70$   
 9 a  $154.25 \text{ cm}$   
 b  $1413.72 \text{ cm}^2$

**CHAPTER REVIEW**

- 1  $15.38 \text{ m}$   
 2  $68 \text{ cm}^2$   
 3 option C  
 4  $13.5 \text{ m}^2$   
 5 a  $5^2 = 25$   
 $25 \times 3.14 = 78.5 \text{ cm}^2$   
 b Reverse the stages with the inverse operation:  
 Step 1 Divide the area by 3.14  
 Step 2 Find the square root of the result
- 6  $660.52 \text{ cm}^2$   
 7  $372.53 \text{ cm}^2$   
 8  $211.25 \text{ cm}^2$

**12 Rounding and estimation****BEFORE YOU START ...**

- 1 a correct      b incorrect      c incorrect  
 2 a true      b true      c false      d true  
 3 a 4.0      b 3.55      c 0.045

**LAUNCHPAD**

- 1 a 90      b 2000      c 134.12  
 d 20.0      e 1000      f 235 000 000
- 2 9 mm  
 3 a  $\pounds 5.15$       b  $\pounds 5.16$   
 4 around  $\pounds 15$   
 5 around 10 litres  
 6 a 14      b 4      c 4  
 7  $9.5 \text{ m} \leq 10 \text{ m} < 10.5 \text{ m}$

**EXERCISE 12A**

- 1 a B      b A      c B      d A      e B  
 2 a i 55      ii 11      iii 9      iv 12  
 b i 30      ii 60      iii 110      iv 35 810  
 c i 500      ii 5700      iii 2400      iv 35 800  
 d i 3000      ii 0      iii 36 000      iv 67 000  
 e i 100 000      ii 1 200 000      iii 12 400 000      iv 123 500 000  
 f i 1 000 000      ii 1 000 000      iii 14 000 000      iv 546 000 000
- 3 a  $\pounds 28$       b 30      c  $\pounds 200$   
 d 2 m      e no, it is 63.8 million to the nearest 100 000

**EXERCISE 12B**

- 1 option C  
 2 a i 4.5      ii 4.53      iii 4.526  
 b i 25.3      ii 25.26      iii 25.256  
 c i 125.6      ii 125.62      iii 125.617  
 d i 0.5      ii 0.54      iii 0.538  
 e i 32.4      ii 32.40      iii 32.397
- 3 a 19.87      b 302.04      c 0.29  
 d 0.21      e 21 245.84      f 0.00  
 g 0.10      h 1.00      i 100.00
- 4 There will be a variety of justifications for answers.  
 a  $24.49 \text{ kg}$       b 3.14      c  $14 \text{ km/litre}$       d  $\pounds 14.10$

**EXERCISE 12C**

- 1 a i 800      ii 4000      iii 70 000      iv 0.05  
 b i 790      ii 3100      iii 0.0033      iv 0.00075  
 c i 789      ii 46 700      iii 0.00421      iv 753 000  
 d i 38      ii -4100      iii 3.0      iv 2 000 000  
 e i 37.7      ii -4130      iii 3.04      iv 2 000 000
- 2 Rounding 0.000 134 567 to two decimal places will give 0.00 which doesn't tell us anything. Rounding to two significant figures is a more accurate way to round very small numbers.
- 3 a option B      b  $1.2 \text{ kg/m}^3$       c  $300 000 000 \text{ m/s}$   
 d  $9.81 \text{ m/s}^2$

**EXERCISE 12D**

- 1 a 37.67      b -4.12      c 3.03      d 0.99  
 2 a 4.52      b 25.2      c 125  
 d 0.537      e 32.3      f 200
- 3  $\pounds 20.67$  Rounding to two decimal places is the most useful way to approximate as this is to the nearest penny. (Rounding up would also always ensure there is enough money to cover the bill.)

**WORK IT OUT 12.1**

Estimate A is the closest estimate to the actual cost, but students may have justification for choosing a different estimate. (For example, always rounding up so you have an overestimate may be good for budgeting.)

## EXERCISE 12E

- 1 a  $100 \times 4 = 400$     b  $400 \times 1 = 400$     c  $1 \times 20 = 20$   
 d  $-10 \times 0.5 = -5$     e  $3 \times 25 = 75$     f  $5 \times 10 = 50$   
 g  $\frac{200}{20} = 10$     h  $\frac{60}{0.5} = 120$

2 option D

3 a option C

b option B

4 a  $\frac{80 \times 0.5}{40 \times 3} = \frac{40}{120} \approx 0.3$     b  $\frac{20 + 3}{20 - 6} = \frac{23}{14} \approx 2$

c  $\frac{900 \div 40}{2 \times 0.2} = \frac{22.5}{0.4} = \frac{250}{4} \approx 56$     d  $\frac{1000 \div 500}{20 \div 40} = \frac{2}{0.5} = 4$

5 a  $\sqrt{\frac{3 \times 4}{0.4 \times 0.3}} = 10$     b  $\sqrt{\frac{4 \times 12}{8 \times 0.25}} = \sqrt{24} \approx 5$

6 a 2400 m

b 250 s

7 a no    b no    c yes

d no    e yes    f no

8 6.9 cm

## EXERCISE 12F

- 1 a  $4.85 \leq L < 4.95$     b  $12.5205 \leq L < 12.5215$   
 c  $42.95 \leq L < 43.05$     d  $28.5 \leq L < 29.5$

2 a option B

b No as  $1.395 \text{ m} \leq \text{length of wood} < 1.405 \text{ m}$ c least weight 43.35 kg; greatest weight 43.4499999 kg (weight  $< 43.45$  kg)

Mass of a piece of jewellery	Maximum value of gold (to nearest penny)	Maximum value of platinum (to nearest penny)
18 g (to nearest g)	£197.21	£619.01
18 g (to nearest 0.1 g)	£192.41	£603.93
18 g (to nearest 0.01 g)	£191.93	£602.45

b The smallest fractions of weight make a big difference in the value

## CHAPTER REVIEW

- 1 a false    b false    c true  
 d true    e false

2 youngest 23.5 years, oldest 24.5 years

3 425 499

4  $7.6 \text{ m} \times 2.4 \text{ m} = 18.24 \text{ m}^2$ 

$18.24 \approx 18$

$18 \times 10 = 180$

$180 + 30 = \text{£}210$

5 option C

6 maximum perimeter 152 m

7 144 people

8  $89.5 \text{ cm} \leq \text{length of rope} < 90.5 \text{ cm}$ 

## 13 Percentages

## BEFORE YOU START ...

- 1 a 2.1    b 0.21    c 24    d 2.4  
 2  $\frac{16}{36} = \frac{4}{9}$ ,  $\frac{15}{35} = \frac{3}{7}$ ,  $\frac{30}{36} = \frac{5}{6}$ ,  $\frac{9}{36} = \frac{1}{4}$ ,  $\frac{39}{52} = \frac{3}{4}$ ,  $\frac{13}{39} = \frac{1}{3}$   
 3 a false    b false    c false    d true    e false

## LAUNCHPAD

- 1 a  $\frac{17}{50}$     b  $1\frac{3}{20}$   
 2 a 12%, 0.125,  $\frac{7}{50}$ , 19%,  $\frac{5}{12}$   
 b 2.5%, 12.5%, 1.08, 1.25, 200%,  $2\frac{3}{4}$   
 3 76%  
 4 64  
 5 27.2%  
 6 3.33%  
 7 £21.90  
 8 £2590  
 9 £3.99

## EXERCISE 13A

- 1 a option D    b option D    c option B  
 2 a 5%    b 54%    c 44%    d 85%  
 e 50%    f 66.7%    g 62.5%    h 184%  
 i 30%    j 4%    k 47%    l 112%  
 m 207%    n 225%    o 3.5%    p 0.7%  
 3 a  $\frac{1}{4}$     b  $\frac{4}{5}$     c  $\frac{9}{10}$     d  $\frac{1}{8}$   
 e  $\frac{1}{2}$     f  $\frac{49}{50}$     g  $\frac{3}{5}$     h  $\frac{11}{50}$   
 4 a 0.82    b 0.97    c 0.45    d 0.28  
 e 0.0005    f 0.0008    g 0.00006    h 0.000007  
 i 1.25    j 3    k 0.0728    l 0.09007  
 5 a false    b true    c false    d true  
 6 a 6.5%    b 33.3%    c 67.5%  
 7 24%  
 8 a 50%    b 75%    c 37.5%    d 5.56%  
 9 a 0.8%,  $\frac{1}{20}$ , 0.1, 30%,  $\frac{3}{5}$     b 0.15,  $\frac{1}{4}$ , 57%, 0.75, 0.88  
 c 0.25, 60%,  $\frac{2}{3}$ , 0.75,  $\frac{9}{10}$     d 0.395,  $\frac{3}{7}$ , 0.43,  $\frac{4}{9}$ , 45%  
 e 49.3%, 55%,  $\frac{19}{25}$ , 80%,  $\frac{5}{6}$   
 10  $\frac{167}{200}$   
 11 6%  
 12 55%  
 13 a 27 out of 30    b 84.7%

## WORK IT OUT 13.1

A is correct.

B - Answer is too big.  $\frac{400}{9}$  is not a percentage, it is a mixed number ( $44\frac{4}{9}$ )C - 0.009 is  $\frac{9}{1000}$  which is only 0.9%.

D – The % sign is missing from the calculation.

E –  $\frac{9}{400}$  is not 9%, it is only 2.25%.

### EXERCISE 13B

- 1 a 12.5      b 36      c 24  
 d 2925      e 9      f 270  
 g 16      h 66      i 135
- 2 a £9.50      b 42 kg      c 15.75 cm  
 d 26.1 kg      e £14      f 2.08 min  
 g £74      h 6.84 m      i 58 litres
- 3 68 out of 80
- 4 a option D      b option C
- 5 5.4, so 5 phones
- 6 a 1127      b 1323
- 7 201
- 8 £22.48
- 9 a  $46.5 \text{ m}^2$       b  $573.5 \text{ m}^2$
- 10 3164
- 11 a 9 ct = 37.5% gold and 18 ct = 75% gold  
 b 5.475 g  
 c 6.1125 g

### WORK IT OUT 13.2

Student B is correct. Student A is wrong. Part of a race cannot be greater than the whole (100%), so 300% can't be right.

### EXERCISE 13C

- 1 a 8%      b 1.5%      c 15%      d 4%  
 e 35%      f 6.33%      g 6.25%      h 18.86%  
 i 33.33%      j 27.78%      k 3.26%      l 53.33%  
 m 57.14%      n 7.14%      o 26.67%      p 16.8%  
 q 25%      r 64.29%      s 17.5%      t 1%
- 2 option C
- 3 Angelika
- 4 60%
- 5 6%
- 6 20%
- 7 29.63%
- 8 81.39%
- 9 a 33.33%      b 0.31%

### WORK IT OUT 13.3

Answers here will vary from student to student.

### EXERCISE 13D

- 1 a £54.72      b £945      c £32.28  
 d £40 236      e £98.55      f £99.68
- 2 option D
- 3 a £58.48      b £520      c £83.16  
 d £19882      e £76.93      f £45.24
- 4 option D

- 5 £129 375  
 6 £3244  
 7 £7  
 8 358  
 9 £2393.75, £2429.66  
 10 £42 430

### EXERCISE 13E

- 1 a £120      b 1500 g      c 666.67 kg      d £1739.13
- 2 option C
- 3 a £1000      b £121.25      c £720.83      d £45.83
- 4 £50
- 5 option A
- 6 a 1200 students      b 960 students
- 7 £150
- 8 260 g
- 9 61.05 kg
- 10 500 runners

### CHAPTER REVIEW

- 1 a option D      b option B
- 2 a  $\frac{1}{4}$       b  $\frac{3}{10}$       c  $\frac{7}{200}$
- 3 a 5%      b 12.5%      c 53.33%  
 d 50%      e 125%      f 0.5%
- 4 4% increase
- 5 223 435
- 6 A  $12 \times 10\%$  of £100 = £120  
 B  $24 \times 6\%$  of £100 = £144  
 C  $36 \times 4\%$  of £100 = £144  
 Method A is cheaper
- 7 33.6 hours (33 h 36 min)
- 8 a 12.5%      b 37.5%
- 9 £460
- 10 £850

## 14 Powers and roots

### BEFORE YOU START ...

- 1 a <      b =      c >      d =
- 2 a B      b C      c C
- 3 a  $\frac{4}{3}$       b  $\frac{1}{12}$       c  $\frac{5}{7}$

### LAUNCHPAD

- 1 a  $4^5$       b  $8^3$       c  $5^2$   
 d  $9^7$       e  $\left(\frac{1}{3}\right)^4$
- 2 a  $3^5 = 243$       b  $4^2 = 16$       c  $6^0 = 1$   
 d  $6^2 = 36$       e  $4^{-3} = \frac{1}{4^3} = \frac{1}{64}$       f  $2^6 = 64$

### EXERCISE 14A

- 1 a  $4^3$       b  $3^6$       c  $7^4$   
 d  $9^3$       e  $5^5$       f  $12^3$   
 g  $18^7$       h  $11^9$       i  $19^8$   
 j  $23^6$       k  $11^{14}$       l  $9^8$
- 2 a  $3 \times 3 \times 3 \times 3$       b  $9 \times 9 \times 9$   
 c  $4 \times 4 \times 4 \times 4 \times 4$       d  $8 \times 8 \times 8$   
 e  $5 \times 5 \times 5 \times 5 \times 5 \times 5$       f  $3 \times 3 \times 3 \times 3 \times 3 \times 3 \times 3 \times 3$   
 g  $23 \times 23 \times 23 \times 23 \times 23$       h  $51 \times 51 \times 51 \times 51$   
 i  $72 \times 72 \times 72 \times 72 \times 72$       j  $203 \times 203 \times 203$   
 k  $121 \times 121 \times 121 \times 121$       l  $100 \times 100 \times 100 \times 100 \times 100$
- 3 option C
- 4 a 8      b 36      c 1      d 512  
 e 10 000      f 1 000 000      g 7      h 50  
 i 64      j 32      k 128      l 729  
 m 2      n 16      o 49 000      p 7 000 000  
 q 3200      r 36 000 000

### EXERCISE 14B

- 1 option C
- 2 a 4096      b 1728      c 32 768      d 2401  
 e 3375      f 10 000      g 784      h 15 625
- 3 a 1472      b 159 775      c 759 375  
 d 531 522      e 985      f 343
- 4 a >      b <      c >  
 d <      e <      f >

### EXERCISE 14C

- 1 option C
- 2 a  $\frac{1}{2}$       b  $\frac{1}{3}$       c  $\frac{1}{4}$   
 d  $\frac{1}{3^2}$       e  $\frac{1}{4^3}$       f  $\frac{1}{3^5}$   
 g  $\frac{1}{3^4}$       h  $\frac{1}{6^6}$       i  $\frac{1}{34^5}$
- 3 a  $3^{-1}$       b  $5^{-1}$       c  $7^{-1}$   
 d  $3^{-2}$       e  $4^{-5}$       f  $2^{-6}$   
 g  $7^{-2}$       h  $10^{-5}$       i  $2^{-2}$   
 j  $12^{-3}$       k  $10^{-4}$       l  $\frac{2^{-2}}{3}$
- 4 a =      b =      c =  
 d  $\neq$       e =      f =  
 g =      h =      i  $\neq$

### EXERCISE 14D

- 1 a  $2^7$       b  $10^7$       c  $4^6$       d  $5^7$   
 e  $2^{11}$       f  $3^{-2}$       g  $2^3$       h  $3^2$   
 i  $2^{-1}$       j  $3^5$       k  $10^1$       l  $10^0$
- 2 a  $6^2$       b  $10^3$       c  $6^2$       d  $6^{-2}$   
 e  $10^{-2}$       f  $3^{10}$       g  $3^7$       h  $10^0$   
 i  $5^6$       j  $10^{10}$       k  $3^1$       l  $2^{-3}$
- 3 a  $2^6$       b  $2^9$       c  $2^8$       d  $10^4$   
 e  $10^6$       f  $10^8$       g  $2^{-12}$       h  $10^{-4}$   
 i  $10^{-6}$       j  $3^{-8}$       k  $2^0$       l  $2^{10}$

- 4 a true      b false,  $3^6$       c true  
 d true      e true      f true  
 g false,  $3^8$       h true      i true

### EXERCISE 14E

1 a

Base \ Index	-3	-2	-1	0	1	2	3	4	5
2	$2^{-3} = \frac{1}{8}$	$2^{-2} = \frac{1}{4}$	$2^{-1} = \frac{1}{2}$	$2^0 = 1$	$2^1 = 2$	$2^2 = 4$	$2^3 = 8$	$2^4 = 16$	$2^5 = 32$
3	$3^{-3} = \frac{1}{27}$	$3^{-2} = \frac{1}{9}$	$3^{-1} = \frac{1}{3}$	$3^0 = 1$	$3^1 = 3$	$3^2 = 9$	$3^3 = 27$	$3^4 = 81$	$3^5 = 243$
4	$4^{-3} = \frac{1}{64}$	$4^{-2} = \frac{1}{16}$	$4^{-1} = \frac{1}{4}$	$4^0 = 1$	$4^1 = 4$	$4^2 = 16$	$4^3 = 64$	$4^4 = 256$	$4^5 = 1024$
5	$5^{-3} = \frac{1}{125}$	$5^{-2} = \frac{1}{25}$	$5^{-1} = \frac{1}{5}$	$5^0 = 1$	$5^1 = 5$	$5^2 = 25$	$5^3 = 125$	$5^4 = 625$	$5^5 = 3125$

- b The negative powers are unit fractions of the matching positive powers.  
 c Every second power of 2 is equivalent to a power of 4.  
 d If it does not end in 5 and is not equal to 1 it cannot be a power of 5.

### EXERCISE 14F

- 1 option B
- 2 a true      b false      c true      d false  
 e true      f false      g false      h true  
 i true      j true      k false      l true
- 3 a 5      b 2      c 4      d 5  
 e 3      f 4      g 7      h 50  
 i 5      j 30      k 20      l 25

### EXERCISE 14G

- 1 a 8 cm      b 0.3 cm      c 0.4 m      d 40 mm
- 2 yes:  $30 \times 30 = 900$
- 3 a option A      b option D
- 4 yes
- 5 a  $12.25 \text{ m}^2$       b  $\sqrt{1024} = 32 \text{ cm}$   
 c  $12.25 \div 0.1024 = 119.6$ . He will need 120 tiles.  
 d  $120 + 15\% = 138$  but this is not a multiple of 8, so he'll need to buy 144 tiles in 18 boxes of 8.  
 e £423
- 6 a Nisha is not correct: small is  $200.96 \text{ cm}^2$ , large is  $803.84 \text{ cm}^2$   
 b It increases by a factor of 4 (it is four times bigger).
- 7 a 5 cm      b 4 cm      c 0.5 m
- 8 1.5 cm
- 9 a £4072.24      b £3257.79
- 10 a      £120511.77      b £99051.89      c £21 459.88

### CHAPTER REVIEW

- 1 option C
- 2 a  $8^5$       b  $3^3$       c  $9^2$       d  $14^5$





- 3 a 2500      b 39 000      c 426 500  
 d 0.00001045      e 0.00000915      f 0.000000001  
 g 0.000028      h 94 000 000      i 0.00245
- 4 a  $9.05 \times 10^6$       b  $7.848 \times 10^{-1}$       c  $4.04 \times 10^{10}$       d  $3.18 \times 10^{-1}$
- 5 a  $5.74 \times 10^7$       b  $1.764 \times 10^{15}$   
 c  $3.4 \times 10^4$       d  $1.33 \times 10$  (to 3 sf)
- 6 a 17 million =  $1.7 \times 10^7$   
 $1.7 \times 10^7 \times 1.8 = 3.06 \times 10^7$   
 b  $5.6 \times 10^{11} \div 1.7 \times 10^7 = \text{£}33\ 000$  to two significant figures
- 7 a the Sun      b  $6.051 \times 10^6$  times
- 8 a  $7.36 \times 10^6 \text{ km}^2$       b  $7.84 \times 10^6 \text{ km}^2$       c 31.7 times (to 3 sf)

## 16 Further algebra

### BEFORE YOU START ...

- 1  $x + 6y + 2xy$   
 2  $2x^2 - 2xy$   
 3  $9x(3y - 1)$
- 4 a Yes, each expression will be identical in value for any values of  $a$   
 b No, for example when  $x = 0$ ,  $4 \neq -8$
- 5 b is the correct expression
- 6 a -30      b 21      c  $-2ab$       d  $y^2$       e  $10a^2$

### LAUNCHPAD

- 1 a  $x^2 + 8x + 15$       b  $x^2 + 2x - 15$       c  $x^2 - 8x + 15$   
 2 a  $(a + 2)(a + 3)$       b  $(x - 2)(x - 1)$   
 c  $(p - 9)(p + 5)$       d  $(y + 4)(y - 4)$

### EXERCISE 16A

- 1 option D  
 2 option A
- 3 a  $x^2 + 7x + 10$       b  $x^2 - 7x + 10$       c  $x^2 - 3x - 10$   
 d  $x^2 + 3x - 10$       e  $x^2 - x - 12$       f  $x^2 + 2xy + y^2$
- 4 a  $x^2 - 6x + 5$       b  $a^2 - 11a + 28$       c  $m^2 - m - 20$   
 d  $p^2 - 2p - 24$       e  $x^2 - x - 42$       f  $x^2 + 8x - 33$   
 g  $x^2 - 18x + 77$       h  $x^2 + 5x - 24$       i  $x^2 - 18x + 72$
- 5 a  $6x^2 + 18x + 12$       b  $15x^2 + 26x + 8$       c  $6x^2 - 13x - 5$   
 d  $20y^2 - 11y - 3$       e  $6a^2 - 13a + 5$       f  $2b^2 - 11b + 15$   
 g  $6y^2 - 19y + 15$       h  $4x^2 - 4x - 24$       i  $20x^2 - 17x + 3$
- 6 a  $x^2 + 10x + 25$       b  $x^2 - 10x + 25$   
 c Take the sum of the squares of the terms and add twice the product of the terms.
- 7 a  $x^2 + 4x + 4$       b  $x^2 + 14x + 49$       c  $x^2 - 6x + 9$   
 d  $x^2 - 18x + 81$       e  $4x^2 + 4x + 1$       f  $1 - 6x + 9x^2$
- 8 a  $6x^2 + x - 2$       b  $13x^2 + 8x + 5$   
 c  $5x^2 + 16x + 3$
- 9 a  $x^2 + 10x + 25$       b  $4x^2 - 28x + 49$       c 169 and 81

### EXERCISE 16B

Much of this is an investigative activity. Other than for the answers given here, students will provide their own answers and explanations.

- 1 a  $x^2 - 1$       b  $a^2 - 4$       c  $9 - x^2$       d  $25 - y^2$   
 5  $(x + y)(x - y) = x^2 + yx - xy - y^2 = x^2 - y^2$   
 6 a  $x^2$  and  $y^2$

### EXERCISE 16C

- 1 a 2, 3      b 1, 7      c -2, 4  
 d -6, -4      e -3, 8      f -3, 6
- 2 a  $(x + 2)(x + 12)$       b  $(x + 1)(x + 2)$       c  $(x + 3)(x + 4)$   
 d  $(x + 5)(x + 7)$       e  $(x + 3)(x + 9)$       f  $(x + 1)(x + 6)$   
 g  $(x + 5)(x + 6)$       h  $(x + 2)(x + 8)$       i  $(x + 1)(x + 10)$   
 j  $(x + 1)(x + 7)$       k  $(x + 4)(x + 20)$       l  $(x + 6)(x + 7)$
- 3 a  $(x - 2)(x - 6)$       b  $(x - 4)(x - 5)$       c  $(x - 3)(x - 4)$   
 d  $(x - 4)(x - 2)$       e  $(x - 4)(x - 8)$       f  $(x - 7)(x - 7)$   
 g  $(x - 10)(x + 2)$       h  $(x - 9)(x + 2)$       i  $(x - 8)(x + 4)$   
 j  $(x + 3)(x - 2)$       k  $(x + 11)(x - 3)$       l  $(x + 12)(x - 2)$
- 4 a  $2(x + 1)(x + 2)$       b  $6(x - 1)(x - 3)$       c  $5(x + 1)(x - 2)$   
 d  $2(x + 2)(x + 5)$       e  $2(x + 3)(x - 1)$       f  $3(x + 1)(x - 11)$
- 5 option B

### WORK IT OUT 16.1

Option B is correct.

Option A: The mistake was going from  $169 - x^2 = 25$  to  $x^2 = 194$ .

The correct next step would be  $x^2 = 144$ .

It would have been easier to rearrange the equation initially from  $13^2 - x^2 = 5^2$  to  $13^2 - 5^2 = x^2$ .

Option C: The mistake was writing  $x^2 = (13 - 5)(13 - 5)$  instead of  $(13 - 5)(13 + 5)$ .

### EXERCISE 16D

- 1 a  $(x + 6)(x - 6)$       b  $(p + 9)(p - 9)$       c  $(w + 4)(w - 4)$   
 d  $(p + 6q)(p - 6q)$       e  $(12s + c)(12s - c)$       f  $(8h + 7g)(8h - 7g)$
- 2 a  $(100 - 97)(100 + 97) = 3 \times 197 = 591$   
 b  $(50 - 48)(50 + 48) = 2 \times 98 = 196$   
 c  $(639 - 629)(639 + 629) = 10 \times 1268 = 12\ 680$   
 d  $(98 - 45)(98 + 45) = 53 \times 143 = 7579$   
 e  $(83 - 77)(83 + 77) = 6 \times 160 = 960$   
 f  $(1234 - 999)(1234 + 999) = 235 \times 2233 = 524\ 755$
- 3 a  $(17 - 15)(17 + 15) = 2 \times 32 = 64$ ;  $a = \sqrt{64} = 8$   
 b  $(15 - 4)(15 + 4) = 11 \times 19 = 209$ ;  $a = \sqrt{209}$   
 c  $(20 - 14)(20 + 14) = 6 \times 34 = 204$ ;  $a = \sqrt{204}$   
 d  $(20 - 14.5)(20 + 14.5) = 5.5 \times 34.5 = 189.75$ ;  $a = \sqrt{189.75}$

### EXERCISE 16E

- 1 a true      b false      c false      d true
- 2 a  $(x + 3)^2 = x^2 + 6x + 9$       b  $(x + 4)(x - 1) = x^2 + 3x - 4$   
 c  $\frac{1}{2}(x - 2)(2x + 6) = x^2 + x - 6$
- 3 a  $(x + 4)(x + 7)$       b  $19.5(x + 4)(x + 7)$   
 c  $19.5 \times 16 \times 19 = \text{£}5928$

- 4 a**  $(x + 0.6); (x - 0.6)$       **b**  $x^2 - 0.36$   
**c** difference of two squares      **d**  $x^2 - (x^2 - 0.36) = 0.36 \text{ m}^2$
- 5 a** 4      **b**  $2m + \frac{3}{n}$       **c**  $2y - 7$       **d**  $x - 5$
- 6 a**  $(x + 5)(x + 7) = x^2 + 12x + 35$   
**b**  $(x + 3)(x + 6) = x^2 + 9x + 18$   
**c**  $(x + 4)(x - 6) = x^2 - 2x - 24$   
**d**  $(2x + 3)(x + 2) = 2x^2 + 7x + 6$   
**e**  $(2x + 1)(2x + 5) = 4x^2 + 12x + 5$
- 7 a**  $(x - 3)(x - 8)$       **b**  $(x - 1)(x - 24)$   
**c** There are several possible answers eg  $x^2 - 10x + 24$  or  $x^2 + 25x + 24$
- 8**  $(1999 - 1998)(1999 + 1998) = 1 \times 3997 = 3997$
- 9**  $x^2 - 25 = (x - 5)(x + 5); (x - 5) \neq (x + 5)$  so this is not a perfect square

### CHAPTER REVIEW

- 1 a**  $2x^2 - 12x + 20$       **b**  $2x^2 + 8$
- 2 a**  $(x + 3)(x - 5) = x^2 - 2x - 15$   
**b**  $(x + 3)(x + 7) = x^2 + 10x + 21$   
**c**  $(x + 2)(x - 3) = x^2 - x - 6$   
**d**  $(x + 6)(x + 5) = x^2 + 11x + 30$   
**e**  $(x + 4)(x + 6) = x^2 + 10x + 24$
- 3 a**  $3 \times (x - 6) = 3x - 18$   
**b**  $5(y - 2)$   
**c**  $12w + 3 - 15w + 10 = -3w + 13$
- 4 a**  $(x - 5)(x + 1) \text{ m}^2$       **b**  $(4x - 8) \text{ m}$
- 5**  $32x$
- 6**  $x^2 - x - 6$
- 7 a**  $(x + 8) \text{ cm}; 8 > 6 > -1$       **b**  $(x^2 + 16x + 64) \text{ cm}^2$   
**c**  $(2x^2 + 10x + 37) \text{ cm}^2$       **d**  $x = 9 \text{ cm}$

## 17 Equations

### BEFORE YOU START ...

- 1** option A  $6x + 1 = 37$
- 2 a**  $7 + [-7] = 0$       **b**  $[8] - 8 = 0$   
**c**  $-4a + [4a] = 0$       **d**  $5 \times \left[\frac{1}{5}\right] = 1$   
**e**  $\frac{1}{6} \times [6] = 1$       **f**  $\left[\frac{1}{12}\right] \times 12x = x$
- 3 a** option C      **b** option A  
**c** option B      **d** option D

### LAUNCHPAD

- 1 a** option D      **b** option B      **c** option A  
**d** option E      **e** option C  
**f** substituting answer back into equation to check
- 2 a**  $a = 5$       **b**  $x = -3$
- 3**  $2x + 16 = 44; x = 14$
- 4**  $x = 3$  or  $x = -1$
- 5**  $x = \pm 4$

- 6 a**  $x + y = 6$  has solutions:  $x = 1, y = 5; x = 2, y = 4; x = 3, y = 3; x = 4, y = 2; x = 5, y = 1$   
**b**  $x = 5$  and  $y = 1$  are the only pair that satisfy the pair of equations simultaneously
- 7 a** £100      **b**  $x = 9$       **c**  $y = 115$

### EXERCISE 17A

- 1** option B
- 2 a** -3      **b** 17      **c** -8  
**d**  $22\frac{1}{2}$       **e** -8      **f** 4
- 3 a** 6      **b** 5      **c** 6  
**d** 6      **e** -2      **f** -3  
**g** -5      **h** -7      **i** 6.5
- 4 a** 1      **b** 7      **c** 4  
**d** 1      **e** 9      **f** 3  
**g**  $-\frac{4}{3}$       **h** -1  
**i** dividing first makes the equation simpler
- 5** option C
- 6 a** It is not possible to divide the equation by 2 or 3 without producing fractional values.  
**b**  $x = 2$

### EXERCISE 17B

- 1 a** 4      **b** 5      **c**  $2\frac{1}{2}$       **d** 6  
**e**  $3\frac{1}{2}$       **f** 2      **g** 4      **h**  $\frac{1}{2}$   
**i** 1      **j**  $\frac{1}{3}$
- 2 a** 2      **b** 1      **c** 12      **d** 2  
**e** 2      **f** 1      **g**  $\frac{13}{6}$       **h**  $\frac{15}{4}$
- 3** option A
- 4 a ii** is an identity because the equation is true for any value of  $x$ .  
**b** If  $x = 0$  the equation is true.

### EXERCISE 17C

- 1 a**  $3x = 348; x = 116$   
**b**  $x - 7 = -2; x = 5$   
**c**  $x + 6 = -4; x = -10$   
**d**  $4x - 2 = 66; x = 17$   
**e**  $x + x + 1 = 63; x = 31$ ; numbers are 31 and 32  
**f**  $2x - 3 = -2; x = \frac{1}{2}$
- 2 a** Melissa is 14      **b** £2.40  
**c** 6      **d** daughter is 15
- 3 a**  $12x \text{ cm}$       **b**  $(6x + 18) \text{ cm}$   
**c**  $6x + 18 = 12x; x = 3$ ; side of square is 9 cm
- 4**  $4x + 2 = 10x - 1; x = \frac{1}{2}$ ; length = 4 cm, width = 2.5 cm

### EXERCISE 17D

- 1** option D
- 2 a**  $x = 0$  or  $x = 5$       **b**  $x = 0$  or  $x = 1$       **c**  $x = 0$  or  $x = -2$   
**d**  $x = 0$  or  $x = \frac{1}{4}$       **e**  $x = 0$  or  $x = -\frac{2}{5}$       **f**  $x = 0$  or  $x = -\frac{1}{2}$

- 3 a**  $x = \pm 4$       **b**  $x = \pm 10$       **c**  $x = \pm 1$   
**d**  $x = \pm 2$       **e**  $x = \pm \frac{1}{2}$       **f**  $x = \pm \frac{2}{3}$   
**4 a**  $x = -3$  or  $x = -6$       **b**  $x = 9$  or  $x = 1$       **c**  $x = 2$  or  $x = -4$   
**d**  $x = 5$ , or  $x = 4$       **e**  $x = -2$ , or  $x = 6$       **f**  $x = -1$  or  $x = \frac{2}{3}$   
**5 a**  $x = 4$  or  $x = -3$       **b**  $x = 2$  or  $x = -8$       **c**  $x = 0$  or  $x = -\frac{1}{2}$   
**d**  $x = 0$  or  $x = \frac{3}{4}$       **e**  $x = 1$  or  $x = -5$       **f**  $x = 3$  or  $x = -9$   
**g**  $x = 6$  or  $x = -3$       **h**  $x = 3$  or  $x = 4$

### EXERCISE 17E

- 1 a**  $x(x + 4) = 140$ ;  $x = -14$  or  $x = 10$   
**b**  $x(x - 3) = 108$ ;  $x = 12$  or  $x = -9$   
**c**  $x^2 - 3x = 10$ ;  $x = 5$  or  $x = -2$   
**d**  $x(x + 2) = 48$ ;  $x = 6$ ; numbers are 6 and 8  
**2** 6 cm  
**3**  $10\text{m} \times 21\text{m}$

### EXERCISE 17F

- 1 a**  $x = -3$ ,  $y = -5$       **b**  $x = -\frac{1}{2}$ ,  $y = 5$       **c**  $x = 1$ ,  $y = 2$   
**d**  $x = 4$ ,  $y = 2$       **e**  $x = 2$ ,  $y = 5$       **f**  $x = -1$ ,  $y = 3$   
**2** option D  
**3 a**  $x = 2$ ,  $y = 1$       **b**  $x = 2$ ,  $y = 1$       **c**  $x = \frac{21}{5}$ ,  $y = \frac{13}{5}$   
**4 a**  $x = 3$ ,  $y = 4$       **b**  $x = 1$ ,  $y = 2$       **c**  $x = 3$ ,  $y = 4$   
**d**  $x = 7$ ,  $y = -4$       **e**  $x = -\frac{11}{3}$ ,  $y = 17$       **f**  $x = -2$ ,  $y = 4$

### EXERCISE 17G

- 1 a**  $x = 4$ ,  $y = 2$       **b**  $x = 3$ ,  $y = 1$       **c**  $x = 2$ ,  $y = -2$   
**d**  $x = \frac{26}{7}$ ,  $y = -\frac{39}{7}$       **e**  $x = \frac{28}{5}$ ,  $y = \frac{21}{5}$       **f**  $x = -1$ ,  $y = -2$   
**g**  $x = 2$ ,  $y = 3$       **h**  $x = 1$ ,  $y = 3$       **i**  $x = 4$ ,  $y = 1$   
**2 a**  $x = 3$ ,  $y = -1$       **b**  $x = 3$ ,  $y = -1$       **c**  $x = 2$ ,  $y = 1$   
**3 a**  $x = 2$ ,  $y = 3$       **b**  $x = 1$ ,  $y = 1$       **c**  $x = 10$ ,  $y = 5$   
**d**  $x = -5$ ,  $y = -2$       **e**  $x = -2$ ,  $y = 5$       **f**  $x = 2$ ,  $y = -1$

### EXERCISE 17H

- 1** fizzers cost 20p, toffees cost 30p  
**2** option B  
**3** three 5p pieces, fifteen 10p pieces  
**4** 45 and 219  
**5**  $a = 70$ ,  $b = 50$   
**6** 62 and 14  
**7** £6.20

### EXERCISE 17I

- 1** option B  
**2 a** 5 miles      **b** 48 min      **c** 10 mph  
**3 a**  $\approx 45$  min      **b** 30 km      **c** 90 km/h  
**4 a** -2      **b** 1      **c** 4  
**5 a** 2000 litres      **b** 100 min  
**c** student's chosen points and explanations

- 6 a** When 500 units have been sold.  
**b** It tells the business owner how many units must be sold in order to make a profit.  
**7**  $x = 2$ ,  $y = 4$   
**8 a** The  $x$ -axis represents time in seconds and the  $y$ -axis represents height above the ground in metres.  
**b**  $x = 1$  and  $x = 11.75$  (approx.)  
**c** They are the roots of the equation  $y = 0$   
**d** (6.25, 5)  
**9 a**  $x = -1$ ,  $x = 5$       **b**  $x = -4$ ,  $x = 2$   
**10** The roots are where the line crosses the  $x$ -axis.  
**11 a** Plan B because the cost is fixed  
**b** when 400 texts are sent  
**c** 600 texts  
**d** Plan B because it has the least overall cost

### CHAPTER REVIEW

- 1 a** -19      **b**  $x = -4$  or  $x = 2$       **c**  $x = -5$   
**d**  $x = -6$  or  $x = -2$       **e**  $x = 4$  or  $x = -8$       **f**  $x = -1$  or  $x = -6$   
**2 a** false; if  $x = 2$ , then  $5(x - 2) = 0$  not 15  
**b** true  
**c** false; substituting  $x = 3$  or  $x = -5$  does not give answer 0  
**d** false; the values of  $x$  and  $y$  do not work in the equations  
**e** true  
**3 a**  $a = 9$       **b**  $x = 9$       **c**  $x = 12$       **d**  $x = 2$   
**4** Bag A has  $n$  plums  
 Bag B has  $3n$  plums  
 Bag C has  $n + 14$  plums.  
 Bag B = Bag C so  
 $3n = n + 14$   
 So  $2n = 14$   
 $n = 7$  so Bag A has 7 plums  
**5** option B  
**6 a**  $x = 10$  and  $x = 60$   
**b** Increasing the selling price increases the profit until the price is 35, but increasing it further decreases the profit.  
**7** yes, because one equation is a multiple of the other  
**8 a** Not possible to solve; you end up with  $2 = 4$ .  
**b** Lines would be parallel so never cross or touch.  
**9** At  $x = -3.24$  and  $x = 1.24$   
**10 a**  $x + y = 19$ ;  $x - y = 5$       **b**  $x = 12$ ,  $y = 7$

## 18 Functions and sequences

### BEFORE YOU START ...

- 1 a** 7, 14, 21, 28, 35      **b** 66, 18, 54, 36  
**2 a** 1, 16, 25, 4, 9, 49      **b** 9, 15  
**3 a** Pattern is built up using square and triangle shapes with some common sides. Each new shape has three extra matches to make the sides of the next square and two extra matches to make the sides of the triangle. Rule is  $5n + 1$ .  
**b** 31 matchsticks

### LAUNCHPAD

- 1 a** 59, 71, 83    **b** add 12 to the previous term  
**2 a**  $T(10) = 29, T(20) = 59, T(100) = 299$     **b**  $3n - 4$   
**3** input  $\rightarrow [\times 2] \rightarrow [-4] \rightarrow$  output  
**4** 4, 5, 6, 7, 8  
**5** Quadratic sequence. The first difference between terms is not consistent; it increases by 1 each time. The second differences between terms are equal.

### EXERCISE 18A

- 1 a** 16, 19, 22; add 3                    **b** 58, 63, 68; add 5  
**c** 15, 11, 7; subtract 4                **d** 45, 39, 33; subtract 6  
**e** 16, 32, 64; multiply by 2            **f** 8, 4, 2; divide by 2  
**g** 108, 324, 972; multiply by 3       **h** 27, 9, 3; divide by 3  
**2** 27, 33, 39  
**3 a** 16  
**b** add 4  
**4 a** add 7                                      **b** subtract 4  
**c** multiply by 4                              **d** divide by 2  
**5 a** add 2; 9.5, 11.5, 13.5              **b** multiply by 2; 9.6, 19.2, 38.4  
**c** add  $1\frac{1}{2}$ ; 6,  $7\frac{1}{2}$ , 9                      **d** subtract 3; -1, -4, -7  
**e** divide by 2; 9, 4.5, 2.25              **f** add 3; -1, 2, 5  
**6 a** 6 cm                                        **b** 7th bounce will be 0.75 cm  
**7 a**  $\frac{1}{2}$     **b**  $1\frac{1}{3}$     **c** any negative value

### WORK IT OUT 18.1

Option B is correct.  
 Option A is wrong because this sequence is defined as  $3n - 5$ .  
 Option C is wrong because this sequence is defined as  $2n - 3$ .

### EXERCISE 18B

- 1 a** pattern 16  
**b** 40  
**c** number of straws is twice the pattern number  
**2 A**  
**3 a** 2, 5, 8, 11, 14, 17                      **b** 59  
**c** no; 40th term is 119, which is not  $2 \times 59$

Position-to-term rule	1st term	2nd term	3rd term	4th term	10th term	20th term	100th term
$4n + 1$	5	9	13	17	41	81	401
$4n - 5$	-1	3	7	11	35	75	395
$8n + 2$	10	18	26	34	82	162	802
$5n - \frac{1}{2}$	$4\frac{1}{2}$	$9\frac{1}{2}$	$14\frac{1}{2}$	$19\frac{1}{2}$	$49\frac{1}{2}$	$99\frac{1}{2}$	$499\frac{1}{2}$
$\frac{n}{2} + 1$	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	6	11	51
$-2n + 1$	-1	-3	-5	-7	-19	-39	-199

**5 D**

- 6**  $4n + 1$   
**7 a**  $2n + 1$   
**b**  $4n - 1$   
**c**  $5n - 6$   
**d**  $5n + 2$   
**e**  $3n - 6$   
**f**  $7n - 8$   
**8**  $6n + 61$   
**9 a**  $2.2n + 2.3$   
**b** 222.3 cm  
**c** A sunflower will not continue growing steadily for nearly two years.  
**10 a** £308  
**b** 75 weeks  
**11 a** 14  
**b** 22  
**c** No, because any number in the sequence  $2n + 2$  must be even  
**12 C**

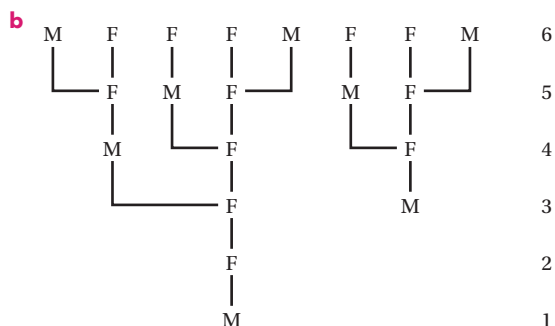
### EXERCISE 18C

- 1** 4, 5, 6, 7, 8, 9, 10, 11, 12, 13  
**2 B**  
**3 a** -4, -3, -2, -1, 0, 1, 2, 3, 4, 5  
**b** 3, 6, 9, 12, 15, 18, 21, 24, 27, 30  
**c** 8, 9, 10, 11, 12, 13, 14, 15, 16, 17  
**d**  $\frac{1}{2}, 1, 1\frac{1}{2}, 2, 2\frac{1}{2}, 3, 3\frac{1}{2}, 4, 4\frac{1}{2}, 5$   
**4 a** 42, 44, 46, 48, 50, 52, 54, 56, 58, 60  
**b** 13, 14, 15, 16, 17, 18, 19, 20, 21, 22  
**c**  $7, 7\frac{1}{3}, 7\frac{2}{3}, 8, 8\frac{1}{3}, 8\frac{2}{3}, 9, 9\frac{1}{3}, 9\frac{2}{3}, 10$   
**d**  $21\frac{1}{2}, 22\frac{1}{2}, 23\frac{1}{2}, 24\frac{1}{2}, 25\frac{1}{2}, 26\frac{1}{2}, 27\frac{1}{2}, 28\frac{1}{2}, 29\frac{1}{2}, 30\frac{1}{2}$   
**5 a** 1, 4, 9, 16, ...  
**b** 25  
**c** input ( $n$ )  $\rightarrow [\times n] \rightarrow$  output  
**d** 6th shape = 36, tenth shape = 100  
**6**  $n \rightarrow 6.25n$   
**7 a** salary =  $500 + 3p$                       **b** £620

### EXERCISE 18D

- 1 a B**  
**b** For the sequence of square numbers, the next two terms are 49 and 64. For the sequence of triangular numbers, the next two terms are 45 and 55.  
**2 a**  $n^2$   
**b** Square numbers  
**3 a** Triangular number. It can be arranged to form an equilateral triangle.  
**b** 1, 3, 6, 10, 15, 21, 28, 36, 45, 55  
**c** first difference 2, 3, 4, 5, 6, 7, 8, 9, 10; second difference is 1  
**d** a quadratic sequence

4 a 5 (3 female 2 male)



- i (1,) 1, 2, 3, 5, 8
- ii 34 (the ninth Fibonacci number)
- iii Term-to-term rule is 'add the two previous terms together.'
- iv It is the Fibonacci sequence.

5 C

6 a 3, 4, 7, 11, 18, 29, 47, 76, 123, 199

b -2, 3, 4, 11, 26, 63, 152, 367, 886, 2139

c 2, -3, 1, -5, -3, -13, -19, -45, -83, -173

7 2, 5

8 a -27, 69

b 36, -60

c 1, 5

Position-to-term rule	1st term	2nd term	3rd term	5th term	10th term	20th term	50th term
$n^2 + 5$	6	9	14	30	105	405	2505
$n^2 - 3$	-2	1	6	22	97	397	2497
$2n^2 + 1$	3	9	19	51	201	801	5001
$2n^2 - 7$	-5	1	11	43	193	793	4993

10 2, 9, 28, 65, 126, 217

11 2, 6, 12, 20, 30, 42, 56, 72, 90, 110

12 a  $\frac{1}{2}(n^2 + n)$       b 10th term is 55, 25th term is 325

### CHAPTER REVIEW

1 i 1.5, 2, [2.5], 3, 3.5, [4], ...;  $1.5 + 0.5(n - 1) = 1 + 0.5n$ ;  $T(25) = 13.5$

ii [-12], -8, -4, [0], 4, 8, [12], ...;  $-12 + 4(n - 1) = 4n - 16$ ;  $T(25) = 84$

iii  $\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}, \frac{1}{32}, \frac{1}{64}, \dots; \frac{1}{2^n}$ ;  $T(25) = \frac{1}{33554432}$

iv 5, [11], 17, 23, 29, [35], ...;  $6n - 1$ ;  $T(25) = 149$

2 D

3 B

4 a £460

b Price = £100 + 10 × (pond number)<sup>2</sup>

5 a 32

b 12

c No because it is an odd number

6 a 10th row is 1 10 45 120 210 252 210 120 45 10 1

b i 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024.

ii Powers of two (or doubles each time).

c i triangular numbers

ii  $\frac{1}{2}(n^2 + n)$

7 a 28      b  $5n + 3$       c 25 days

8 a  $2n + 2$

b 12

c input ( $n$ )  $\rightarrow$   $[\times 2] \rightarrow$   $[+ 2] \rightarrow$  output

d 42, 52 and  $2n + 2$

9 a  $28 + \frac{b}{2}$

b 36 days

## 19 Basic probability

### BEFORE YOU START ...

1 a C      b B      c C

2 a >      b >      c <

### LAUNCHPAD

1 a B      b D      c A      d C

2  $\frac{6}{11}$

3 a 0.0012      b 8 or 9

### EXERCISE 19A

1 a choosing a black scarf from six scarves

b red, yellow or black

c low, there is only one black among the six scarves, probability =  $\frac{1}{6}$

d red, there are 3 red ones ( $\frac{3}{6} = \frac{1}{2}$ )

2 a black      b green      c  $\frac{1}{4}$       d  $\frac{1}{3}$

3 Student's own estimates. Some realistic possibilities include:

a  $\frac{1}{2} = 0.5 = 50\%$       b 0      c 0

d  $1000 = 0.001 = 0.001\%$

e  $\frac{49}{100} = 0.49 = 49\%$       f  $\frac{1}{2} = 0.5 = 50\%$

g depends - on television 100%, in person, less likely

h depends - seasonal

4 Class discussion. Some possible starting points for discussion:

a This is a matter of interpretation. A 50% chance of rain means that given the same conditions on the same date over recorded historical record keeping it has rained 50% of the time.

b False. The chance of a future event is independent of the past events in this case.

c True as the chance is  $\frac{1}{6}$ .

d False, biologically she has the same chance of a boy or girl each time she has a child. Birth rates indicate slightly more boys are born than girls (107 : 100 in 2013 according to the UN).

e True.

f This is highly dependent on who the teams are and where they are playing, but students could argue either way.

### WORK IT OUT 19.1

Solution B is correct.

Solution A is wrong because in part a the fraction should be  $\frac{1}{6}$ , in part b the fraction should be  $\frac{4}{6}$  and in part c you should subtract  $\frac{1}{6}$  instead of 5.

Solution C is wrong because the percentages are all 10 times too small; they should be 16.7%, 66.7% and 83.3%.

### EXERCISE 19B

- 1 a 0.5      b  $\frac{1}{6} = 0.17$       c  $\frac{1}{9} = 0.11$       d  $\frac{6}{36} = 0.17$

Ordered: a, b and d, c

- 2 a option B      b option B      c option D

	i Possible outcomes	ii Equally likely?
a	1, 2, 3, 4, 5, 6	Yes, if dice is fair, outcome is random.
b	Any number from 1 to 100 could be drawn.	Yes, draw is random.
c	Point up, point down.	Not really, shape of drawing pin means it is more likely to land point up.
d	Draw a £1 or a 50p.	Not equally likely as there are more 50p coins.
e	student from class, student not from class.	Only if the number of students in your class is the same as the remaining number of students.
f	(head, head), (head, tail) and (tail, tail).	(head, tail) is most likely as there are two ways of achieving this.

- 4 0.5  
 5 a  $\frac{3}{7}$       b  $\frac{4}{7}$       c 0  
 6 a  $\frac{1}{2}$       b  $\frac{3}{5}$       c  $\frac{3}{20}$   
 d 0      e  $\frac{19}{20}$   
 7 a  $\frac{5}{26}$  (note that y is not a vowel)      b  $\frac{21}{26}$   
 c  $\frac{3}{13}$       d  $\frac{7}{26}$       e  $\frac{4}{13}$

8 No. The three outcomes are:

1. Person A wins, Person B loses
2. Person B wins, Person A loses
3. Draw

So the probability that one person wins is  $\frac{2}{3}$ .

### EXERCISE 19C

This is an investigative task. Students must predict outcomes before they start so that they can begin to explore the fact that theoretical probabilities are not the same as relative frequency of outcomes and that these tend to get closer with a greater number of trials.

### WORK IT OUT 19.2

Option B is correct.

Option A is wrong because one of the fractions has been converted to a percentage incorrectly.

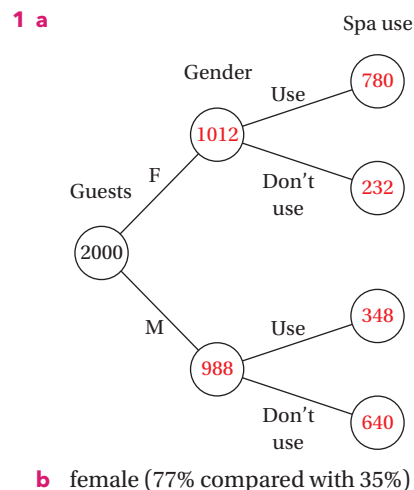
### EXERCISE 19D

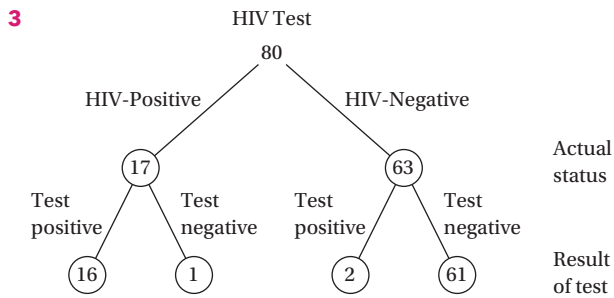
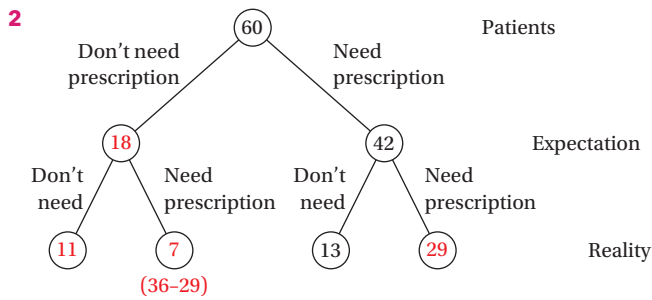
- 1 option D  
 2 option D  
 3  $\frac{7}{12}$   
 4  $\frac{7}{8}$   
 5 a No, there are more multiples of three than there are multiples of two.  
 b  $\frac{3}{4}$   
 6 Student's own reasons, but they should realise that Paul is picking one T-shirt from eight (not three); as there are six reds, his chances of red are 6 out of 8 ( $\frac{3}{4}$ ).  
 7  $\frac{1}{5}$   
 8 a i  $\frac{11}{80}$       ii  $\frac{27}{80}$   
 b No, it's a very small sample.  
 9 a 127

Brand	Number sold	Relative frequency
Make-it-go-away	381	$\frac{381}{508} = 0.75$
Generic	127	$\frac{127}{508} = 0.25$
Total	508	

- b i 0.75      ii 0.25  
 10 a  $\frac{7}{10}$       b  $\frac{3}{10}$   
 c Student's own answers, but they should realise if the weather forecast says rain and it's correct 70% of the time they'd be foolish not to take rain gear. They should also realise just from a common sense and safety point of view that you should take a rain jacket any time you go hiking in case of emergency.  
 11 a Day and date, time in 2-hourly increments, wind speed and direction, temperature in °C, rainfall in mm, sky conditions (sunny, cloudy, etc).  
 b Probably not, but Mica could take a chance on filming between 14.00 and 8 pm as no rain is projected for those times.  
 c Students to investigate and report back to class.

### EXERCISE 19E





**EXERCISE 19F**

**1** Busi is using theoretical probability to argue for an equal number of heads and tails. This is technically correct, but the reality is that each time you toss the coin, there is an equal chance of getting heads or tails. 20 tosses is too small a trial to decide that the coin is biased.

**2 a**  $\frac{13}{30}$

**b** It has been sunny for 7 tournaments and Grey College has won  $\frac{4}{7}$  (57%). When it has been cloudy Grey has won  $\frac{3}{10}$  (30%) and when it has been rainy, Grey has won  $\frac{3}{13}$  (23%). So it appears they have a better chance of winning when it is sunny.

**c** They are not correct. St George's has an experimental probability of  $\frac{1}{2} = 0.5$  of winning if it is cloudy, of  $\frac{6}{13} \approx 0.46$  of winning if it is rainy but only of  $\frac{2}{7} \approx 0.29$  of winning if it is sunny, so they have about 50% chance of winning unless it is sunny.

**d**  $\frac{1}{5}$ . Grey College has drawn one out of every five tournaments played.

**3** option C

**4** option C

**5 a** i 80%      ii 10%

**b** It is certain that it will rain.

**c** The probability that it rains is 10%, so there is a slight chance of rain. Rhys should be sensible and take a raincoat.

**d** It is highly unlikely that it will rain in that period, but weather forecasts can be wrong.

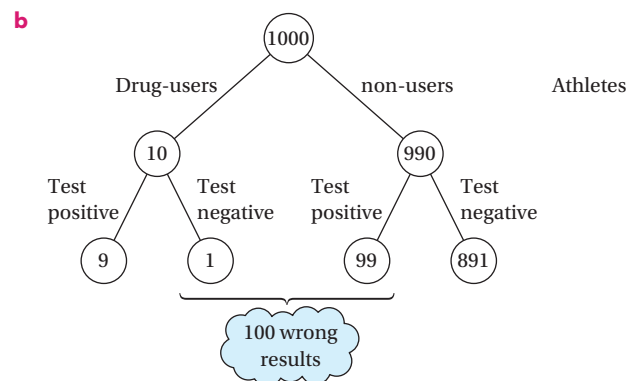
**6 a** 0.005

**b** Students' answers should acknowledge that  $\frac{1}{2}$  % is a very small margin of error and most tests would be correct. However, parents are correct in claiming that four students could incorrectly test positive. The school could agree to retest anyone who gets a positive result for greater accuracy.

**c** 19 160

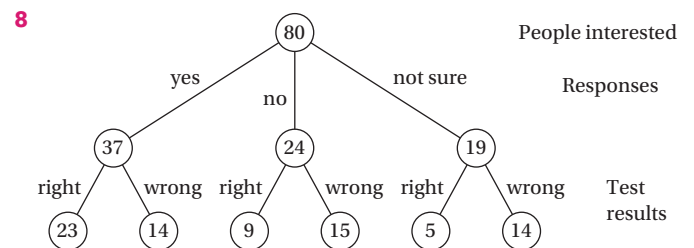
**7 a**

Status	Test positive (ie fail drug test)	Test negative (ie pass drug test)	Total
Athletes who are using illegal substances	9	1	10
Athletes who are not using illegal substances	99	891	990
Total	108	892	1000



**c** 91.7%

**d** No. Diagrams show there are 100 wrong results, so test is only 90% accurate. There is also a 1 in 1000 chance that a drug user will test negative.



**9 a** HH, HT, TH, TT

**b**

Set of coins	Number of tosses	Number of times we got two heads	Running total of two heads	Percentage of two heads (running total)
2 × 10p coins	25	6	6	$\frac{6}{25} \times 100 = 24$
2 × 50p coins	25	8	14	28
2 × £1 coins	25	5	19	25.3
2 × £2 coins	25	7	26	26
2 × 20p coins	25	9	35	28

**c** experimental

**d** 28%

**e** No, different trials could produce different results and these results are not conclusive.



- 10 a Average number of times you get two heads on 1000 tosses.  
 b a probability of 25%  
 c Results change with trials, so line varies.  
 d It gets closer to the 25% probability line.  
 e It shows that the probability of HH increases as the number of trials increases and that it gets closer to the 25% theoretical probability of HH.

**CHAPTER REVIEW**

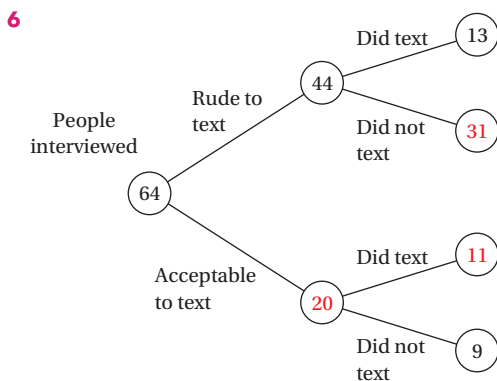
- 1 option B  
 2 option A  
 3 a  $\frac{1}{2}$       b  $\frac{9}{10}$       c  $\frac{1}{8}$   
 4 There are  $n$  blue counters and  $n + 6$  red counters.  
 Probability of a blue =  $\frac{n}{n + n + 6}$  (successful outcomes  $\div$  all possible outcomes)  
 $\frac{n}{n + n + 6} = \frac{1}{4}$   
 $\frac{n}{2n + 6} = \frac{1}{4}$   
 So  $4n = 2n + 6$   
 So  $2n = 6$   
 and  $n = 3$

Therefore there are 9 red counters in the bag

5 a

Result	1	2	3	4	5	6
Frequency	28	20	20	40	36	56
Experimental probability	0.14	0.1	0.1	0.2	0.18	0.28

- b 0.42  
 c  $\frac{1}{6} = 0.167$ , Imogen got 0.2. They may be different as she didn't do enough trials, but it could also be as a result of a biased dice.

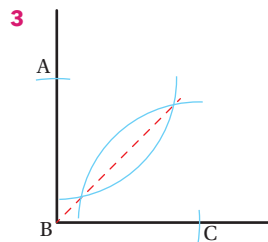


- 7 a 0.072  
 b i Yes      ii sounds better (fewer people)      iii 7  
 iv This is an experimental probability so it might vary in different population samples.

**20 3D objects**

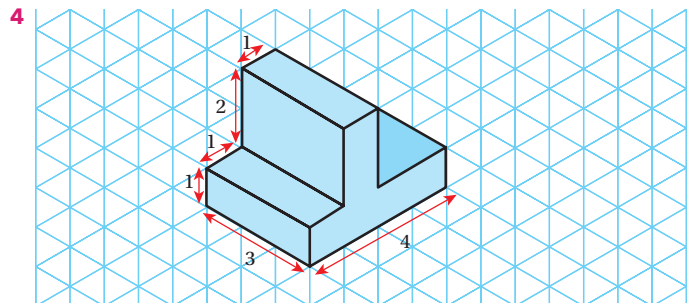
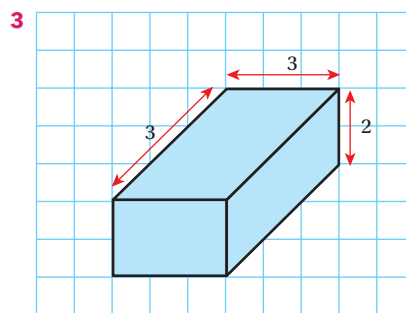
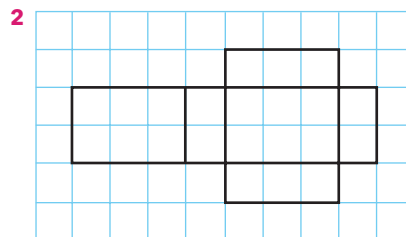
**BEFORE YOU START ...**

- 1 a Square-based pyramid      b Cuboid  
 c Cube      d Triangular prism  
 2 a False; a cube has 6 faces  
 b True      c True

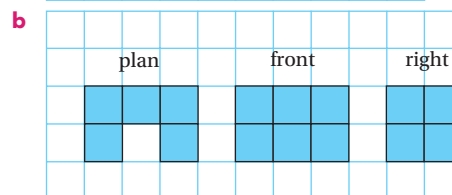
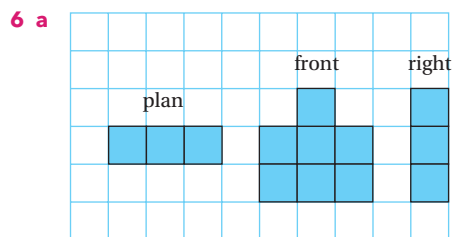


**LAUNCHPAD**

- 1 a Cube      b Triangular prism  
 c Triangular-based pyramid



5 C





### EXERCISE 20A

1 triangular prism, is a polyhedron; cone, not a polyhedron; pentagonal prism, is a polyhedron; hemisphere, not a polyhedron – polyhedrons have flat faces only

2 B

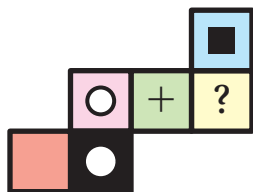
3 C

4 D

5 a tetrahedron

b triangular prism

6



7 a B, D, E, J

b Student's own drawings

### WORK IT OUT 20.1

Student A is likely to end up with the correct drawing. The other two students have extended the horizontal part of the shape in wrong directions.

### EXERCISE 20B

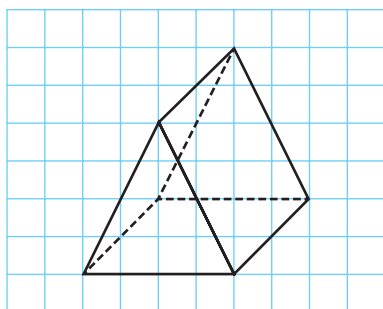
1 a Student's own drawings

c Student's own drawings

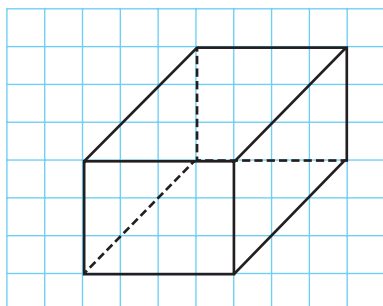
b Student's own drawings

d Student's own drawings

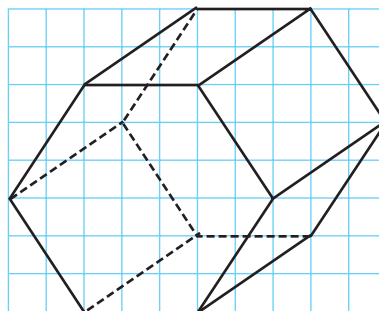
2 a i



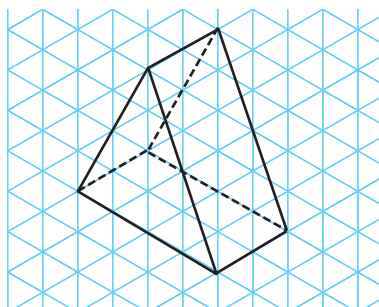
ii



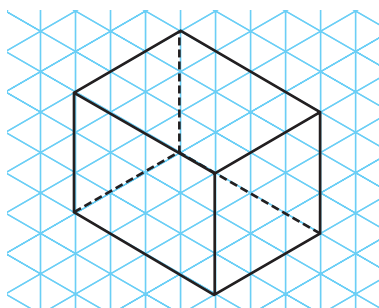
iii



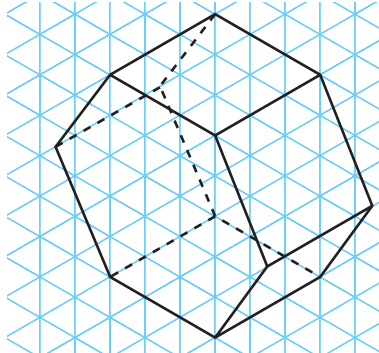
b i



ii

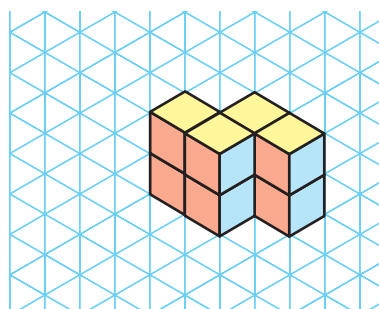


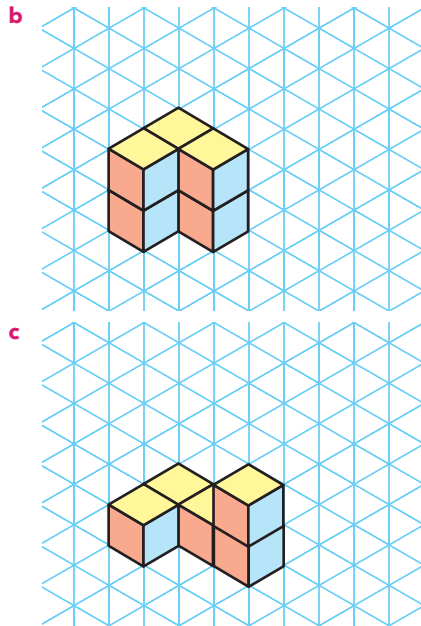
iii



c On a square grid, the objects are drawn as if viewed 'face-on'. On an isometric grid, objects are drawn as if view from one of their edges.

3 a

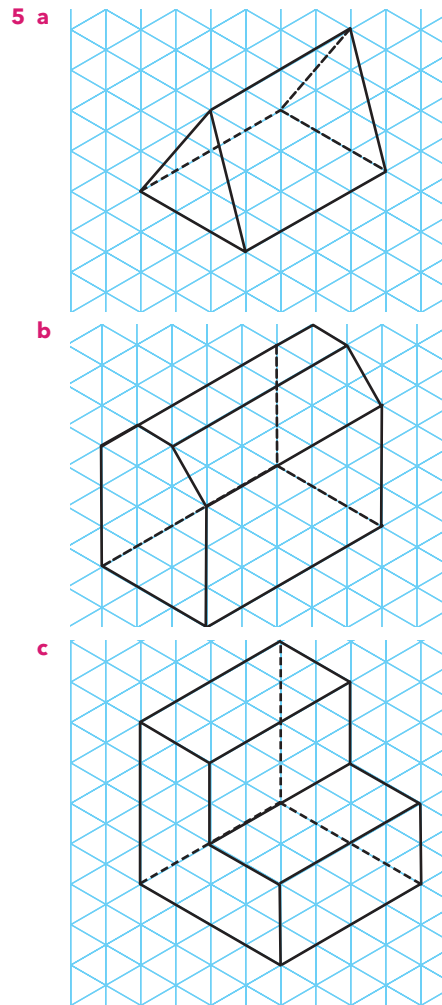
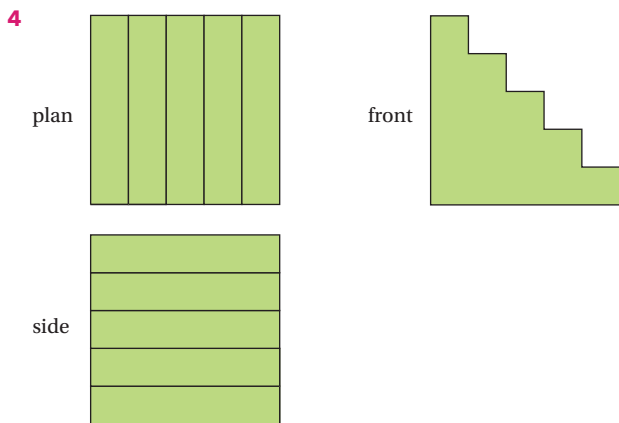
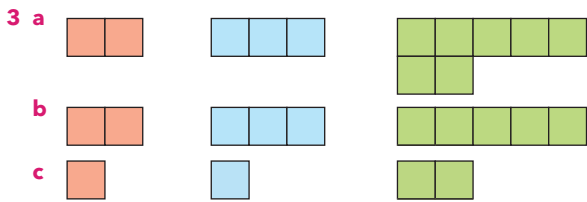
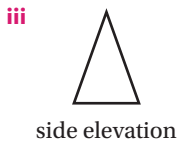
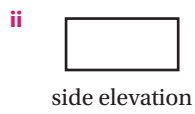
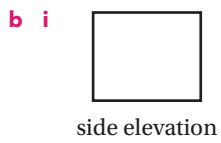




4 a 5      b 7      c 11      d 14

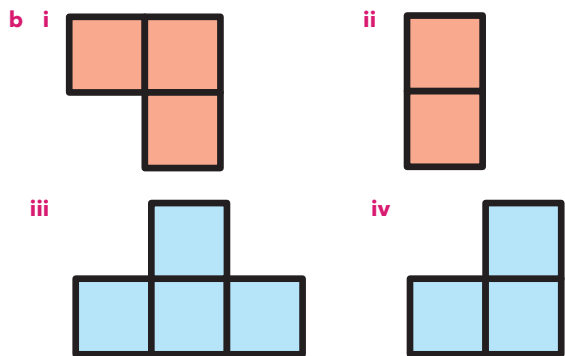
**EXERCISE 20C**

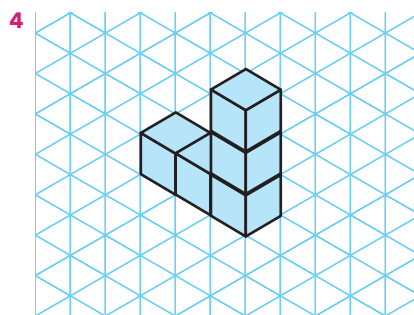
1 a B      b A      c B      d B      e A  
 2 a i B      ii D      iii C      iv A



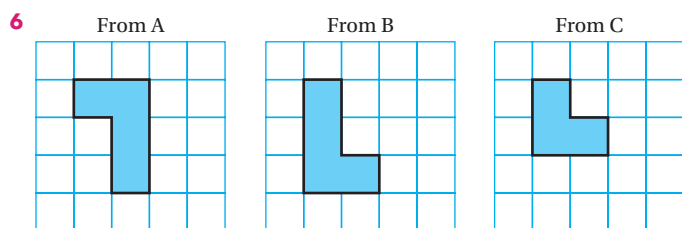
**CHAPTER REVIEW**

1 D  
 2 a cube  
 b cone  
 3 a i C      ii D      iii A      iv B





- 5 a Student's own answers  
 b Student's own answers  
 c 10, 13



## 21 Units and measure

### BEFORE YOU START ...

- 1 a 10 000      b 0.01      c 0.1  
 2 a £140      b £90      c £220  
 3 a 180p = £1.80      b 15p      c 60p

### LAUNCHPAD

- 1 a 11.569 kilograms  
 b 16 200 seconds      c £1230  
 d 0.0005 m<sup>2</sup>  
 2 a 48 kilometres per hour      b 13.33 m/s  
 3 90 kilometres per hour  
 4 800 cm = 8 m  
 5 a Scale drawing      b 24° (23.8° (3sf))  
 c 19 km (18.6 km (3sf))

### WORK IT OUT 21.1

option C

### EXERCISE 21A

- 1 Option D  
 2 10000mm = 10 m; 10000ml = 10l; 10kg = 10000g; 0.01 kg = 10g;  
 0.1 cm = 1 mm  
 3 a 2500      b 850      c 34000  
 d 1550      e 7      f 5400  
 g 900      h 0.102      i 0.0145  
 4 a 8500 ml      b 2.75l      c 25.152l  
 5 a Drawing to represent garden.  
 b 20 m  
 c 17 slabs (20 ÷ 1.2 = 16.67)  
 d £77.35  
 e £3.87

- 6 a 3.6 kg      b 776.3 cm      c 3.567 tonnes  
 d 5 000 000 mm<sup>2</sup>      e 96 350 000 cm<sup>3</sup>      f 0.345 l

### EXERCISE 21B

- 1 1:51:52  
 2 option C  
 3 a 832      b 5844 (16 × 365.25 to account for leap years)  
 c 140256      d 504921 600  
 4 21:05  
 5 2.5 to be exact  
 6 a €1 = £0.79      \$1 = £0.59      A\$ = £0.56      1 INR = £0.01  
 b \$212.50  
 c 4602.60 INR  
 d £78.22

### WORK IT OUT 21.2

option A

### EXERCISE 21C

- 1 £71.82  
 2 27p  
 3 2.83 bricks per minute  
 4 21 km/hour  
 5 6 hours 2 minutes  
 6 a 10.38 m/s      b 37.38 km/hour

### EXERCISE 21D

- |       |            |                        |                         |
|-------|------------|------------------------|-------------------------|
| 1 a,b | Balsa wood | 0.2 g/cm <sup>3</sup>  | 200 kg/m <sup>3</sup>   |
|       | Ice        | 0.9 g/cm <sup>3</sup>  | 900 kg/m <sup>3</sup>   |
|       | Chalk      | 2.2 g/cm <sup>3</sup>  | 2200 kg/m <sup>3</sup>  |
|       | Tin        | 7.3 g/cm <sup>3</sup>  | 7300 kg/m <sup>3</sup>  |
|       | Copper     | 9.0 g/cm <sup>3</sup>  | 9000 kg/m <sup>3</sup>  |
|       | Gold       | 19.3 g/cm <sup>3</sup> | 19300 kg/m <sup>3</sup> |
|       | Petrol     | 0.7 g/cm <sup>3</sup>  | 700 kg/m <sup>3</sup>   |
|       | Brick      | 1.8 g/cm <sup>3</sup>  | 1800 kg/m <sup>3</sup>  |
|       | Aluminium  | 2.7 g/cm <sup>3</sup>  | 2700 kg/m <sup>3</sup>  |
|       | Iron       | 7.8 g/cm <sup>3</sup>  | 7800 kg/m <sup>3</sup>  |
|       | Lead       | 11.3 g/cm <sup>3</sup> | 11300 kg/m <sup>3</sup> |
- 2 option D  
 3 2.38 g/cm<sup>3</sup>  
 4 125 cm<sup>3</sup>  
 5 Block A: 18 N/m<sup>2</sup>      Block B: 3 N/m<sup>2</sup>  
 6 60 000 N/m<sup>2</sup>

### WORK IT OUT 21.3

Student C is correct. The actual distance is 0.85 km.  
 Student A has divided rather than multiplied by 25 000.  
 Student B has incorrectly converted mm to km.

**EXERCISE 21E**

- 1 a 2 km      b 25 km      c 24 km  
 2 option B  
 3 a 0.0054 km    b 0.054 km    c 0.54 km    d 5.4 km  
 e 54 km    f 540 km    g 5400 km  
 4 He is correct. 15 000 cm in real life is represented by 1 cm on a 1 : 15 000 map but it is represented by only 0.1 cm on a 1 : 150 000 map.  
 5 3 km  
 6 a 530 km    b 578.18 km/hour  
 7 option B  
 8 a 2.5 m    b 3 cm    c 1.35 m  
 9 39 cm  
 10 a 180 km    b 48.25 mm

**EXERCISE 21F**

- 1 a Scale diagram  
 b Scale diagram  
 c Scale diagram  
 2 Students' scaled diagram.  
 3 Students' scaled diagram.  
 4 a 61.25 mm by 47.5 mm    b 15 mm

**EXERCISE 21G**

- 1 a 180°      b 045°      c 270°  
 2 option A  
 3 a 167°      b 347°      c 141°  
 d 023°      e 251°      f 204°  
 4 a 288°      b 108°      c 147 km

**CHAPTER REVIEW**

- 1 a 259 200 s    b 182.5 km    c 5 km    d 475 litres  
 2 a True  
 b False. It would take 22.5 minutes  
 c False. It would be 220 cm  
 3 6 m<sup>2</sup>  
 4 2 000 000 mm<sup>2</sup>  
 5 a NE is  $\frac{1}{8}$  of a turn so 045°  
 b South west is the opposite direction to north east  
 c 116 or 117° (by measurement)  
 d 110 to 115 km (by measurement)  
 6 a Scale drawing    b 67.5 km/hour  
 7 200 kg  
 8 a Scale drawing    b 283°    c 15.3 km  
 d i 10.2 km/hour    ii 2.83 m/s

**22 Formulae****BEFORE YOU START ...**

- 1 a 7.5      b 1.5      c  $\frac{1}{4}$       d -5.5  
 2 a  $x = 7$     b  $x = 8$     c  $x = \frac{1}{3}$     d  $x = 10$

- 3  $A = \frac{1}{2}bh$  is area of a triangle;  $A = \pi r^2$  is area of a circle  
 a  $A = \text{area}$ ,  $b = \text{base}$ ,  $h = \text{height}$      $A = \text{area}$ ,  $r = \text{radius}$   
 b  $\frac{1}{2}$  is a constant;  $\pi$  is a constant  
 c  $A$  is the subject in both  
 d the  $\pi$  symbol

**LAUNCHPAD**

- 1  $b = \frac{180 - a}{2}$   
 2  $\text{£}C = 20h + 50$   
 3  $T = (40w + 30) \text{ min}$   
 4 a i  $C = 5\pi \text{ cm}$     ii  $C = 15.71 \text{ cm}$     b constant  
 5  $60 \text{ cm}^3$   
 6 a  $d = st$     b  $t = \frac{d}{s}$

**EXERCISE 22A**

- 1 option C  
 2 a  $S = C + P$     b  $D = 90n$     c  $m = 60h$   
 3 a  $y = x + 3$     b  $y = x - 6$     c  $y = 10x$   
 d  $y = x - 8$     e  $y = x + x^2$     f  $y = 2x(x + 1)$   
 4  $m = 40x + 20$

**WORK IT OUT 22.1**

Student B is correct.

**EXERCISE 22B**

- 1 option D  
 2 a i 68      ii -18      iii  $\frac{-7}{9}$   
 b i 45      ii  $\frac{-14}{9}$   
 3 a  $A = 54 \text{ m}^2$     b  $s = 24 \text{ km/h}$     c  $A = 49.5 \text{ cm}^2$   
 d  $x = 12.490$     e  $654.237 \text{ cm}^3$     f  $t = 20$   
 4 option B  
 5  $d = 110.5 \text{ m}$   
 6  $s = 17.0 \text{ cm}^2$  (to 1 d.p.)  
 7  $I = \text{£}180$

**EXERCISE 22C**

- 1 option B  
 2 a B      b B      c B      d C  
 3 a  $c = y - mx$     b  $h = \frac{2v}{\pi r^2}$     c  $t = \frac{v - u}{a}$   
 d  $h = \frac{A - 2\pi r^2}{2\pi r}$     e  $a = \frac{2(s - ut)}{t^2}$     f  $\sqrt{c^2 - a^2}$   
 4  $w = 3 \text{ cm}$   
 5  $a = 2.5 \text{ cm}$   
 6  $u = 30.5 \text{ m/s}$   
 7 a  $m = \frac{2E}{v^2}$     b  $m = 6 \text{ kg}$   
 8  $n = \frac{S}{180^\circ} + 2$ ;  $n = 14$  sides

**EXERCISE 22D**

- 1 a true      b true      c true  
 d True
- 2 a  $P = 29\text{ m}$       b  $h = 18\text{ cm}$       c  $S = 478.4\text{ cm}^2$   
 d  $A = 475.3\text{ cm}^2$       e  $h = 1.72\text{ cm}$
- 3 a  $F = 46.4^\circ$       b  $C = 22.2^\circ$       c  $F = 32^\circ$
- 4 option A
- 5  $s = 53.375$
- 6 a  $V = 8.25\text{ volts}$       b  $I = 27.3\text{ milliamps}$   
 c  $R = 500\text{ ohms}$
- 7 a 113.1  
 b 8235.5
- 8 a  $19^\circ\text{C}$   
 b 1000 m
- 9 Could use A or C; A would be best.
- 10 Location B
- 11 Driver A 62.1 mph, driver B 72.5 mph; driver B has broken the speed limit.

**CHAPTER REVIEW**

- 1 option A
- 2 a  $v = 70$       b  $s = 300$       c  $v = 13$
- 3  $r = \sqrt{\frac{A}{\pi}}$ ;  $r = \frac{5}{\sqrt{\pi}}$
- 4 a  $n = \frac{C - 250}{12}$   
 b i 40      ii 70      iii 80      iv 120
- 5 a  $a = \frac{A}{\pi b}$       b  $a = \frac{P - 2b}{2}$       c  $b = \frac{c^2}{a}$       d  $b = \frac{c^2}{a^2}$   
 e  $b = c^2 - c$       f  $b = x - c^2$       g  $o = h \sin \theta$       h  $y = \frac{x^2}{c^2}$
- 6  $w = 3 + \sqrt{t}$   
 So  $w - 3 = \sqrt{t}$   
 Square both sides:  
 $(w - 3)^2 = t$

**23 Volume and surface area****BEFORE YOU START...**

- 1 a cube      b cylinder  
 c square-based pyramid      d cone  
 e polyhedron      f triangular prism
- 2  $A = \pi r^2$
- 3  $6\text{ cm}^2$
- 4 a cuboid      b The shape of the faces.

**LAUNCHPAD**

- 1  $125\text{ cm}^3$
- 2  $120\text{ cm}^3$
- 3 volume =  $1.087 \times 10^{12}\text{ km}^3$  surface area =  $5.112 \times 10^8\text{ km}^2$
- 4  $8820\text{ m}^3$

**WORK IT OUT 23.1**

Calculation A is correct.

**EXERCISE 23A**

- 1 option D
- 2 a volume =  $169.6\text{ cm}^3$  surface area =  $213.38\text{ cm}^2$   
 b volume =  $96\text{ cm}^3$  surface area =  $152\text{ cm}^2$   
 c volume =  $168\text{ m}^3$  surface area =  $244\text{ m}^2$   
 d volume =  $141.37\text{ cm}^3$  surface area =  $150.8\text{ cm}^2$   
 e volume =  $126\text{ cm}^3$  surface area =  $190\text{ cm}^2$   
 f volume =  $42\text{ cm}^3$  surface area =  $96\text{ cm}^2$
- 3 180 litres
- 4 option A
- 5  $2500\text{ m}^3$
- 6  $33.03\text{ cm}^3$
- 7  $60\text{ m}^2$
- 8  $178.5\text{ m}^3$
- 9  $127.43\text{ m}^3$

**EXERCISE 23B**

- 1 a volume  $109.51\text{ cm}^3$  surface area  $141.37\text{ cm}^2$   
 b volume  $45.81\text{ cm}^3$  surface area  $78.01\text{ cm}^2$   
 c volume  $65.45\text{ cm}^3$  surface area  $78.54\text{ cm}^2$   
 d volume  $56.55\text{ cm}^3$  surface area  $91.5\text{ cm}^2$   
 e volume  $134.04\text{ cm}^3$  surface area  $150.80\text{ cm}^2$
- 2  $2.2 \times 10^{10}\text{ km}^3$
- 3 option C
- 4 a  $8659.01\text{ mm}^2$       b  $126.68\text{ cm}^2$       c  $706.86\text{ cm}^2$   
 d  $5728.03\text{ mm}^2$       e  $1465.74\text{ cm}^2$       f  $2026.83\text{ cm}^2$   
 g  $28.27\text{ cm}^2$       h  $17\,203.36\text{ mm}^2$       i  $153.94\text{ cm}^2$
- 5 a volume  $226.72\text{ cm}^3$  surface area  $235.62\text{ cm}^2$   
 b volume  $9786.68\text{ cm}^3$  surface area  $2940.53\text{ cm}^2$   
 c volume  $1015.94\text{ cm}^3$  surface area  $615.75\text{ cm}^2$   
 d volume  $4047.96\text{ cm}^3$  surface area  $1910.09\text{ cm}^2$   
 e volume  $83\,959.91\text{ cm}^3$  surface area  $23\,373.45\text{ cm}^2$   
 f volume  $2069.06\text{ cm}^3$  surface area  $989.60\text{ cm}^2$   
 g volume  $40\,030.35\text{ cm}^3$  surface area  $7728.32\text{ cm}^2$
- 6  $6.12\text{ m}^3$

**EXERCISE 23C**

- 1 a  $60.82\text{ cm}^2$       b  $11\,713.3\text{ mm}^2$
- 2 a  $128\text{ mm}^3$       b  $2406.58\text{ cm}^3$   
 c  $42\,283.2\text{ m}^3$       d  $753\,982.24\text{ cm}^3$
- 3  $6.03\text{ m}^3$
- 4 a  $46\,518\text{ cm}^2$   
 b  $232\,588\text{ cm}^2$

**EXERCISE 23D**

- 1 a volume  $865.33\text{ cm}^3$  surface area  $600\text{ cm}^2$   
 b volume  $480\text{ cm}^3$  surface area  $423.89\text{ cm}^2$   
 c You can't have a slant height less than the perpendicular height.  
 d volume  $48\text{ cm}^3$  surface area  $96\text{ cm}^2$   
 e volume  $23.09\text{ cm}^3$  surface area  $67.83\text{ cm}^2$   
 f volume  $28.22\text{ cm}^3$  surface area  $61.25\text{ cm}^2$

- 2 option B
- 3 2456 027 m<sup>2</sup>
- 4 54.43 m<sup>3</sup>
- 5 0.289 m<sup>3</sup>
- 6 volume = 145 m<sup>3</sup> and surface area = 268.3 m<sup>2</sup>

**CHAPTER REVIEW**

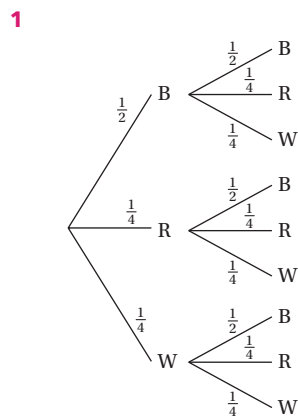
- 1 8.6 m<sup>2</sup>
- 2 a 56 cm<sup>2</sup>      b 96 cm<sup>2</sup>      c 88 cm<sup>2</sup>
- 3 227.5 cm<sup>3</sup>
- 4 24.64 m<sup>2</sup>
- 5 option A
- 6 a 552.92 cm<sup>3</sup>      b 276.46 cm<sup>2</sup>
- 7 Volume of small cylinder =  $\pi \times 4^2 \times 9$   
= 144 $\pi$   
Volume of large cylinder =  $\pi \times 10^2 \times 36$   
= 3600 $\pi$   
3600 $\pi \div 144\pi = 25$   
The large cylinder is 25 times bigger than the small one

**24 Further probability**

**BEFORE YOU START ...**

- 1 a  $\frac{3}{8}$       b  $\frac{13}{15}$       c  $\frac{2}{5}$   
d  $\frac{4}{15}$       e 0.18
- 2 a relative frequency      b outcomes      c event  
d random      e sample space
- 3 a FF, FM, MM, MF  
b HH, HT, TT, TH  
c AB, AC, BA, BC, CA, CB

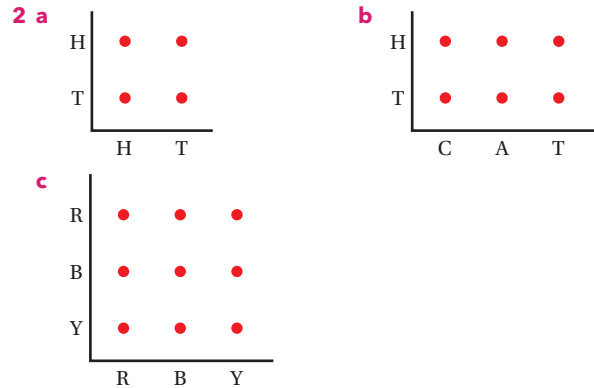
**LAUNCHPAD**



- 2 a  $\frac{1}{52}$       b  $\frac{4}{13}$       c  $\frac{9}{13}$
- 3 a  $\frac{5}{9}$       b  $\frac{41}{81}$       c  $\frac{20}{81}$

**EXERCISE 24A**

- 1 a B      b C



3 a i

Dice 1 \ Dice 2	1	2	3	4	5	6
1	1, 1	2, 1	3, 1	4, 1	5, 1	6, 1
2	1, 2	2, 3	3, 2	4, 2	5, 2	6, 2
3	1, 3	2, 3	3, 3	4, 3	5, 3	6, 3
4	1, 4	2, 4	3, 4	4, 4	5, 5	6, 6
5	1, 5	2, 5	3, 5	4, 5	5, 5	6, 5
6	1, 6	2, 6	3, 6	4, 6	5, 6	6, 6

ii

Spinner \ Coin	H	T
A	HA	TA
B	HB	TB
C	HC	TC
D	HD	TD

- b students' own questions

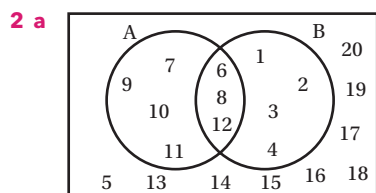
4

First card \ Second card	Diamonds (red)	Hearts (red)	Clubs (black)	Spades (black)
Diamonds (red)	RR	RR	BR	BR
Hearts (red)	RR	RR	BR	BR
Clubs (black)	RB	RB	BB	BB
Spades (black)	RB	RB	BB	BB

- a 16      b  $\frac{1}{4}$       c a red and a black in any order  $\left(\frac{1}{2}\right)$

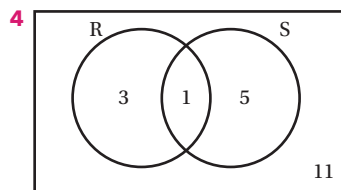
**EXERCISE 24B**

1 a option D b option B c option B

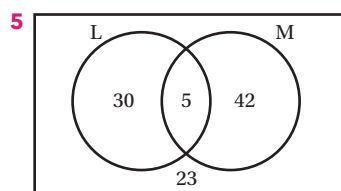


b i {6, 8, 12} ii {1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12}  
 iii 7 iv 13  
 v {5, 7, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20}

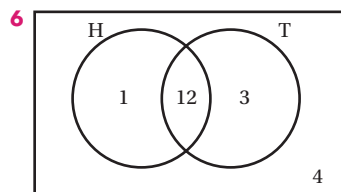
3 a 30 b 19 c 3 d  $\frac{4}{15}$



$p(\text{not red, not sports shoes}) = \frac{11}{20}$

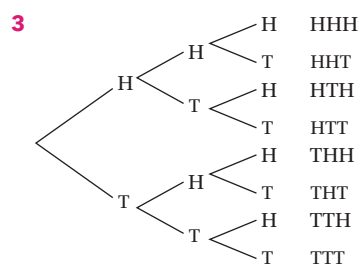
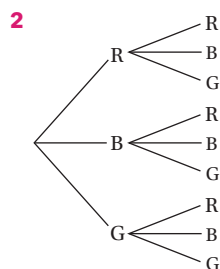
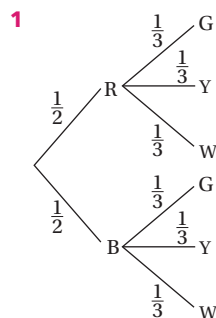


$p(\text{tie hair back}) = \frac{1}{20}$

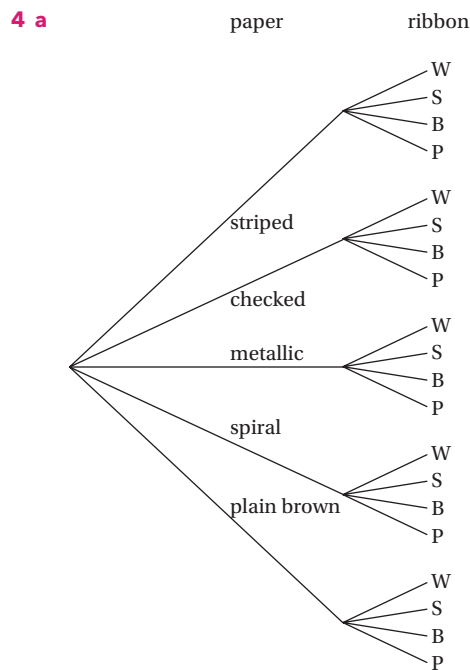


12 students

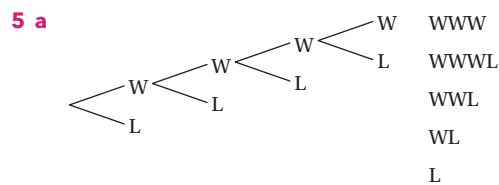
**EXERCISE 24C**



Three ways: HHT, HTH and THH.



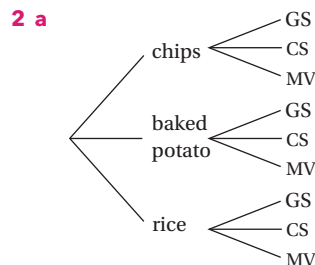
b option D c  $\frac{1}{20}$  d  $\frac{1}{10}$



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

**EXERCISE 24D**

1 option B



b  $\frac{1}{9}$  c 0

**3 a**

	Red (R)	Yellow (Y)	Blue (B)
Red (R)	RR	YR	BR
Green (G)	RG	YG	BG
Purple (P)	RP	YP	BP

**b**  $\frac{1}{9}$       **c**  $\frac{1}{9}$

**d** No. They are in the same box and there is no YB outcome.

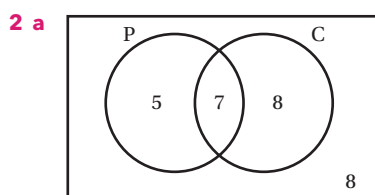
**4 a**

	£1	£1	50p	£2	20p	20p	20p
£2	3.00	3.00	2.50	4.00	2.20	2.20	2.20
£2	3.00	3.00	2.50	4.00	2.20	2.20	2.20
£2	3.00	3.00	2.50	4.00	2.20	2.20	2.20
£1	2.00	2.00	1.50	3.00	1.20	1.20	1.20
50p	1.50	1.50	1.00	2.50	0.70	0.70	0.70
50p	1.50	1.50	1.00	2.50	0.70	0.70	0.70
50p	1.50	1.50	1.00	2.50	0.70	0.70	0.70

**b**  $\frac{6}{49}$       **c**  $\frac{22}{49}$       **d**  $\frac{10}{49}$

**EXERCISE 24E**

**1** option B



**b** **i**  $\frac{5}{28}$       **ii**  $\frac{5}{7}$       **iii**  $\frac{1}{4}$

**3 a** possible sample space:

	U	E	E
D	DU	DE	DE
N	NU	NE	NE
D	DU	DE	DE

**b**  $\frac{4}{9}$       **c**  $\frac{2}{3}$       **d**  $\frac{8}{9}$

**4 a**  $\frac{1}{15}$       **b**  $\frac{2}{15}$       **c**  $\frac{1}{45}$       **d**  $\frac{1}{30}$

**e**  $\frac{2}{45}$       **f**  $\frac{1}{15}$       **g**  $\frac{3}{10} \times \frac{7}{9} = \frac{7}{30}$

**5 a** **i**  $\frac{1}{24}$       **ii**  $\frac{1}{24}$       **iii** 0

**b**  $\frac{1}{4}$       **c**  $\frac{1}{24}$

**6 a**  $\frac{1}{4}$       **b**  $\frac{1}{13}$       **c**  $\frac{1}{52}$       **d**  $\frac{16}{52} = \frac{4}{13}$

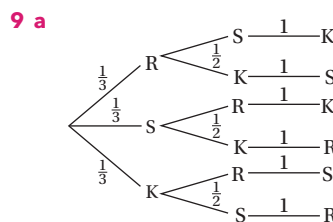
**7 a** **i**  $\frac{5}{17}$       **ii**  $\frac{28}{153}$       **iii**  $\frac{40}{153}$       **iv**  $\frac{40}{153}$

**b** The four situations represent all possible outcomes so they must add up to one.

**8 a**

	green (G)	red (R)	blue (B)	yellow (Y)
purple (P)	PG	PR	PB	PY
orange (O)	OG	OR	OB	OY
pink (Q)	QG	QR	QB	QY
black (K)	KG	KR	KB	KY
brown (N)	NG	NR	NB	NY

**b**  $\frac{1}{20}$       **c**  $\frac{8}{20}$       **d**  $\frac{2}{5}$

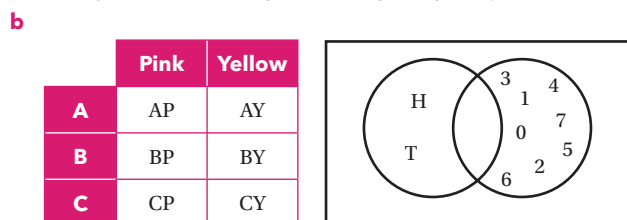
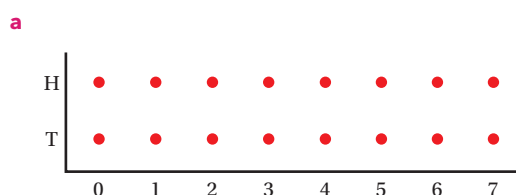


**b** dependent, one affects the other

**c** 1      **d** 6      **e**  $\frac{1}{6}$       **f**  $\frac{1}{2}$

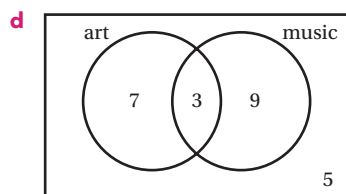
**CHAPTER REVIEW**

**1** Student's own diagrams. Possible answers could be:



**c** PAN      ANP      NAP  
PNA      APN      NPA

$3 \times 2 \times 1 = 6$

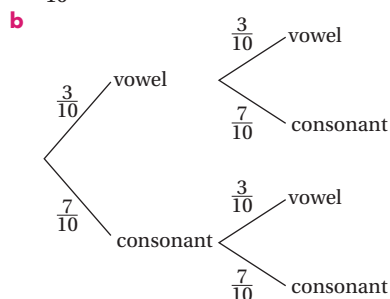




2 Student's own diagrams, but table is most useful.

a  $\frac{1}{36}$       b  $\frac{11}{36}$       c  $\frac{1}{6}$       d  $\frac{11}{36}$

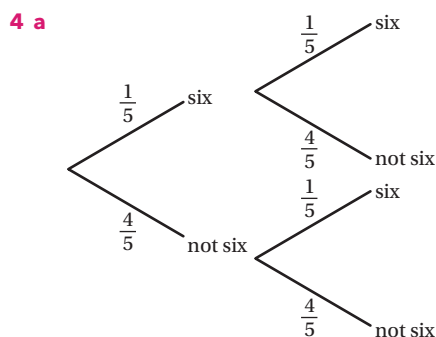
3 a  $\frac{3}{10}$



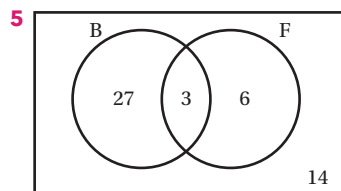
c i  $\frac{9}{100}$       ii  $\frac{49}{100}$       iii  $\frac{21}{50}$       iv  $\frac{91}{100}$

d Letters are replaced, so independent.

e Remove a letter and don't replace it.



b  $\frac{8}{25}$



a  $\frac{7}{25}$       b  $\frac{27}{50}$

6 option D

7 a

	4	6	10	12	15	24
4	4	2	2	4	1	4
6	2	6	2	6	3	6
10	2	2	10	2	5	2
12	4	6	2	12	3	12
15	1	3	5	3	15	3
24	4	6	2	12	3	24

b i  $\frac{5}{18}$       ii  $\frac{2}{3}$       iii 1      iv  $\frac{2}{9}$

## 25 Inequalities

### BEFORE YOU START ...

- 1 a  $x = 3$       b  $n = 9$   
 2  $-27, -2, 2\%, \frac{1}{3}, 1.25, 50$   
 3 a  $-10$       b 10      c 2      d  $-2$       e 8

### LAUNCHPAD

- 1 a  $-3, -4, -5, -6$       b 3, 4, 5, 6      c 4, 5, 6, 7  
 d 7, 8, 9, 10  
 2 a option D      b i  $x > 2$       ii  $x \geq 2$       c  $x \leq 2\frac{1}{2}$   
 3 a  $x < 2$       b  $x > -2$

### EXERCISE 25A

- 1 a  $4 + 7 > 4 + 3$       b  $8 - 5 < 13 - 5$   
 c  $-5 + 3 < -1 + 3$       d  $-4 - 6 > -11 - 6$   
 2 a  $2 \times 7 > 2 \times 3$       b  $2 \times 8 < 2 \times 13$   
 c  $7 \div 2 > 3 \div 2$       d  $8 \div 2 < 13 \div 2$   
 3 a  $(-2) \times 7 < (-2) \times 3$       b  $(-2) \times 8 > (-2) \times 13$   
 c  $7 \div (-2) < 3 \div (-2)$       d  $8 \div (-2) > 13 \div (-2)$   
 4 option D  
 5 a any four integers greater than 14  
 b any four integers greater than or equal to 6  
 c any four integers less than or equal to  $-2$   
 d any four integers greater than or equal to 4  
 e any four integers less than or equal to 9  
 6 infinitely many numbers all bigger than 6  
 7 four values,  $x = 4, 5, 6, 7$ ; including decimals and fractions there are an infinite number of values for  $x$  that satisfy  $3 < x < 8$   
 8 5, 4, 3

### EXERCISE 25B

- 1 option C  
 2 a      b      c      d      e      f   
 3 a  $x > -1$       b  $x < 2$       c  $x \geq -3\frac{1}{2}$       d  $x \leq 1\frac{1}{2}$   
 e  $0 \leq x \leq 5$   
 4 a  $7 < x \leq 11$       b  $7 \leq x < 11$       c  $-1 < x \leq 3$       d  $-1 \leq x < 3$

### EXERCISE 25C

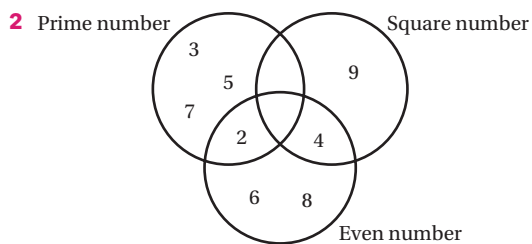
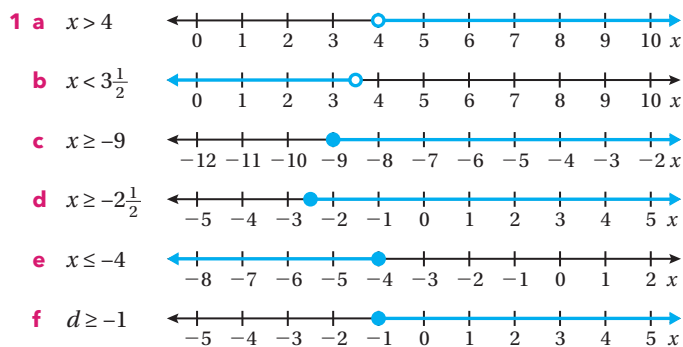
- 1 option D  
 2 a  $x \geq 4$       b  $x \leq 11$       c  $x > -3$       d  $x < 5$   
 e  $x \geq -12$       f  $x > 4$       g  $x > -7$       h  $x \geq 3$

- i**  $x > -5$     **j**  $x \geq -2$     **k**  $x > 0.9$     **l**  $x \leq 5\frac{1}{2}$   
**m**  $x \leq 0$     **n**  $x \leq -15$   
**3 a**  $x \leq 5$     **b**  $x \leq -13$     **c**  $x < 3\frac{1}{2}$     **d**  $x \geq -10$   
**e**  $x < -20$     **f**  $x < -1$     **g**  $x \geq 2$     **h**  $x > 5\frac{3}{4}$   
**4 a**  $x < -12$     **b**  $x < 4\frac{1}{2}$     **c**  $x < 4$     **d**  $x \geq -7\frac{1}{4}$

**WORK IT OUT 25.1**

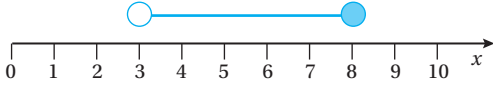
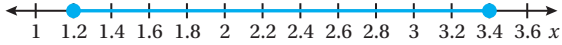
option A is correct  
 option B - the inequality is reversed on the first line  
 option C - 5 is subtracted from both sides instead of being added

**EXERCISE 25D**



- 3 a**  $5 + 2p > 17, p > 6$     **b**  $\frac{q}{2} - 16 < 18, q < 68$   
**c**  $4d + 6 > 2d + 18, d > 6$   
**d**  $2(a + 3) > a, a > -6$   
**4 a** Richard will need to work 25 hours or more to save at least £75.  
**b**  $x \geq \frac{300}{p}$ , where  $x$  represents the number of hours worked to save at least £75

**CHAPTER REVIEW**

- 1** option B  
**2** A true    B false    C false  
**3 a**  $4x - 7 \leq 13$   
 $4x \leq 20$   
 $x \leq 5$   
**b**   
**4 a** 6    **b** 8    **c** 12  
**5** -5  
**6** 0, 1, 2, 3, 4  
**7 a**   
**b**  $1.2 \leq w \leq 3.4$ , where  $w$  is weight in kg of the chickens

**26 Ratio**

**BEFORE YOU START ...**

- 1 a**  $\frac{2}{5}$     **b**  $\frac{3}{4}$   
**2** 28  
**3** 68

**LAUNCHPAD**

- 1** 4:7  
**2** 8:7  
**3** 3:13  
**4** 10:25  
**5** 345g

**EXERCISE 26A**

- 1** option B  
**2** option A  
**3 a** 45:36, simplifies to 5:4    **b** 81:9, simplifies to 9:1  
**c** 81:90, simplifies to 9:10    **d** yes, 9 students per teachers  
**4 a** 3:5    **b** 1:2    **c** 1:2  
**5 a** 1:4    **b** 1:2    **c** 2:5  
**6** 3 squares  
**7** 1:400  
**8** 1:950  
**9** 1:40  
**10 a i** 2:3    **ii** 2:3    **iii** 2:3  
**b** they are similar    **c** they are parallel  
**d** 1:1  
**11** 11:9  
**12** 3:2  
**13** 3:2

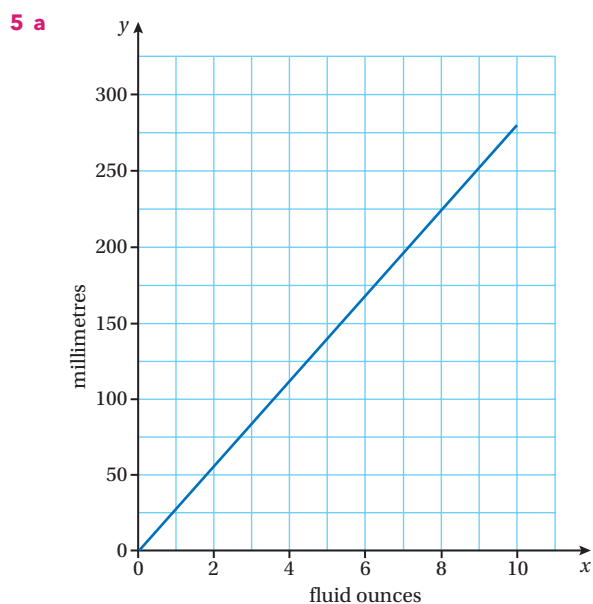
**EXERCISE 26B**

- 1 a** 36:108    **b** 64:80    **c** 132:12  
**d** 48:72:24    **e** 18:36:90    **f** 16:56:40:32  
**2** option C  
**3** option C  
**4 a** 20kg    **b**  $\frac{1}{5}$   
**5** 45g  
**6 a** 200g flour, 75g margarine, 75g lard    **b**  $\frac{3}{7}$   
**7 a** 16 cm by 40 cm    **b** 640 cm<sup>2</sup>  
**8** 4.5 litres  
**9** 0.5 litre  
**10** 200g biscuit, 240g dried fruit, 80g butter, 80g cocoa powder  
**11** 14 students  
**12** 34 pairs  
**13** 18kg

**EXERCISE 26C**

- 1** option C  
**2** latte, flat white, cappuccino, espresso, double espresso

- 3 a 5:6, 1:1.2                      b 6:5, 1:0.83  
 4 a 8:200 → 1:25                    b 200:8 → 1:0.04



- b 1:0.0357  
 6 a 75                      b  $\frac{8}{25}$   
 7 48 km  
 8 8 sausages, 2 tins of tomatoes, 300 g of potatoes, 6 tsp mixed herbs, 400 ml vegetable stock  
 9 42  
 10 9 more milk chocolates than dark chocolates

### EXERCISE 26D

This is an investigative exercise where students will produce their own individual answers.

### EXERCISE 26E

- 1 1:4  
 2 1:π  
 3 isosceles triangle with angles 54°, 54° and 72°  
 4 Regular pentagon, with each interior angle 108°. Ratio 1:1:1:1:1 means all its angles are same size which means pentagon must be regular.  
 5 isosceles right-angled triangle (angles 45°, 90° and 45°)  
 6 option A  
 7 19 white chocolates, 14 milk chocolates, 7 dark chocolates

### CHAPTER REVIEW

- 1 5:21  
 2 2:1  
 3 120:200:40  
 4 1:1.6  
 5 option C  
 6 12 silver; 18 blue, 6 red, 9 black, 3 yellow  
 7 The difference between red and yellow parts is 5 - 2 = 3 parts  
 The difference in bricks is 210, so 210 ÷ 3 = 70 bricks in each part  
 5 × 70 = 350 red bricks

## 27 Proportion

### BEFORE YOU START ...

- 1 a 30 min                      b 15 min                      c 20 min                      d 12 min  
 2 a  $\frac{1}{12}$                           b  $\frac{2}{5}$                               c  $\frac{9}{10}$   
 3 a 21                              b 24                              c 0.4

### LAUNCHPAD

- 1 450 g  
 2 100 km  
 3 €17.14  
 4 a  $c = 6.5a$                       b £208                          c 50.6 m<sup>2</sup>  
 5 a 12 days                          b 5 days

### EXERCISE 27A

- 1 students' own answers, such as 9 km in an hour, 1 km in 400 seconds, ...  
 2 option A  
 3 option D  
 4 560 g  
 5 £5.50 per hour  
 6 a 60p                          b £3.60                          c £12                              d 350 g  
 7 a £6.30  
 b Ben: 35p per minute, Danny: 32p per minute. Danny's phone is better value.

8 a

Ingredients	8 people	4 people	16 people	12 people	20 people
plain flour	100 g	50 g	200 g	150 g	250 g
eggs	2	1	4	3	5
semi-skimmed milk	300 ml	150 ml	600 ml	450 ml	750 ml

- b 36 people  
 9 a i 640 km                      ii 160 km                      iii 80 km                      iv 5.33 km  
 v 0.89 km  
 b 125 hours (5.2 days)  
 10 500 m

### EXERCISE 27B

1 option B  
 2 option D  
 3

Pounds (£)	1	2	5	15	16	42.50	47.91*	124.53
Dollars (\$)	1.68	3.36	8.40	25.20	26.88	71.40	80.50	209.21

\*values rounded down - as happens when exchanging money

- 4 AU\$316.75  
 5 £26.19  
 6 a 750 ml = £9                      b 1 litre = £12                      c 5 litres = £60  
 d 25 litres = £300  
 7 a £1 = €1.21                      b €1 = £0.826

	Accommodation	Food	Ski rental	Flights
Bun di Scuol	£340	£65	£300	£69
Flims-Laax-Falera	£300	£100	£111	£144

Bun di Scuol = £774, Flims-Laax-Falera = £655; cheaper by £119

- 9 a £1 = JIB2.4    b JIB1 = £0.42
- 10 a €423.50    b £280    c KSh26 825    d ₦153 000
- e Mongolia, India, Brazil, New Zealand, Kenya, France
- 11 Area of each playing field, number of people using each playing field. Calculate number of people per unit of area, such as  $10\text{m}^2$ .

### WORK IT OUT 27.1

Graph 1 because as  $x$  increases so does  $y$  at a constant rate. The other graphs either do not start at 0 or the rate is not constant.

### WORK IT OUT 27.2

- Formula 1 is not proportional – graph doesn't go through origin.  
 Formula 2 is directly proportional – one variable = other variable  $\times$  constant  
 Formula 3 is inversely proportional.  
 Formula 4 is not directly proportional – formula involves a square.

### EXERCISE 27C

- 1 option B
- 2 a 3 km    b 2.25 h    c runner B  
 d runner A = 6 km/h, runner B = 8 km/h  
 e The athletes run at a constant speed.
- 3 a £2    b cost =  $2 \times$  length    c  $c = 2l$
- 4 1 600 cars
- 5 a The triangles produced by the object, its shadow and the line joining the height of the object to the end of its shadow are similar. Therefore the length of shadow is directly proportional to the object's height.  
 b i  $s = 0.75h$     ii 15 m    iii 6.7 m
- 6 a  $q = 8p$     b  $q = 30.4$     c  $p = 1.85$
- 7  $d = \frac{20h}{3}$

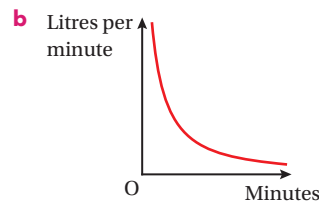
### WORK IT OUT 27.3

Graph 3 is correct since the greater  $x$  is, the less  $y$  is. The formula is  $xy = 24$ , or  $y = \frac{24}{x}$ , which is the same shape as the graph shown.

### EXERCISE 27D

- 1 option B
- 2 a 12 person-days    b 6 days    c 2 days  
 d 12 people  
 e Everybody works at the same rate; several people can paint the hall at the same time.
- 3 a \$12    b 15    c \$1.50
- 4 a 45 mph    b 3 h    c 80 mph

$m$ (minutes)	10	20	30	40	50	60	70	80	90	100
$r$ (litres per minute)	60	30	20	15	12	10	8.57	7.5	6.67	6



### CHAPTER REVIEW

- 1 a £3.60    b 611 g
- 2 10 people
- 3  $300 \div 450 = \frac{2}{3}$   
 $\frac{2}{3} \times 900 = 600$  g potatoes  
 $\frac{2}{3} \times 75 = 50$  g carrots  
 $\frac{2}{3} \times 300 = 200$  ml stock
- 4 option B
- 5  $c = 2.2m$
- 6 20 minutes

## 28 Graphs of linear functions

### BEFORE YOU START ...

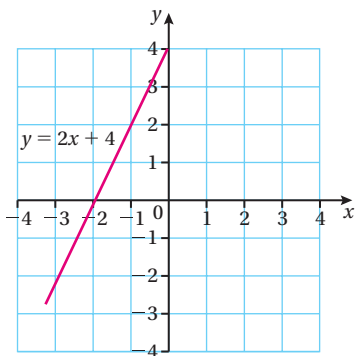
- 1
- | Term number | 1 | 3 | 5  | 10 |
|-------------|---|---|----|----|
| Term        | 1 | 7 | 13 | 28 |
- 2 a A(-3, 4), D(1, -4), E(4, 0)  
 b i B    ii F  
 c the origin
- 3 a  $x = -3$     b  $x = 42$     c  $x = -0.4$
- 4 a 1    b 1.5
- 5 a  $y = 1 - 2x$     b  $y = \frac{6 - 2x}{3}$     c  $y = \frac{x + 2}{2}$

### LAUNCHPAD

- 1 a
- |     |    |    |    |    |
|-----|----|----|----|----|
| $x$ | -2 | -1 | 0  | 1  |
| $y$ | -4 | -3 | -2 | -1 |
- b
- |     |    |   |   |   |
|-----|----|---|---|---|
| $x$ | -2 | 0 | 1 | 2 |
| $y$ | 6  | 4 | 3 | 2 |
- c
- |     |    |    |    |    |
|-----|----|----|----|----|
| $x$ | -3 | -2 | 0  | 1  |
| $y$ | 4  | 2  | -2 | -4 |
- d
- |     |    |   |   |   |
|-----|----|---|---|---|
| $x$ | -2 | 0 | 2 | 4 |
| $y$ | 0  | 1 | 2 | 3 |

2 a  $x - 2y + 2 = 0$       b  $2x + y + 2 = 0$

3 a



b gradient = 2; y-intercept = 4

4  $y = \frac{1}{2}(3x + 5)$

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

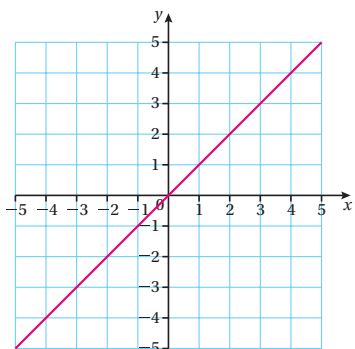
6 A and B

7  $y = \frac{1}{2}x + 3$

### EXERCISE 28A

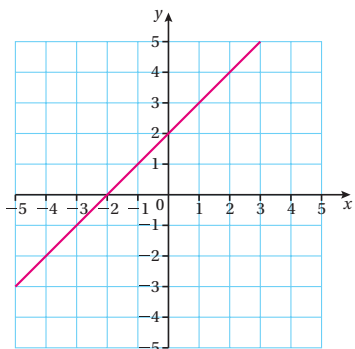
1 a  $y = x$

<b>x</b>	-2	-1	0	1
<b>y</b>	-2	-1	0	1



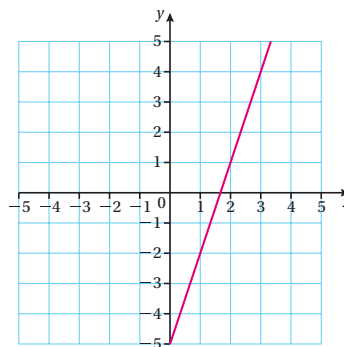
b  $y = x + 2$

<b>x</b>	-2	-1	0	1
<b>y</b>	0	1	2	3



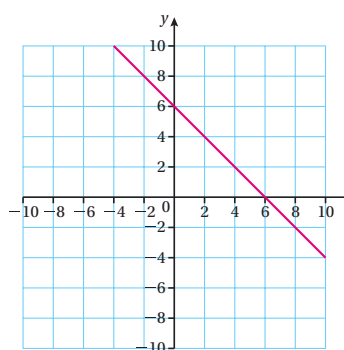
c  $y = 3x - 5$

<b>x</b>	0	1	2	3
<b>y</b>	-5	-2	1	4



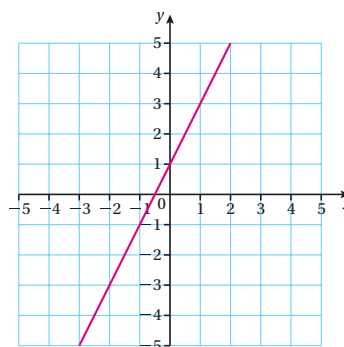
d  $y = 6 - x$

<b>x</b>	0	2	6	8
<b>y</b>	6	4	0	-2



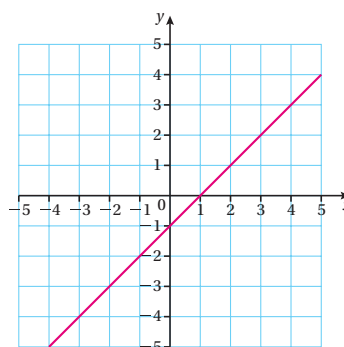
e  $y = 2x + 1$

<b>x</b>	-2	-1	0	1
<b>y</b>	-3	-1	1	3



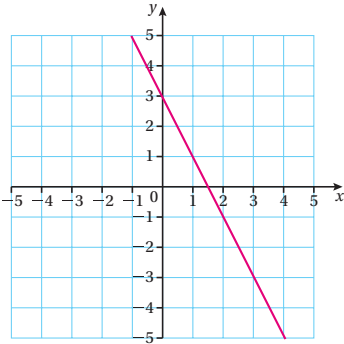
f  $y = x - 1$

<b>x</b>	-2	-1	0	1
<b>y</b>	-3	-2	-1	0



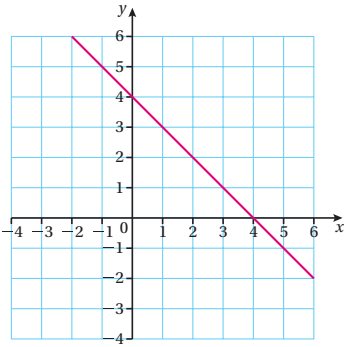
**g**  $y = -2x + 3$

<b>x</b>	-2	-1	0	1
<b>y</b>	7	5	3	1



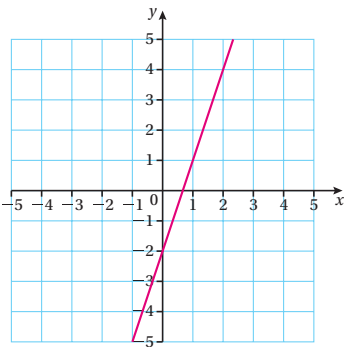
**h**  $y = 4 - x$

<b>x</b>	0	1	3	6
<b>y</b>	4	3	1	-2



**i**  $y = 3x - 2$

<b>x</b>	-1	0	1	2
<b>y</b>	-5	-2	1	4



**2** You need a minimum of 3 points: two to plot the line and one to check that it is correct.

**3** option B

### EXERCISE 28B

- 1** a 3                      b 1                      c -2  
       d  $-\frac{1}{2}$                 e  $\frac{2}{3}$                     f  $-\frac{5}{4}$   
**2** a 3                      b 1                      c -3                      d  $\frac{7}{4}$   
**3** option C

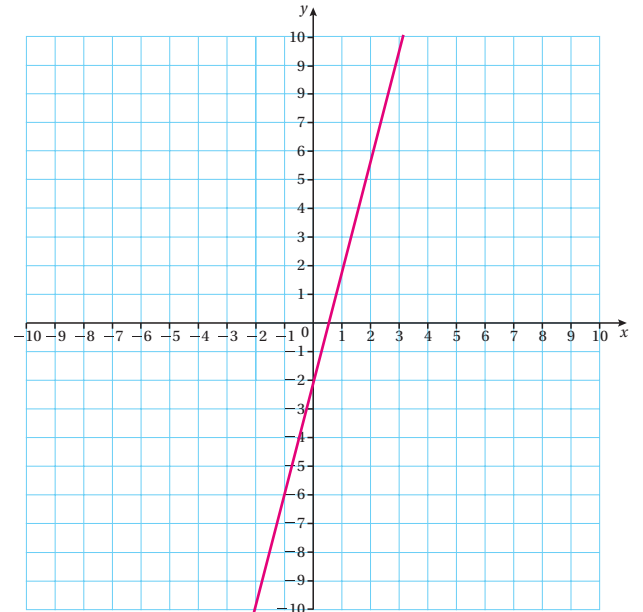
### WORK IT OUT 28.1

Option B is correct.

Option A is incorrect because the coefficient of  $x$  is negative so the gradient must be negative.

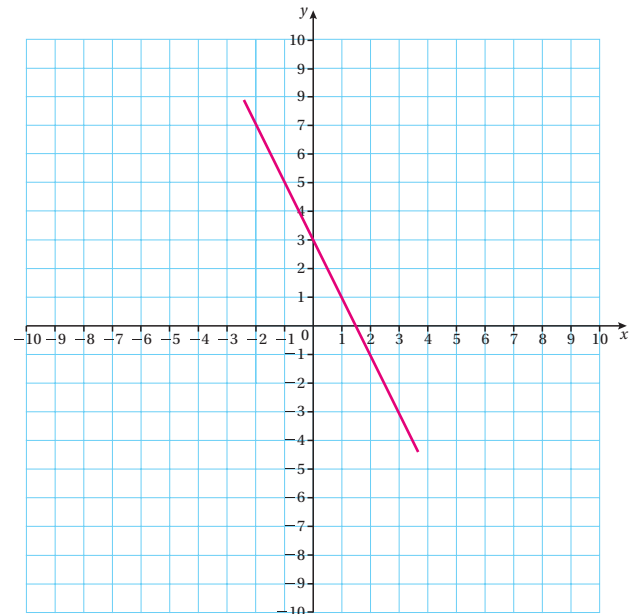
### EXERCISE 28C

**1 a**

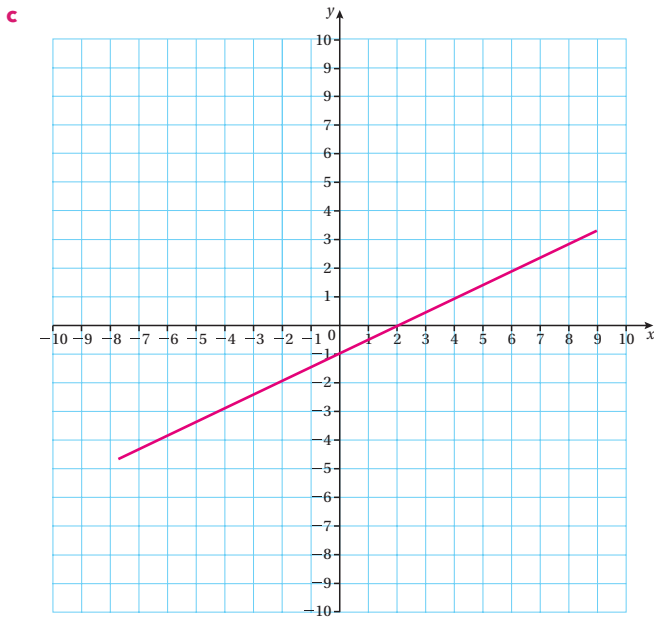


line with a positive gradient of 3 and  $y$ -intercept  $(0, -2)$

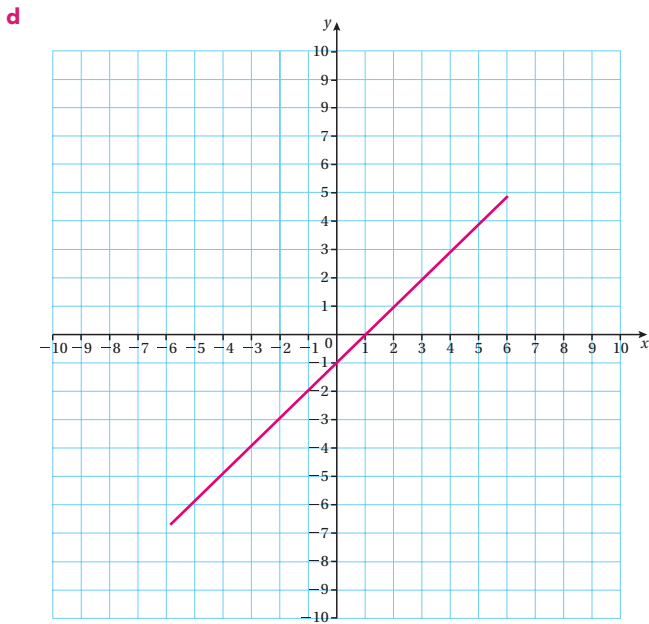
**b**



line with a negative gradient of  $-2$  and  $y$ -intercept  $(0, 3)$

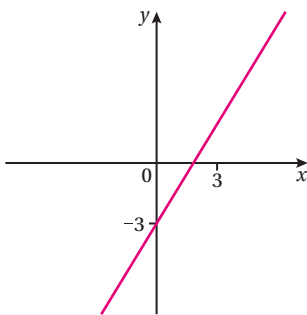


line with a positive gradient of  $\frac{1}{2}$  and y-intercept  $(0, -1)$

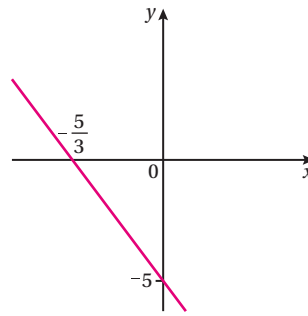


line with a positive gradient of 1 and y-intercept  $(0, -1)$

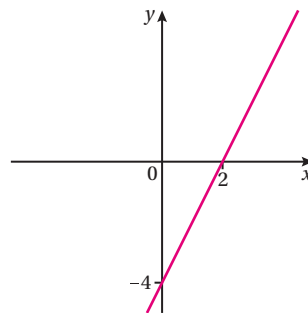
**2 a**  $y = \frac{3}{2}x + 3$



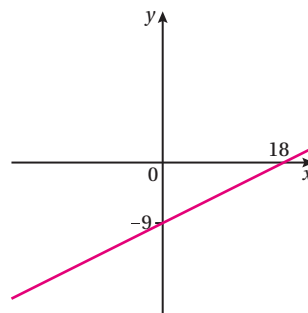
**b**  $y = -3x - 5$



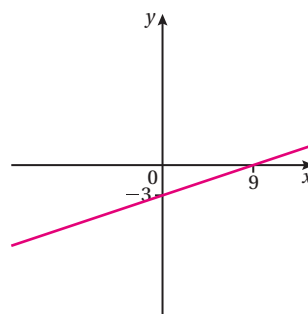
**c**  $y = 2x - 4$



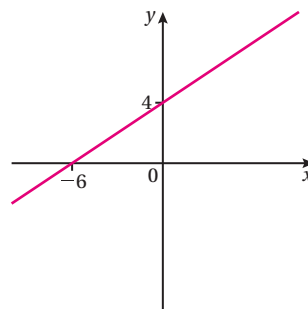
**d**  $y = \frac{1}{2}x - 9$



**e**  $y = \frac{1}{3}x - 3$

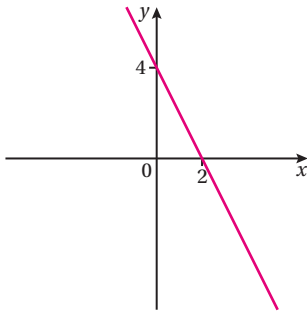


**f**  $y = \frac{2}{3}x + 4$

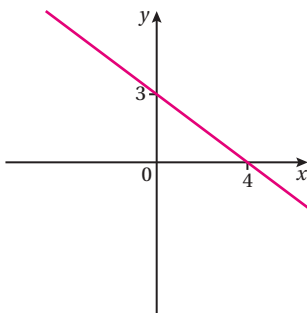


- 3 a** A      **b** C      **c** D  
**d** B      **e** E

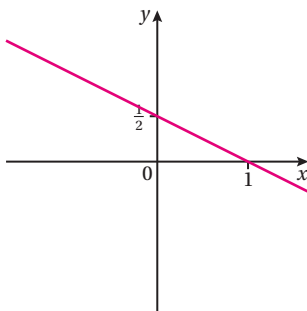
**4 a**  $y = -2x + 4$ ; gradient =  $-2$



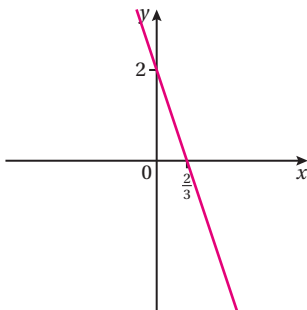
**b**  $y = -\frac{3}{4}x + 3$ ; gradient =  $-\frac{3}{4}$



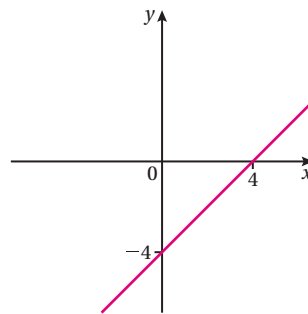
**c**  $y = -\frac{1}{2}x + \frac{1}{2}$ ; gradient =  $-\frac{1}{2}$



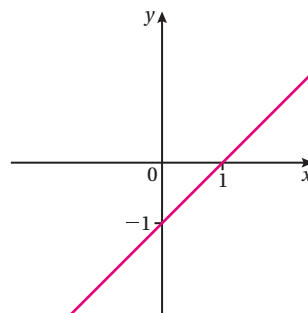
**d**  $y = -3x + 2$ ; gradient =  $-3$



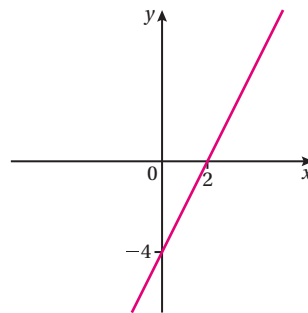
**e**  $y = x - 4$ ; gradient =  $1$



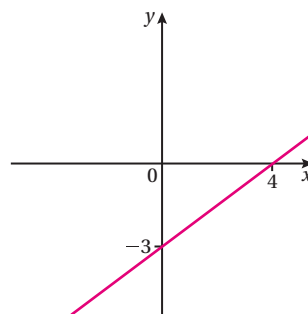
**f**  $y = x - 1$ ; gradient =  $1$



**g**  $y = 2x - 4$ ; gradient =  $2$



**h**  $y = \frac{3}{4}x - 3$ ; gradient =  $\frac{3}{4}$



**EXERCISE 28D**

- 1 a** 2      **b**  $-4$       **c**  $-9$       **d**  $-8$   
**2** option A  
**3 a**  $y = -\frac{1}{3}x$       **b**  $y = \frac{3}{2}x$       **c**  $y = -2x - 9$       **d**  $y = -2x + 5$   
**4 a**  $y = 2x$ , when  $x = 3$ ,  $y = 6$       **b**  $y = \frac{1}{2}x + 6$ , when  $x = 8$ ,  $y = 10$   
**c**  $y = -x + 5$ , when  $x = 4$ ,  $y = 1$



### WORK IT OUT 28.2

option A

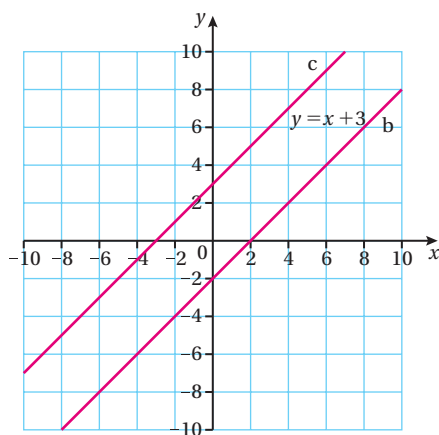
### EXERCISE 28E

- 1 a  $y = 3x + 7$  and  $y = 3x - 5$   
 b  $y = 2x + 3$ ,  $2x - y = -6$  and  $y = 2x - 3$   
 c  $x + y = 3$  and  $y + x = 8$
- 2 a  $y = 2x + 3$     b  $y = 3x + 5$
- 3 a = 3, b = -1
- 4  $y = -2x - 2$
- 5 a gradient of AB = 4                      b  $y = 4x + 2$
- c If ABCD is a parallelogram then AB//CD and BC//AD.  
 Gradient of CD =  $\frac{8 - 16}{13 - 15} = \frac{-8}{-2} = 4$ , CD//AB same gradient;  
 gradient of BC =  $\frac{16 - 14}{15 - 3} = \frac{2}{12} = \frac{1}{6}$ ; gradient of  
 AD =  $\frac{8 - 6}{13 - 1} = \frac{2}{12} = \frac{1}{6}$ , BC//AD same gradient. ABCD is a  
 parallelogram.

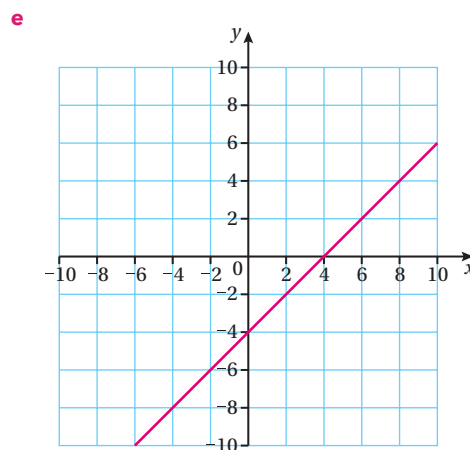
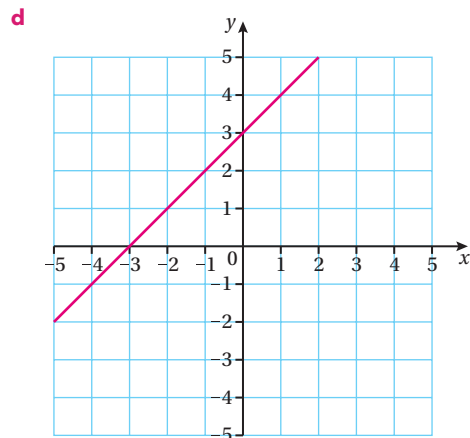
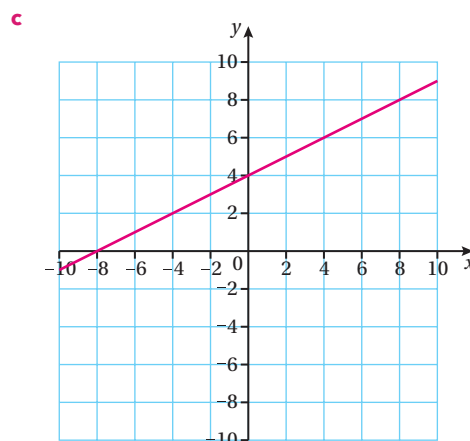
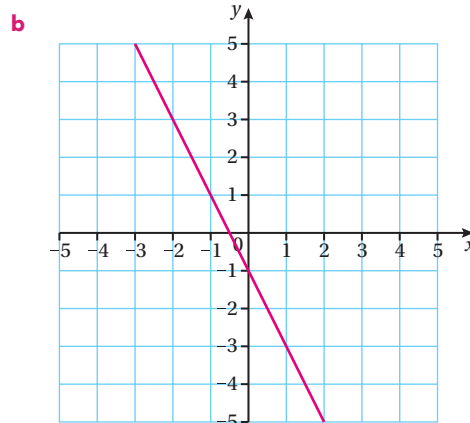
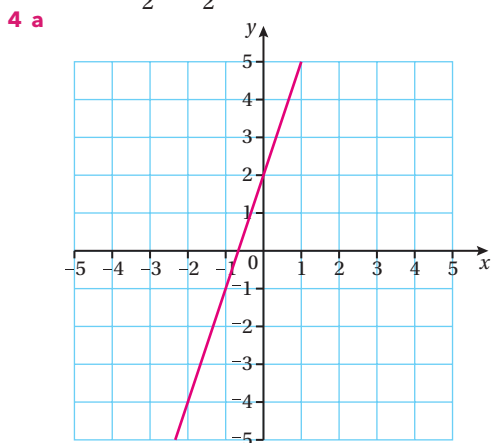
6 investigation

### EXERCISE 28F

- 1 a option D  
 b, c



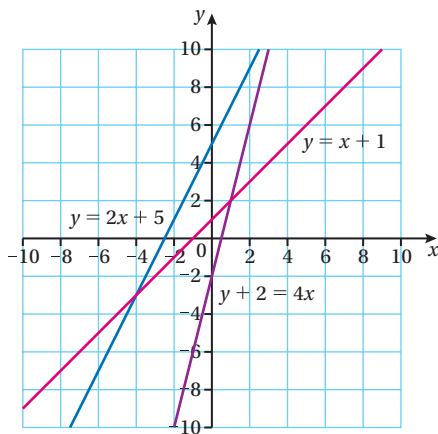
- 2 a any equation with a negative gradient and a negative y-intercept, eg  $y = -x - 3$   
 b examples are  $y = 2x$  and  $y = 4x + 3$   
 c  $y = 3x - 3$
- 3 gradient =  $\frac{1}{2}$ ,  $y = \frac{1}{2}x + 3$



- 5 a  $9y + 4x = 74$     b  $4x + 5y = 32$     c  $3y = 4x + 26$   
 6 a  $y = -4x - 6$     b  $y + 4x = 20$     c  $y = 5x + 28$   
 7  $b = -4$   
 8 a Gradient of graph in Student Book is 2;  $y = 2x + 1$   
 b  $y = -x + 1$   
 9  $y + x = 3$ ;  $y + x = -3$ ;  $y - x = -3$ ;  $y - x = 3$

### CHAPTER REVIEW 28

1 a, b, c



2 a  $y = 6x - 1$     b  $y + x = 1$     c  $y = 3x + 1$     d  $x + y = 2$

3 A, B and D are parallel

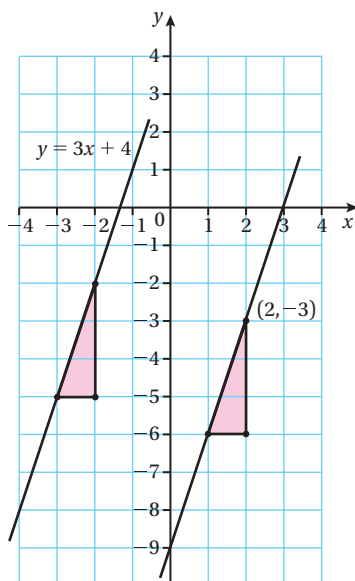
4  $y = \frac{1}{2}x + \frac{5}{2}$      $2y = x + 5$

5 a Gradient is  $-\frac{3}{2}$ , and y intercept is 3  
 Therefore equation is  $y = -\frac{3}{2}x + 3$

b Line passing through  $(2, -3)$  and parallel to  $y = 3x + 4$  must have the same gradient, so is  $y = 3x + c$

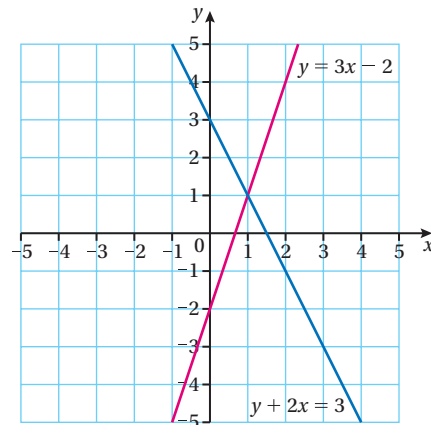
Using the gradient of 3, the line passes through the y axis at  $(0, -9)$

Equation of line is  $y = 3x - 9$



6 option A

7 a



b when  $x = 1$  and  $y = 1$ ,  $y = 3x - 2 \rightarrow 1 = 3 - 2 \checkmark$   
 $y + 2x = 3 \rightarrow 1 + 2 = 3 \checkmark$

## 29 Interpreting graphs

### BEFORE YOU START ...

- 1 A, Inverse proportion means that  $y = \frac{k}{x}$ , where  $k$  is a constant.  
 A is the graph of  $y = \frac{6}{x}$  therefore represents an inverse proportion  
 2 1.47

### LAUNCHPAD

- 1 a the distance increases at a constant rate with time, such as a car travelling at constant speed  
 b the distance remains the same over time, such as a stationary car  
 c the distance increases at a steady rate, and then suddenly returns to the starting distance  
 d the object is stationary, then leaps forward; this repeats twice  
 e the object travels slowly, then very quickly, then slowly  
 f the object starts at a far point, then travels at a constant rate back, then turns and travels in the other direction  
 2 Check that students' justifications are sensible.

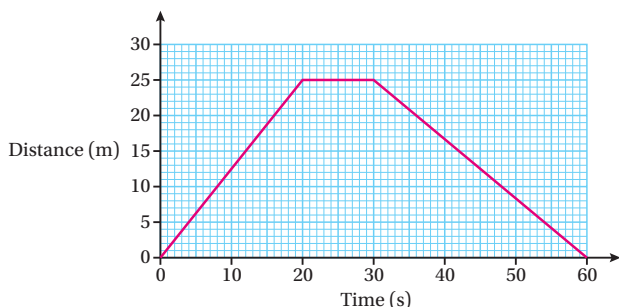
- A a, e  
 B c, d  
 C f  
 D b

### EXERCISE 29A

- 1 option C  
 2 a The taxi travels 10 miles in 50 minutes, then stops for 50 minutes. The taxi returns to its original starting point in 20 minutes, then stops for 40 minutes. The taxi travels 5 miles in 40 minutes, then stops.  
 b 90 minutes (50 minutes and then 40 minutes). This is when the taxi was stationary away from its starting point.  
 c 25 miles  
 d i 12 miles per hour  
 ii 10 miles per hour  
 iii 6 miles per hour  
 iv 6.25 miles per hour

- 3 a 720 metres  
 b 7 minutes  
 c 09:07 and 09:21  
 d Going to the supermarket

4 a

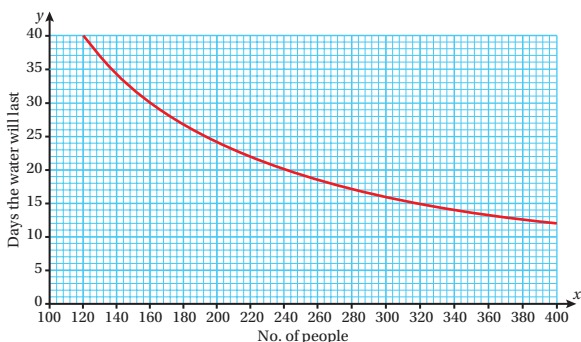


- b 15 metres                      c 5 metres

5 a

<b>No. of people</b>	120	150	200	300	400
<b>Days the water will last</b>	40	32	24	16	12

b



**EXERCISE 29B**

- 1 Students' own drawings of gradient triangles.
- a Tank being filled at a constant rate
  - b No water going in
  - c Water flow is increasing
  - d Water draining out of tank at a constant rate
  - e Water draining out of tank, flow is slowing
  - f Water draining out of tank, flow is increasing
- 2 a The price is falling at a decreasing rate - the gradient triangles all have negative gradients getting less steep as time goes on
- b The price is constant - gradient triangle has a gradient of 0
  - c The price is rising at an increasing rate - the gradient triangles all have positive gradients getting more steep as time goes on
  - d The price is rising at a decreasing rate - the gradient triangles all have positive gradients getting less steep as time goes on
  - e The price is rising at a fixed rate - each gradient triangle has the same gradient
  - f The price rises (gradients positive) then decreases (gradients negative)
- 3 The speed increases rapidly until the parachute opens. Then the speed is constant for a while before it begins to decrease rapidly until it becomes constant again.

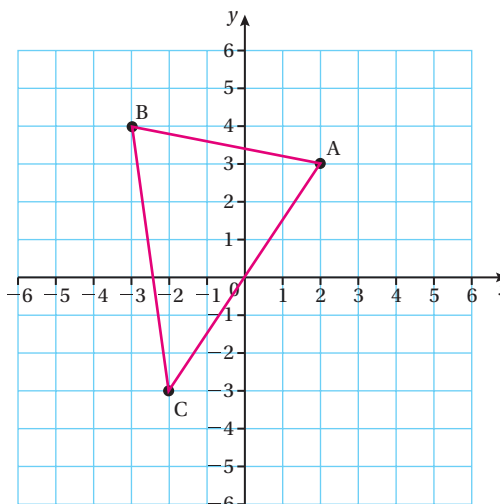
**CHAPTER REVIEW**

- 1 a 90 km/h  
 b  $0.083 \text{ m/s}^2$   
 c 15 km  
 d 2.5 min  
 e 0.3 km/min  
 f 17499 m
- 2 Alf is stopped when the line is horizontal so he was stopped for  $4 \times 15 + 2 \times 15 = 90$  minutes  
 Total journey time was 10 am to 3 pm = 5 hours or 300 minutes.  
 Alf was stopped for  $\frac{90}{300}$  of his journey  
 $\frac{90}{300} = \frac{3}{10}$   
 Alf was incorrect as  $\frac{3}{10}$  is greater than  $\frac{1}{4}$
- 3 a 5.325  
 b the rate of change of the population

**30 Vector geometry**

**BEFORE YOU START ...**

1 a

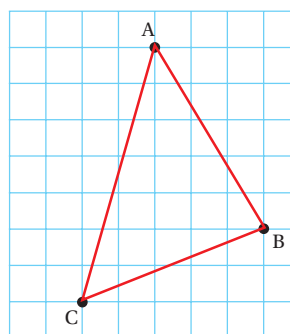


- 2 a -4      b 7      c -23      d -28      e 27  
 3 a  $m = 12$       b  $k = -4$       c  $d = -7$   
 4  $x = 2, y = 1$

**LAUNCHPAD**

1  $\vec{HG} = \begin{pmatrix} -3 \\ -4 \end{pmatrix}$

2



- 3 a  $\mathbf{j} + \mathbf{k} = \begin{pmatrix} 1 \\ 4 \end{pmatrix}$       b  $2\mathbf{k} - \mathbf{l} = \begin{pmatrix} 8 \\ 4 \end{pmatrix}$

4  $f=3, g=6$

5  $\vec{CA} = \begin{pmatrix} -14 \\ -2 \end{pmatrix}$      $\vec{CA} + \vec{AB} = \begin{pmatrix} -5 \\ 10 \end{pmatrix}$

6  $\begin{pmatrix} -3 \\ 4 \end{pmatrix}$  and  $\begin{pmatrix} 15 \\ -20 \end{pmatrix}$

**EXERCISE 30A**

- 1 1 civ    2 d ii    3 bi    4 ei    5 a iii

2 option D

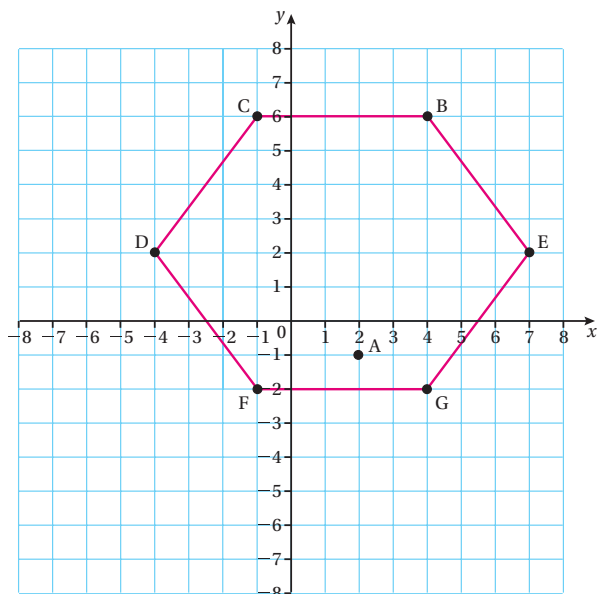
3 option C

4 a i  $\begin{pmatrix} 2 \\ -1 \end{pmatrix}$     ii  $\begin{pmatrix} -2 \\ 1 \end{pmatrix}$     iii  $\begin{pmatrix} 2 \\ 1 \end{pmatrix}$     iv  $\begin{pmatrix} -3 \\ -2 \end{pmatrix}$     v  $\begin{pmatrix} -5 \\ 1 \end{pmatrix}$     vi  $\begin{pmatrix} 6 \\ -3 \end{pmatrix}$

b Vectors  $\vec{AB}$  and  $\vec{DC}$  are the same length and go in opposite directions.

c Vectors  $\vec{AB}$  and  $\vec{BH}$  are parallel,  $\vec{BH}$  is 3 times as long as  $\vec{AB}$ .

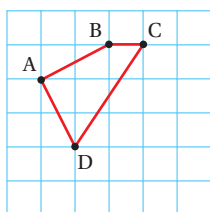
5



6 a  $\begin{pmatrix} -4 \\ 6 \end{pmatrix}$     b an example is E(0, 0) and F(-4, 6)

7 a  $\begin{pmatrix} -6 \\ 10 \end{pmatrix}$     b (-5, 4)

8



9 a  $\begin{pmatrix} -12 \\ 8 \end{pmatrix}$     b (15, -3)

**WORK IT OUT 30.1**

option C

**EXERCISE 30B**

1 option D

2 a i  $\begin{pmatrix} 2 \\ 1 \end{pmatrix}$     ii  $\begin{pmatrix} 7 \\ -5 \end{pmatrix}$     iii  $\begin{pmatrix} -12 \\ 8 \end{pmatrix}$     iv  $\begin{pmatrix} -12 \\ 21 \end{pmatrix}$

v  $\begin{pmatrix} -1 \\ -1 \end{pmatrix}$     vi  $\begin{pmatrix} -9 \\ -17 \end{pmatrix}$

b result c iii (vector 4p) is parallel to  $\begin{pmatrix} 3 \\ -2 \end{pmatrix}$

3 three vectors of the form  $\begin{pmatrix} 2k \\ -3k \end{pmatrix}$  for any three values of  $k$

4 a  $x=4, y=0$     b  $x=12, y=5$     c  $x=17, y=-5$

d  $z=-2, x=-3.5$     e  $z=-\frac{1}{4}, y=32$     f  $z=3, y=6$

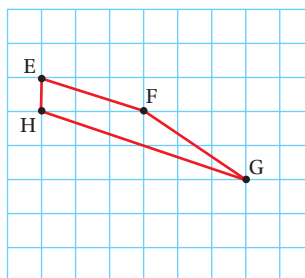
g  $z=3, x=5$     h  $z=4, t=3$

5 a  $\begin{pmatrix} 5 \\ 4 \end{pmatrix}$     b  $\begin{pmatrix} -15 \\ -12 \end{pmatrix}$

6 a sides EF and HG are parallel

b a trapezium

c



$\vec{GF} = \begin{pmatrix} -3 \\ 2 \end{pmatrix}$

7 It is a parallelogram, because opposite sides, AB and DC, and DA and CB, are parallel.

**EXERCISE 30C**

1 a  $\begin{pmatrix} -10 \\ -2 \end{pmatrix}$     b  $\begin{pmatrix} -2 \\ 12 \end{pmatrix}$

2 a i  $\vec{DE} = 2\vec{AB}$     ii  $\vec{DF} = 2\vec{AC}$

b The two triangles are similar. DEF is an enlargement of ABC, scale factor 2

3 a king can move vectors of the form  $\begin{pmatrix} 1 \\ 0 \end{pmatrix}, \begin{pmatrix} -1 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ 1 \end{pmatrix}, \begin{pmatrix} 0 \\ -1 \end{pmatrix}, \begin{pmatrix} 1 \\ 1 \end{pmatrix}, \begin{pmatrix} -1 \\ 1 \end{pmatrix}$  and  $\begin{pmatrix} -1 \\ -1 \end{pmatrix}$

b knight can move  $\begin{pmatrix} 2 \\ 1 \end{pmatrix}, \begin{pmatrix} 2 \\ -1 \end{pmatrix}, \begin{pmatrix} -2 \\ 1 \end{pmatrix}, \begin{pmatrix} -2 \\ -1 \end{pmatrix}, \begin{pmatrix} 1 \\ 2 \end{pmatrix}, \begin{pmatrix} 1 \\ -2 \end{pmatrix}, \begin{pmatrix} -1 \\ 2 \end{pmatrix}$  and  $\begin{pmatrix} -1 \\ -2 \end{pmatrix}$

4 option D

5  $\begin{pmatrix} 8 \\ 10 \end{pmatrix}$

6 a  $\begin{pmatrix} -1 \\ 3 \end{pmatrix}$     b  $\begin{pmatrix} -5 \\ -1 \end{pmatrix}$     c  $\begin{pmatrix} -3 \\ 1 \end{pmatrix}$     d  $\begin{pmatrix} -2 \\ -2 \end{pmatrix}$

7  $\begin{pmatrix} 5 \\ -10 \end{pmatrix}$

**CHAPTER REVIEW**

1 The coordinate (-2, 3) is a point in two-dimensional space.

The vector  $\begin{pmatrix} 2 \\ 3 \end{pmatrix}$  describes movement from one point to another. It has magnitude and direction.

2 a and c; b and d; e, f and g

3 a  $\begin{pmatrix} -1 \\ -3 \end{pmatrix}$     b  $\begin{pmatrix} 2 \\ -7 \end{pmatrix}$     c  $\begin{pmatrix} -6 \\ 3 \end{pmatrix}$

4 All the options are incorrect. The correct answer is  $-\frac{3}{4}\mathbf{e} + \frac{1}{4}\mathbf{f}$

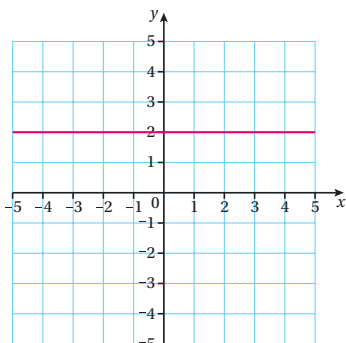
5 a  $\mathbf{b} - \mathbf{a}$     b  $\frac{1}{2}(\mathbf{b} - \mathbf{a})$     c  $-\frac{1}{2}(\mathbf{b} + \mathbf{a})$

# 31 Transformations in a plane

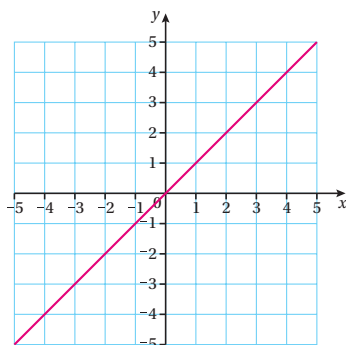
## BEFORE YOU START ...

- 1 a 90° anticlockwise      b 180° clockwise  
 c 270° clockwise

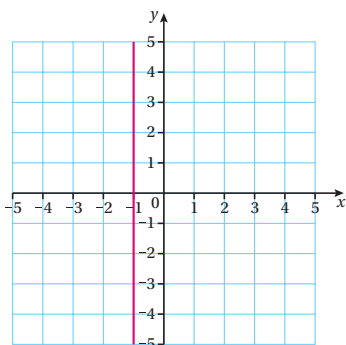
2 a



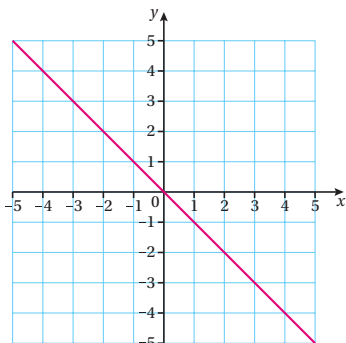
b



c

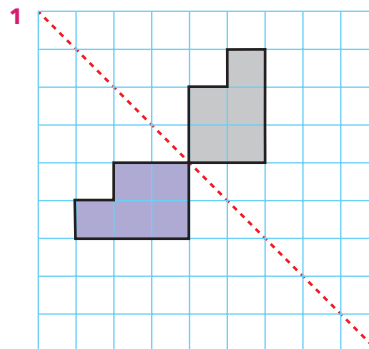


d

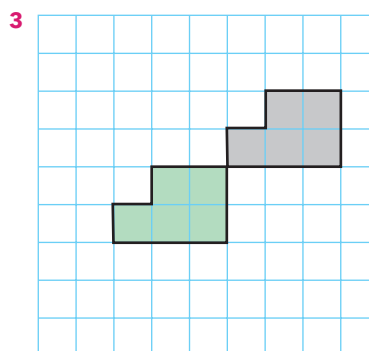


- 3 a The coordinate (3, 2) is a single point in  $xy$  space; the vector  $\begin{pmatrix} 3 \\ 2 \end{pmatrix}$  has magnitude and direction, and determines the movement from one point in  $xy$ -space to another.  
 b The vectors are the same length but in different directions.

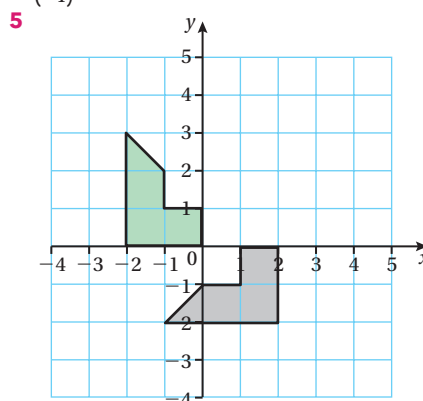
## LAUNCHPAD



2  $y = -x$

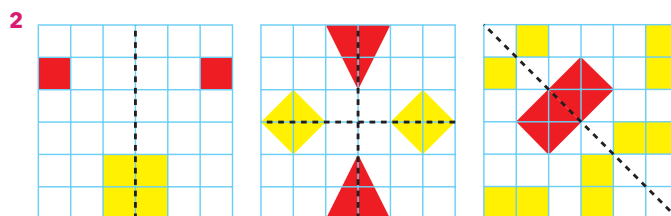


4  $\begin{pmatrix} 2 \\ -4 \end{pmatrix}$

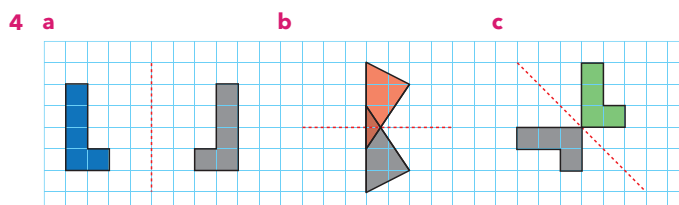


## EXERCISE 31A

1 option C



3 The lines are perpendicular to the line of reflection.



### WORK IT OUT 31.1

Option C is correct.

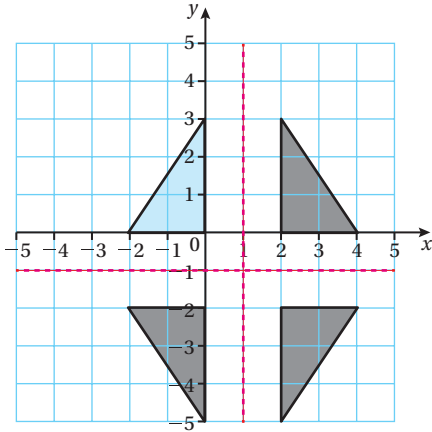
Option A is a reflection in  $x = -1$ .

Option B is not a reflection.

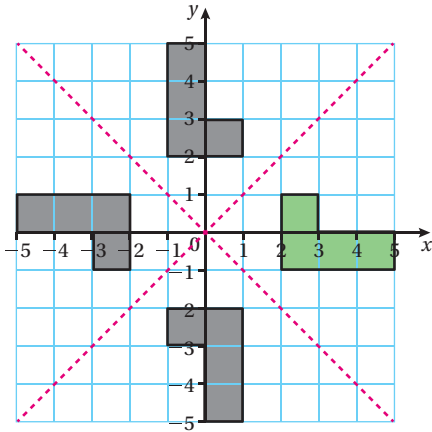
### EXERCISE 31B

1 option B

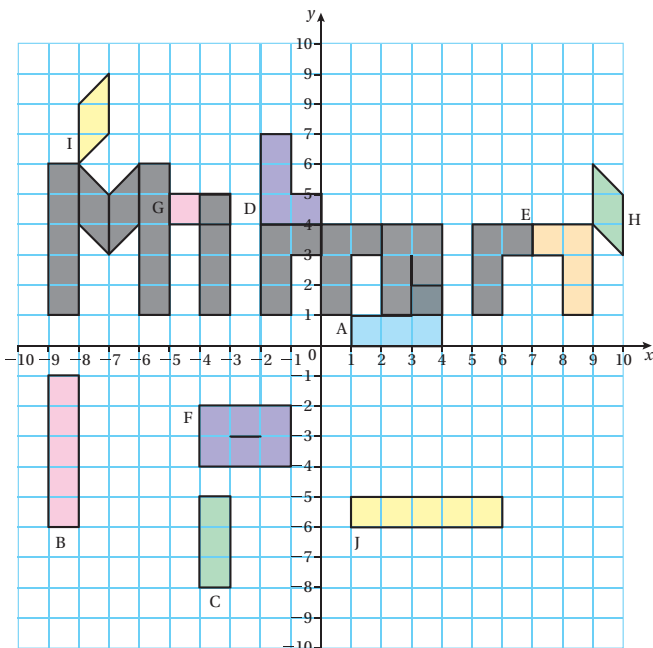
2



3



4 a to j



### EXERCISE 31C

1 option C

2 a  $x = 1$

b  $y = x$

c  $y = 1$

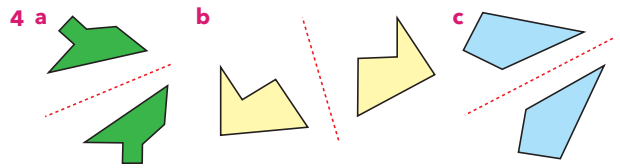
d  $y = -x$

3 a i  $y = -1.5$

ii  $x = -1.5$

iii  $y = x$

iv  $y = -x$

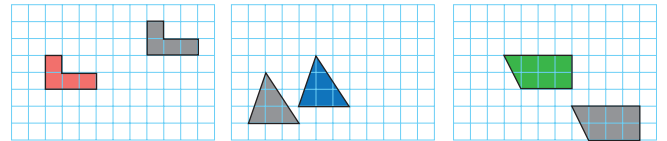


### EXERCISE 31D

1 a

b

c



### WORK IT OUT 31.2

Option B is correct.

Option A is a translation  $\begin{pmatrix} 5 \\ -2 \end{pmatrix}$ .

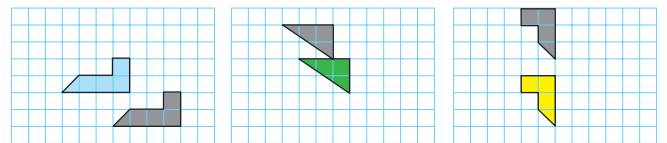
Option C is a translation  $\begin{pmatrix} -1 \\ 3 \end{pmatrix}$ .

### EXERCISE 31E

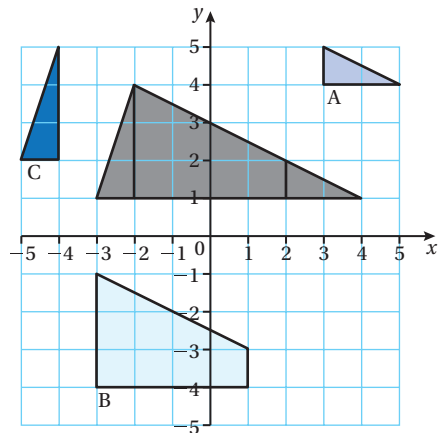
1 a

b

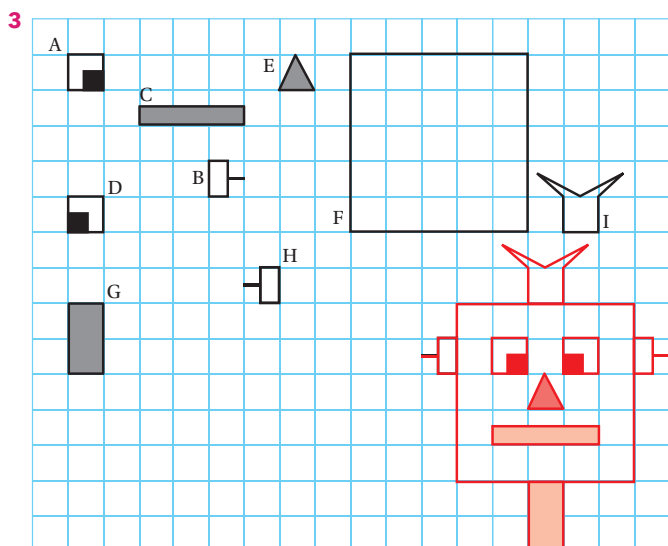
c



2 a



b a triangle



**WORK IT OUT 31.3**

- a Transformation B is a reflection. Transformations A and E are translations.
- b In a reflection, the image is a mirror image of the object. In a translation, the image has the same orientation as the object.

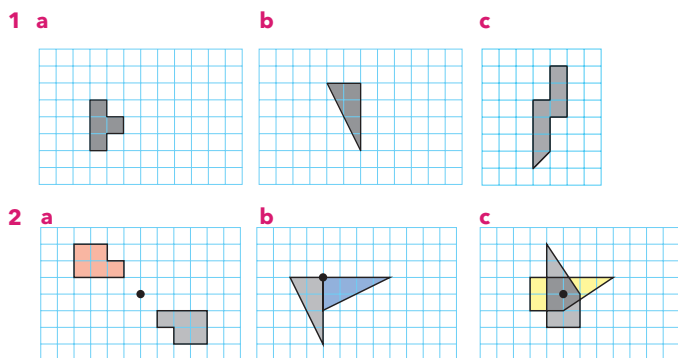
**EXERCISE 31F**

- 1 option D
- 2  $S \begin{pmatrix} -3 \\ 7 \end{pmatrix}$      $L \begin{pmatrix} 0 \\ -6 \end{pmatrix}$      $I \begin{pmatrix} 8 \\ 10 \end{pmatrix}$      $D \begin{pmatrix} -4 \\ -5 \end{pmatrix}$      $E \begin{pmatrix} 13 \\ -5 \end{pmatrix}$
- 3 students' own answers

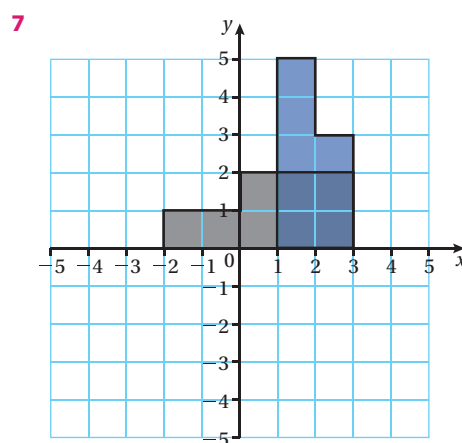
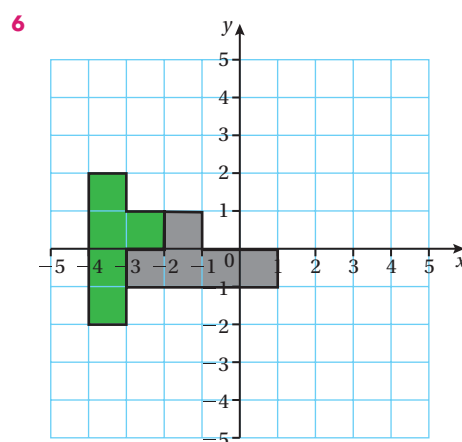
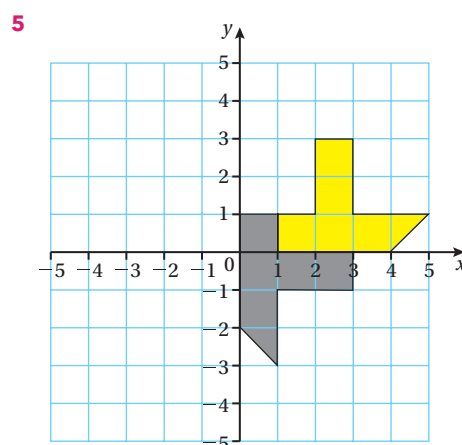
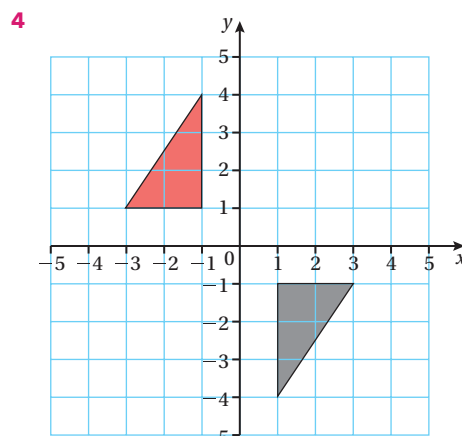
**WORK IT OUT 31.4**

Option B is correct.  
 Option A is a rotation about the origin.  
 Option C is a rotation in a clockwise direction.

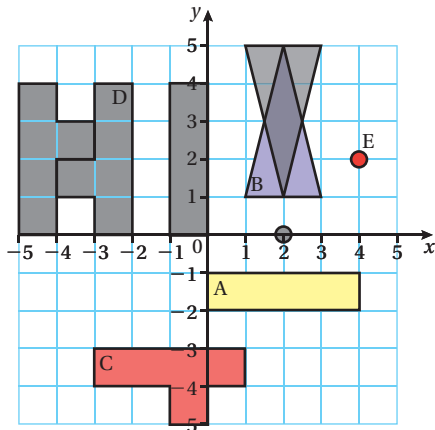
**EXERCISE 31G**



- 3 option B



8



9 Each coordinate is a combination of the same two numerals, for example,  $(-1, 5)$ ,  $(5, 1)$ ,  $(1, -5)$ ,  $(-5, -1)$ . This result is only obtained if the centre of rotation is the origin.

**WORK IT OUT 31.5**

- a Transformation A is a rotation. Transformations B and F are reflections. Transformation D is a translation.
- b In a reflection, the image is a mirror image of the object. In a rotation, the image is the same as the object but has a different orientation. In a translation, the image has the same orientation as the object.

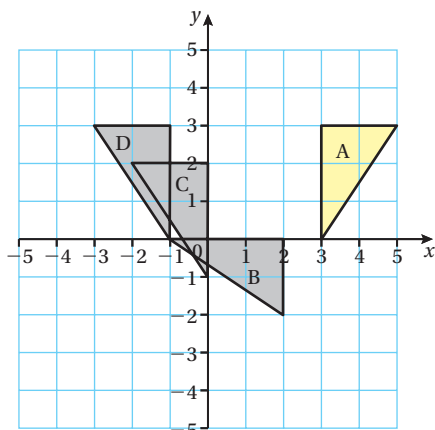
**EXERCISE 31H**

- 1 option D
- 2 a rotate  $180^\circ$ , centre  $(-1, 0)$   
 b rotate  $90^\circ$ , anticlockwise centre  $(2, -3)$   
 c rotate  $90^\circ$  clockwise, centre  $(-4, 2)$   
 d rotate  $90^\circ$  anticlockwise, centre  $(-2, 3)$
- 3 There are many possible answers for this question, which should encourage discussion and comparison of suggestions.

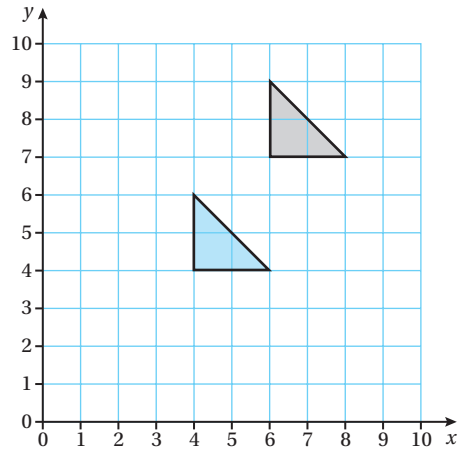
**CHAPTER REVIEW**

- 1 a true      b true      c false      d true
- 2 a rotation  $180^\circ$  around  $(4, 0)$     b rotation  $180^\circ$  around  $(3, -2)$   
 c translation through vector  $\begin{pmatrix} 2 \\ 4 \end{pmatrix}$
- 3 For example, translate the original shape through vectors  $\begin{pmatrix} 2n \\ 0 \end{pmatrix}$  and  $\begin{pmatrix} 0 \\ 6m \end{pmatrix}$ , where  $n$  and  $m$  are integers, then rotate the original triangle  $180^\circ$  around  $(2, 3)$  and translate this new triangle using the same vectors.

4



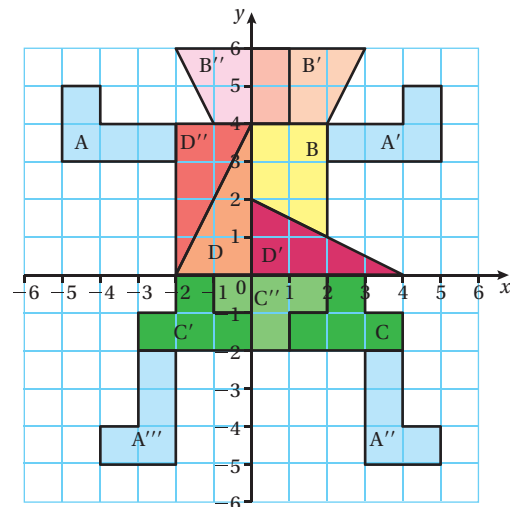
5 a



b Clockwise rotation of  $90^\circ$  about the point  $(4, 3)$

6 For example:

- Reflect A in  $y$ -axis to give  $A'$ .
- Rotate A,  $90^\circ$  anticlockwise around  $(-2, 3)$  and then translate through vector  $\begin{pmatrix} 0 \\ -5 \end{pmatrix}$  to give  $A'''$ .
- Reflect  $A'''$  in  $x = 0.5$  to get  $A''$ .
- Rotate B,  $90^\circ$  anticlockwise around  $(0, 4)$  to give  $B'$ .
- Reflect  $B'$  in the line  $x = 0.5$  to give  $B''$ .
- Reflect C in the line  $x = 0.5$  to give  $C'$ .
- Rotate C,  $180^\circ$  around  $(1.5, -1)$  to give  $C''$ .
- Rotate D,  $90^\circ$  clockwise around the origin to give  $D'$ .
- Rotate D,  $180^\circ$  around  $(-1, 2)$  to give  $D''$ .



**32 Construction and loci**

**BEFORE YOU START ...**

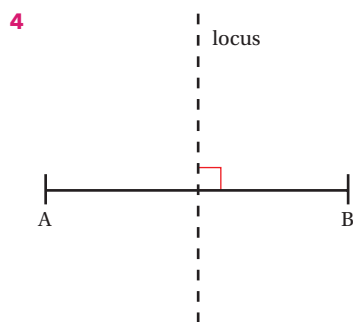
- 1 a  $120^\circ$       b  $40^\circ$
- 2 student's own drawing
- 3 a C      b C
- 4 a side      b vertex      c centre  
 d radius      e diameter

**LAUNCHPAD**

- 1 a false      b true      c false      d false
- 2 a and c



- 3 a angle bisector
- b placed a pair of compasses at B to draw arcs on BA and BC, then drew arcs from points P and Q and then drew a line BR from point B through the intersection of these arcs
- c  $24^\circ$



**EXERCISE 32A**

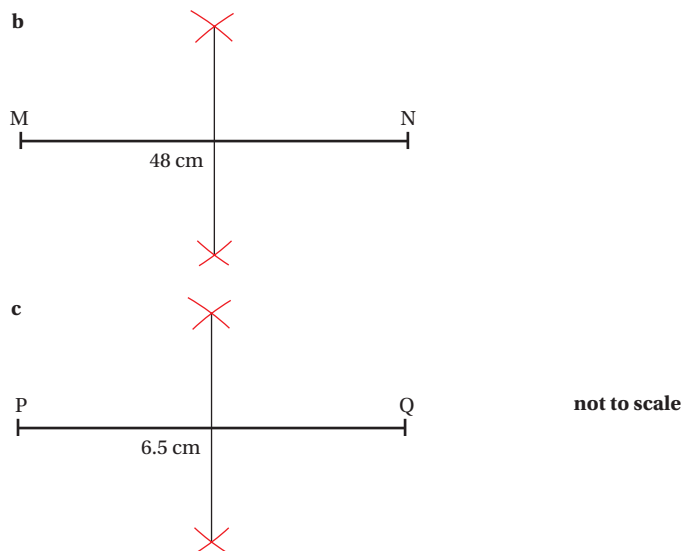
- 1 option A
- 2 a b c

- 3 Use the protractor to measure the smaller (non-reflex) angle at the point, which in this case will measure  $122^\circ$  and subtract this from  $360^\circ$ .
- 4 a Student drawings as specified in question
- b The lengths of the lines are irrelevant because the length of the line does not change the size of the angle.
- 5 student's drawing
- 6 student's drawing
- 7 student's drawing; angles measured according to their diagram
- 8 student's drawing

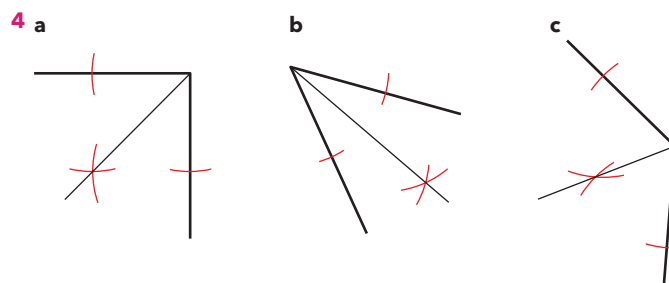
- 9 a Draw a line longer than 6.4 cm and mark a point A on this line.  
Set the compass to 6.4 cm and placing the compass at A draw an arc that crosses this line. Mark this point B.  
Placing the compass at A draw an arc above the midpoint of AB. Repeat this step from point B. Mark the point where the arcs intersect as C.  
Use the ruler to join A to C and B to C.  
ABC is an equilateral triangle with sides of 6.4 cm.
- b Draw a line longer than 60 mm and mark a point O towards the middle of this line  
Set the compass to 30 mm. Place the compass at O and draw a semicircle by drawing the arc above the line.

**EXERCISE 32B**

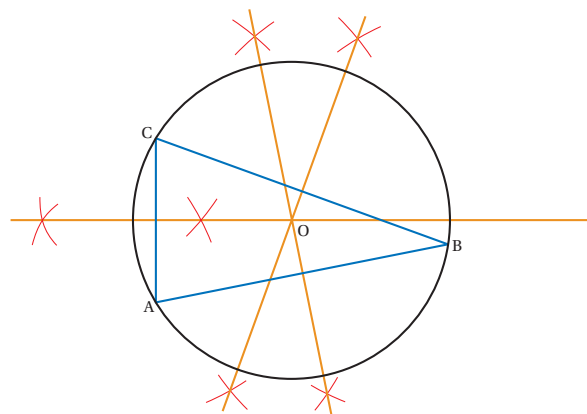
- 1 option D
- 2 a



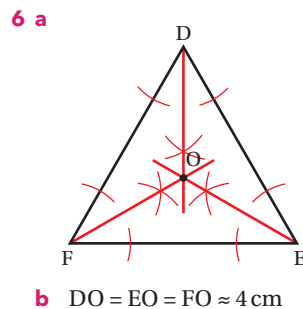
- 3 a student's drawings
- b constructions can be checked for accuracy with a protractor



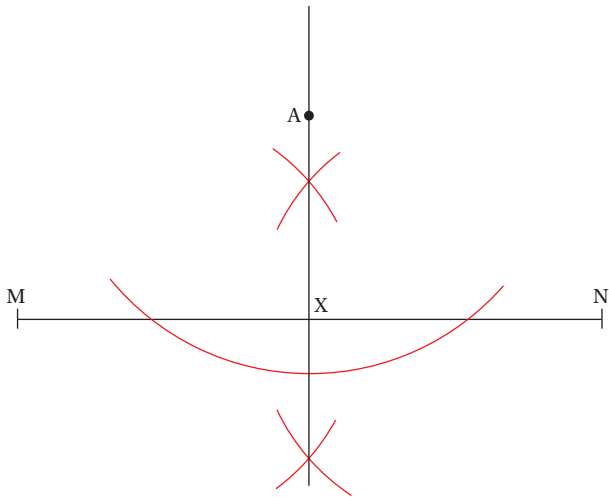
- 5 a and b



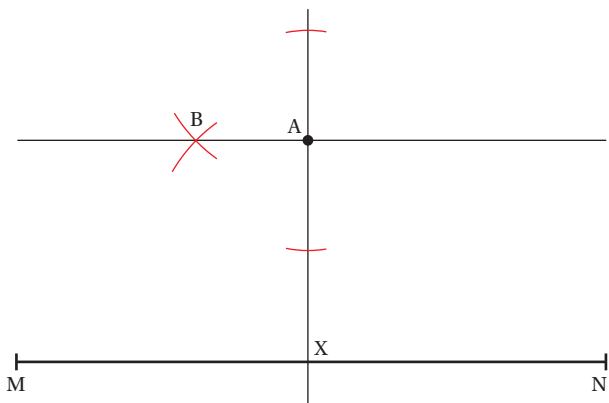
- c For any triangle ABC, a circle with a centre at the intersection of the perpendicular bisectors and passing through point A will also pass through points B and C.



7 a



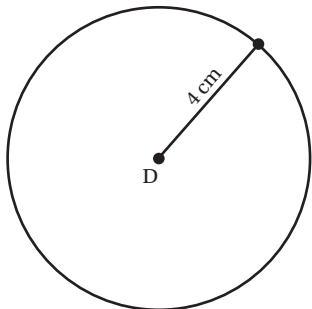
b



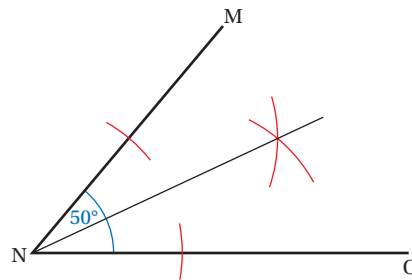
**EXERCISE 32C**

- 1 discussion question
- 2 option C
- 3 a Points on a circle, centre at X, radius 200 km.
- b Points within the area defined by lines A and B: line A is an oval defined by parallel lines 1 km long and at 2 km either side of the straight fence joined by semicircles of radius 2 km at each end; line B is an oval defined by parallel lines 1 km long and at 3 km either side of the straight fence joined by semicircles of radius 3 km at each end.
- c Points on the straight line across the centre of the court.
- d The centre spot.
- e Points within the area defined by two parallel lines that are 1 km either side of the railway line.

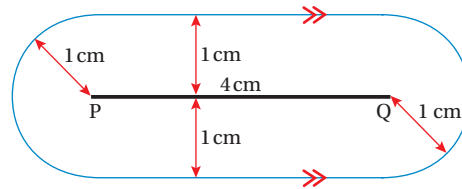
4



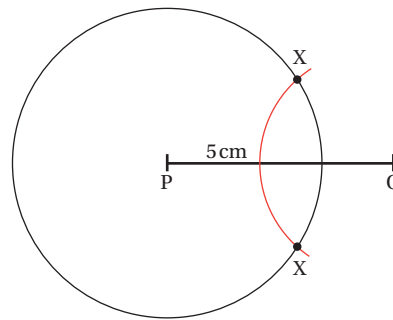
5



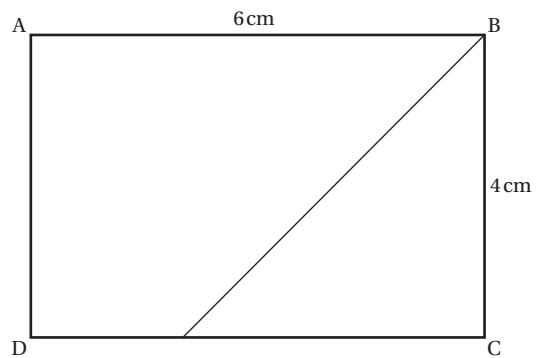
6



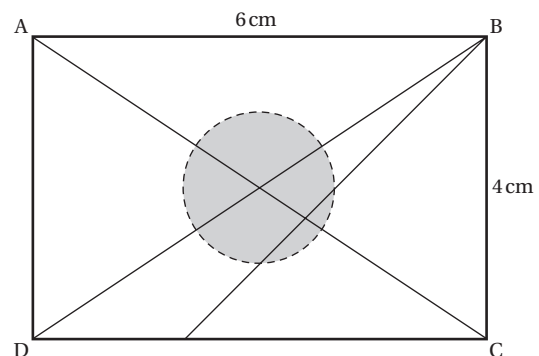
7 There are two points that are 4 cm from P and 2.5 cm from Q.

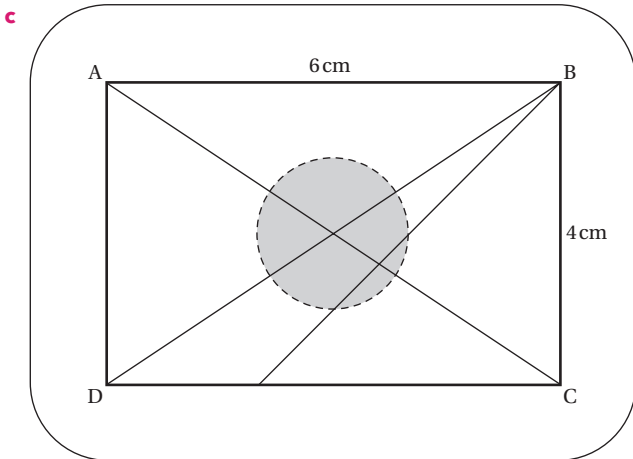


8 a



b

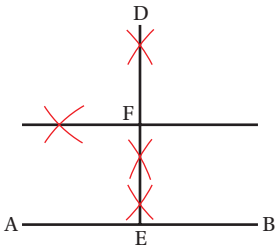




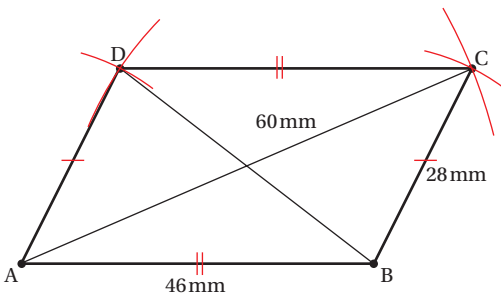
**EXERCISE 32D**

**1** Option B

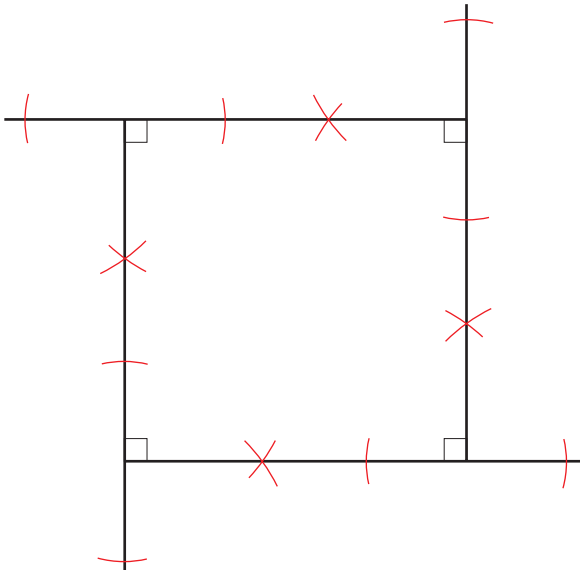
**2**



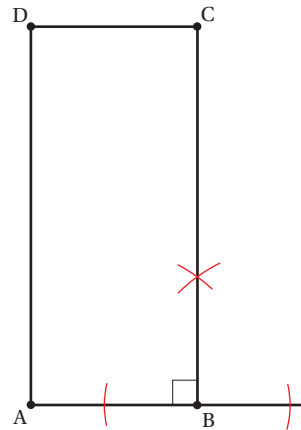
**3** Length of diagonal DB is 47 mm.



**4**

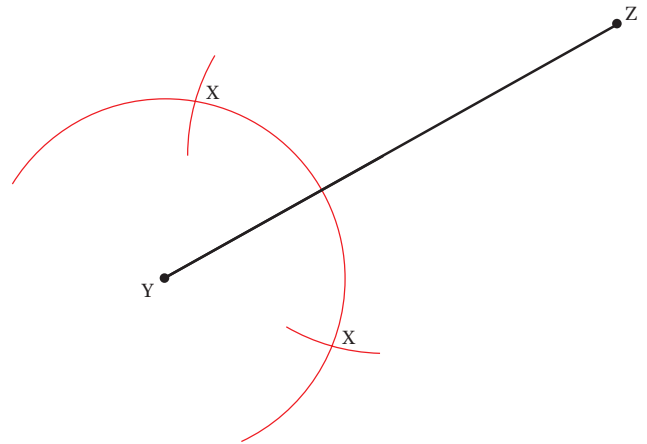


**5 a**



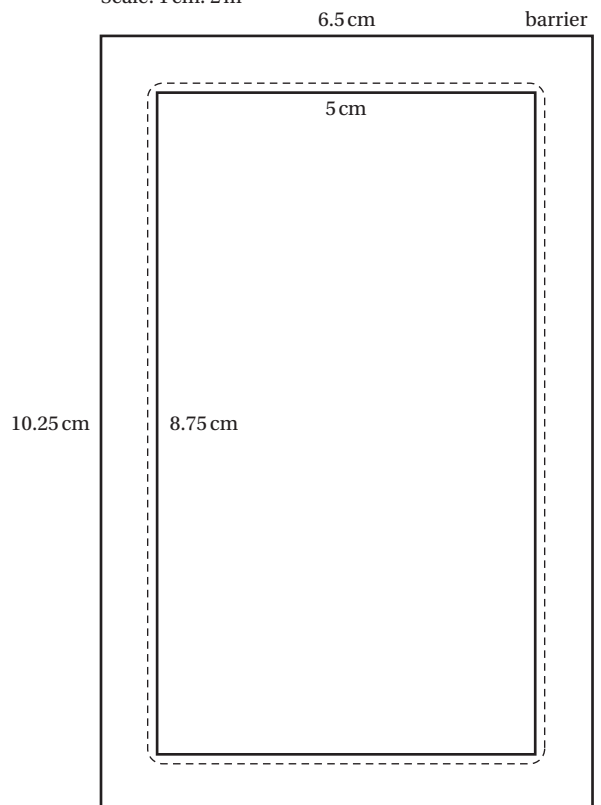
**b** A rectangle

**6** Drawings should be to scale 1 cm to 2 m, so line YZ measures 7.5 cm



**7 a**

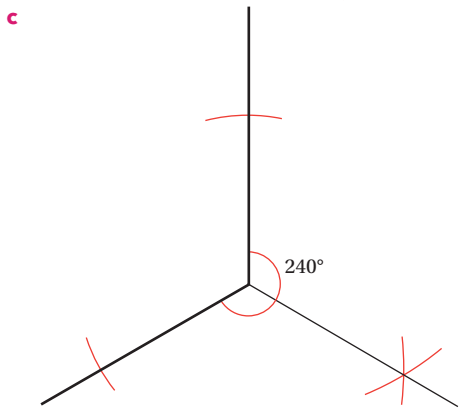
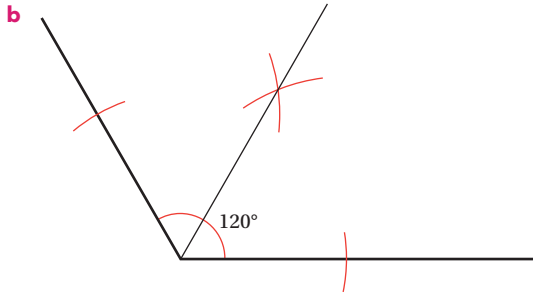
Scale: 1 cm : 2 m



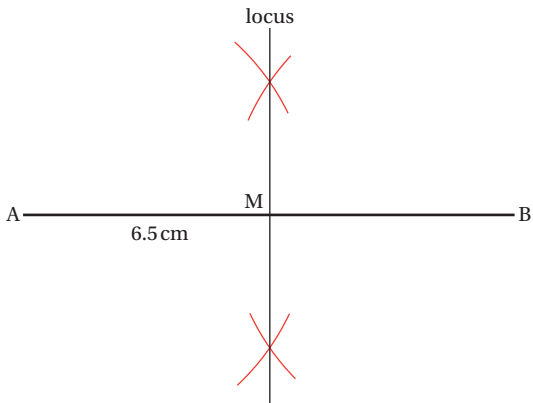
- b** The barrier should be 1.5 m away from the enclosure because people can reach out about 1 m. This means that visitors will not be able to touch the monkey when both are stretching out (leaving a small margin for error).

**CHAPTER REVIEW**

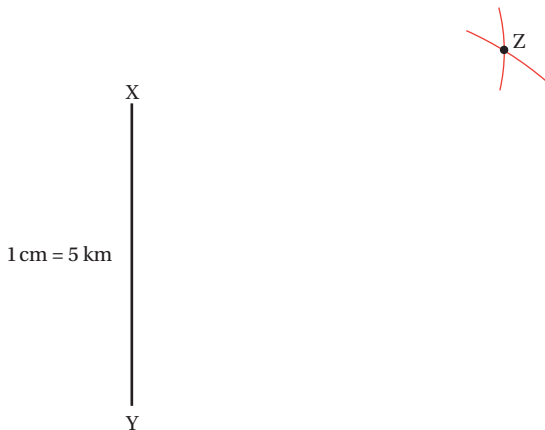
**1 a**  $120^\circ$  and  $240^\circ$



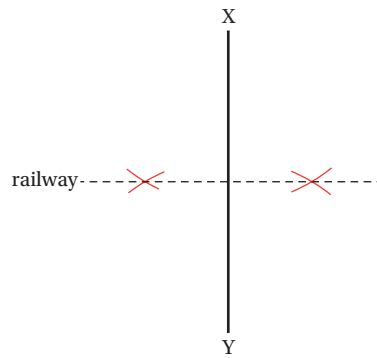
**2 a and b**



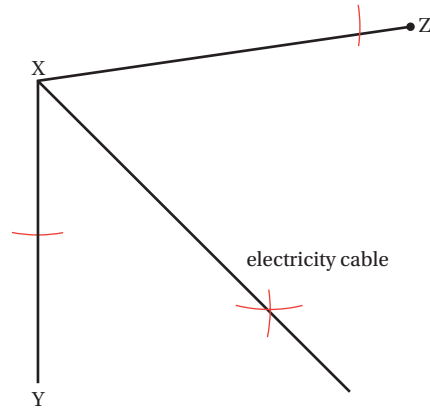
**3 a**



**b**

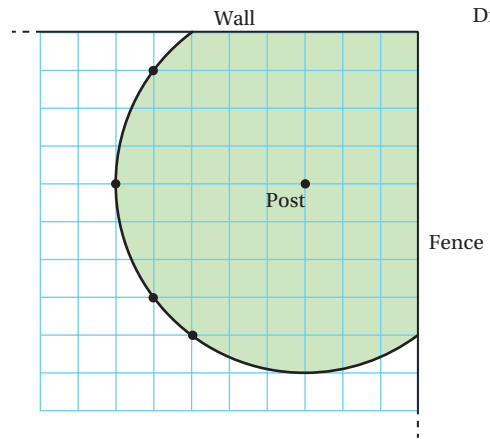


**c**



**4 a** 3 squares is 1.5 m so 1 square = 0.5 m.  
Post is  $4 \times 0.5 \text{ m} = 2 \text{ m}$  from the wall.

**b**



**c** Scale is 1 cm = 0.5 m  
So scale is 1 cm = 50 cm  
Ratio is 1 : 50

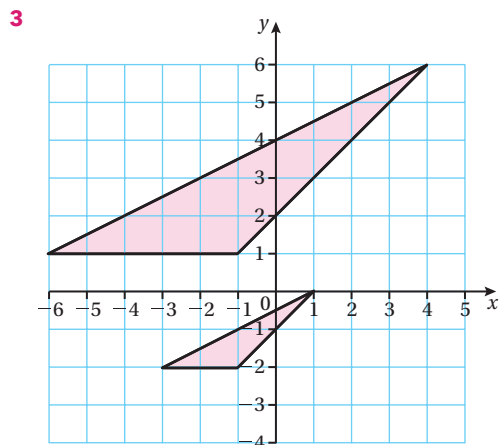
**33 Similarity**

**BEFORE YOU START ...**

- 1 a** BOC                      **b**  $80^\circ$                       **c**  $150^\circ$   
**2** side DF = side AC, angle EDF = angle BAC, side DE = side AB, SAS congruency  
**3 a**  $x = 8$                       **b**  $h = 2.5$                       **c**  $k = 0.25$   
**4** none  
**5**  $x = \frac{2}{3}$

**LAUNCHPAD**

- 1 a no, rectangles sides can be in any ratio
- b Yes - AAA
- 2 AC = 14.1cm, BC = 4.7cm, AE = 4cm

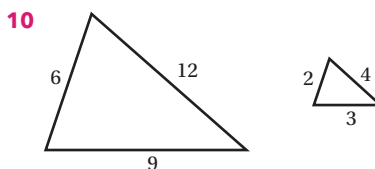
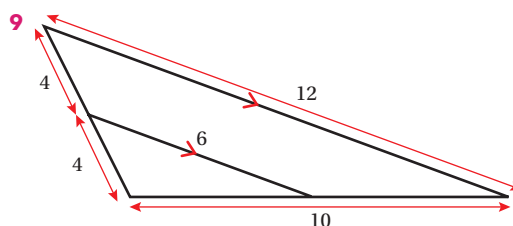


- 4 Enlargement centre (4,2) scale factor 0.5
- 5 No  $BC \times \frac{14}{9} = VW$  whereas  $CD \times \frac{3}{2} = WX$ ,

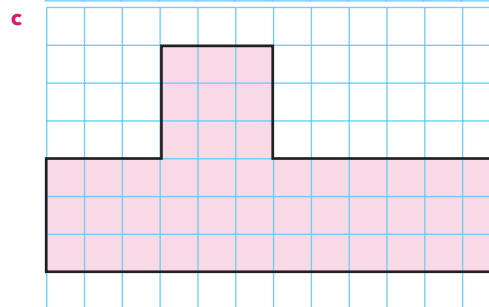
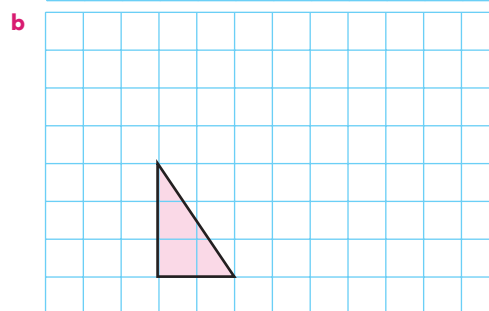
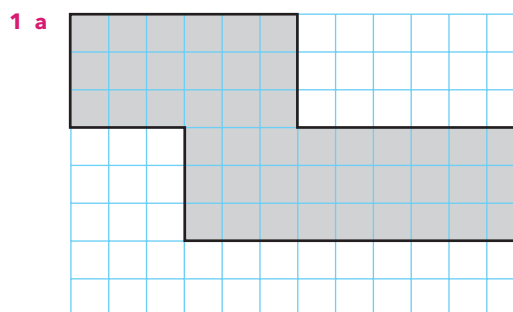
**EXERCISE 33A**

- 1 a Matching angles: BAD and CED, ABD and ECD (corresponding angles) CDE and BDA. Sides in proportion: BD:CD, AD:ED, AB:EC
- b Matching angles: WYX and VYZ (vertically opposite angles), WXY and YVZ, YZV and YWX (alternate angles). Sides in proportion: WX:VZ, WY:YZ, XY:VY.
- c Matching angles: QPS and QRS (opposite angles of parallelogram), PQS and RSQ, QSP and RQS (alternate angles). Sides in proportion: QS (common side), PS = QR, PQ = SR (sides of parallelogram).
- d Matching angles: HGF and NML, HFG and NLM, FHG and LNM (alternate angles). Sides in proportion: HF:LN, GH:MN, FG:LM.
- 2 a yes (3 corresponding angles)
- b no (sides not in proportion)
- c yes (corresponding sides in proportion)
- 3 a false, two triangles with sides 4, 4, 3 and 4, 4, 5
- b true
- c false, one triangle with angles of 90, 30 and 60, another triangle with angles 90, 45 and 45.
- d true
- e true
- f false, triangles of sides 1, 2, 3 and 2, 4, 6
- 4 a triangles NMO, KJO and LJM. Matching angles: NOM and JOK (vertically opposite angles), JOK and JML (corresponding angles); NMO and KJO (alternate angles), KJO=LJM; MNO and JKO (alternate angles), JKO and JLM (corresponding angles). Matching sides: MN, JK and JL; NO, KO and LM; MO, JO and JM.
- b triangle ABC, CDB and ADB. Matching angles: ABC, CDB and ADB (right angles); DAB and CAB (common angle) and CBD (exterior angle = sum of two opposite angles); ACB, BCD and ABD (angles in triangle add to 180°). Matching sides: AB, BC and AC (hypotenuses); AD, BD and AB; BD, CD and BC.

- 5  $c = 8 \text{ cm}$   $d = 15 \text{ cm}$
- 6  $e = 16 \text{ m}$   $f = 13.5 \text{ m}$
- 7 AE = 1.5 cm CE = 10 cm AB = 12.5 cm
- 8 YZ = 3 cm, XY = 9 cm



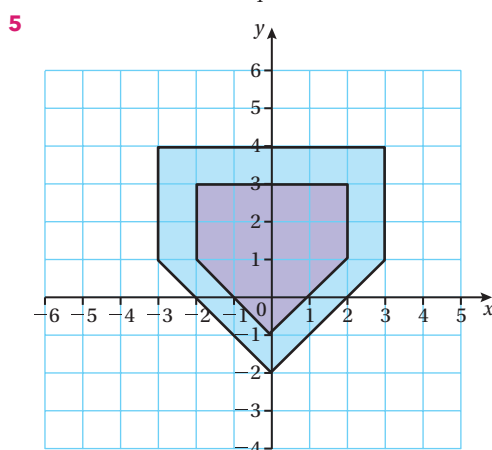
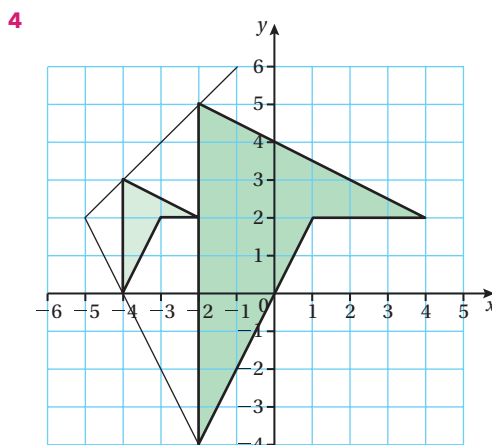
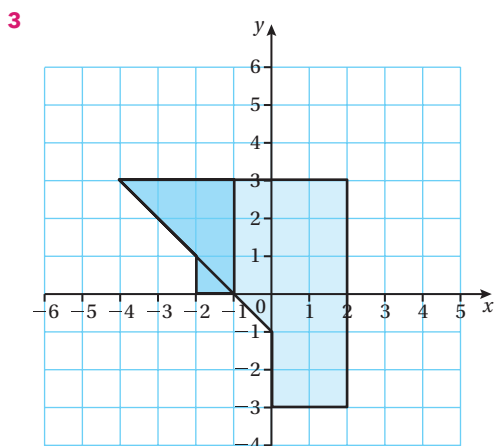
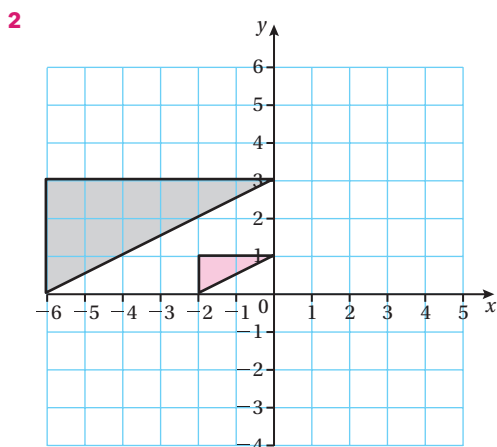
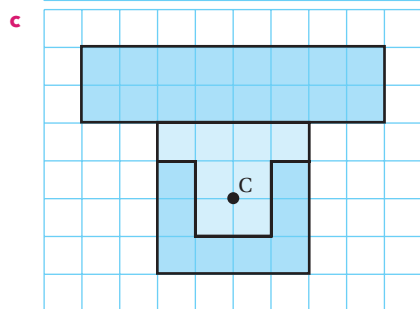
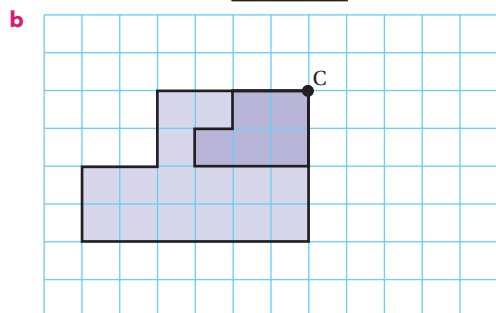
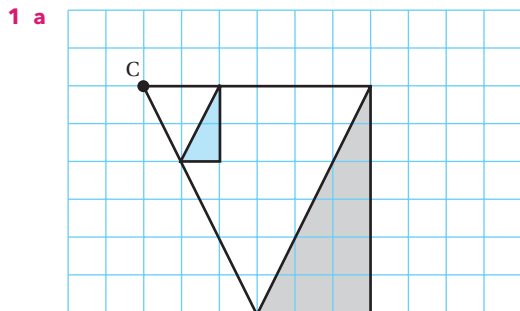
**EXERCISE 33B**



**WORK IT OUT 33.1**

- Option A is correct.
- Option B is wrong because the base length has not doubled in the image.
- Option C is wrong because a scale factor 3 has been used.

**EXERCISE 33C**



**WORK IT OUT 33.2**

Shape A has been enlarged by a scale factor of  $\frac{1}{2}$ . Shape B is not an enlargement. Student B is correct. Student A should check whether the shape has got bigger or smaller. Also the scale factor does not have to be a round number.

Student C should know that the scale factor is a multiple not an addition. They should also check that the factor is the same horizontally and vertically.

**EXERCISE 33D**

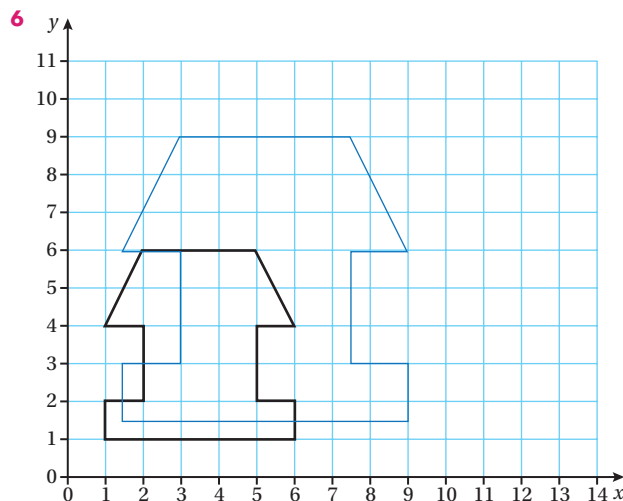
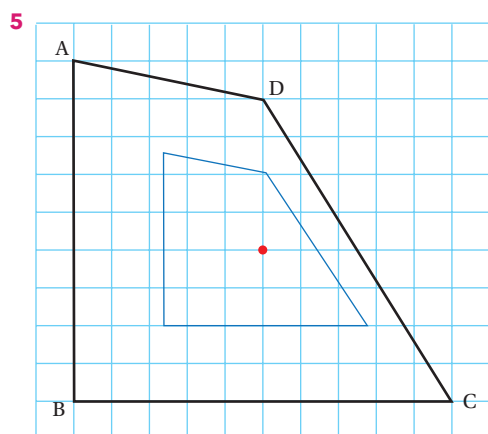
- 1** B is the only photo that has been enlarged in the same ratio in both directions.
- 2** option B
- 3** House C is an enlargement of scale factor  $\frac{1}{2}$ . House D is an enlargement of scale factor 2. House F is an enlargement of scale factor  $1\frac{1}{2}$ .
- 4 a** Enlargement scale factor 2 centre  $(-4, -4)$
- b** Enlargement scale factor 4 centre  $(-1, -4)$
- c** Enlargement scale factor 3 centre  $(-4, 4)$
- d** Enlargement scale factor  $\frac{1}{2}$  centre  $(2, 5)$
- e** Enlargement scale factor  $\frac{1}{2}$  centre  $(4, 2)$
- f** Enlargement scale factor  $1\frac{1}{2}$  centre  $(-5, 4)$

### EXERCISE 33E

- 1 D
- 2 a true as the sides will always be in proportion  
 b false as the angles can be different  
 c false as side and base can be different factors of another rectangle  
 d true as all angles are the same and side lengths will be in proportion
- 3 a Rectangle ABCD with AB = 5 cm and BC = 3 cm. Rectangle EFGH with EF = 10 cm and FG = 6 cm.  
 They are similar as their sides are in proportion.  
 b Rectangle ABCD with AB = 5 cm and BC = 3 cm. Rectangle EFGH with EF = 10 cm and GH = 9 cm.  
 They are not similar because their sides are not in the same proportion.  
 c Square ABCD with AB = 4 cm. Square EFGH with EF = 6 cm.  
 They are similar because their sides are in proportion.
- 4  $a = 8$  cm  $b = 6$  cm
- 5 Scale factor is 0.9. LG = 4.5; GH = 3.6; HI = 2.7; IJ = 7.2; JK = 11.25
- 6 7.5 cm and 10.5 cm
- 7 a plan to real life scale factor 200, real life to plan scale factor 0.005  
 b ratio of plan to real life 1:200

### CHAPTER REVIEW

- 1 B
- 2 a Three angles are equal – one shared, others are corresponding pairs.  
 b 3.75 cm
- 3 6.5 m
- 4 Side of length 10 cm becomes 15 cm so multiplier is  $\frac{15}{10} = \frac{3}{2}$   
 $3 \text{ cm} \times \frac{3}{2} = 4.5 \text{ cm}$   
 Area of larger rectangle =  $15 \times 4.5 = 67.5 \text{ cm}^2$



- 7 Yes – sides all the same length, internal angles all 120 degrees, so they are enlargements
- 8 No – different angles are possible in different rhombuses

## 34 Congruence

### BEFORE YOU START ...

- 1 a AB and DE, or BC and EF, or AC and DF  
 b angle EDF  
 c ACB and DFE, or CBA and FED
- 2 a C                      b B                      c A
- 3 a true                      b false                      c false                      d true
- 4 C

### LAUNCHPAD

- 1 a no; the corresponding sides are not equal  
 b yes; three equal sides  
 c yes, three equal angles and one equal side
- 2 a Triangles share the side AC, CD = CB and AB = AD. Hence by SSS the triangles are congruent.  
 b AC is a line of symmetry hence angle ADC is equal to angle ABC.

### WORK IT OUT 34.1

Option C is correct.  
 Option A is wrong because for SAS the angle has to be between the two sides.  
 Option B is wrong because not enough information has been written down to complete the proof.

### EXERCISE 34A

- 1 a RHS                      b SSS                      c ASA                      d SAS
- 2 B
- 3 a Can't tell.                      b SSA, so can't tell.  
 c Calculate the missing angle and then you can see they are congruent by ASA.  
 d RHS

- 4** Angle BCA is opposite to angle DCE and hence equal, hence angle CBA and CED are equal.  
Triangles are congruent by ASA.
- 5** SAS – DF shared, angle DFG = angle DFE and side EF = side FG.  
SSS – DF shared, side EF = side FG, using Pythagoras' theorem side DE = side DG.
- 6** Angle RTS is opposite to angle PTQ and hence equal, angle TRS and TQP are alternate angles and therefore equal. Triangles are congruent by ASA.
- 7** Angle EAB and DCB are both right angles, since they are co-interior angles with AED and CDE. Side BE = BD. AE = CD. Hence congruent (RHS).
- 8** SSS – share AC, AD = AB (isosceles triangle) and BC = BD (AC bisects base of triangle).
- 9** Since UQRT is a kite angle QUT = angle QRT and side QR = QU. The two triangles PQR and SQU share angle UQR. Hence by ASA the two triangles are congruent.
- 10 a** Kite, so AB = BC and AD = CD, triangles share side BD. SSS congruency.  
**b** Kite, so AD = CD, share side ED, angle AED = CED = right angle. RHS congruency.
- 11 a** Rhombus, so AD = BC, AD and BC parallel. Hence angle DAE = angle ECB, alternate angles are equal and angle CBE = angle EDA, alternate angles are equal. ASA congruency.  
**b** Rhombus, so AB = DC, AB and DC parallel. Hence angle EAB = angle ECD, alternate angles are equal and angle EBA = angle EDC, alternate angles are equal. ASA congruency.

### EXERCISE 34B

- 1** Triangles share side JL, JK = JM and right angled. Hence congruent and KL = ML.
- 2 a** Angle AED = angle BEC opposite angles are equal, third angles in triangles EBC = EDA, so triangles AED and CEB are congruent, hence side AE = side CE.  
Angle AEB = angle DEC opposite angles are equal, side DE = BE, side AE = CE, so triangles ABE and CDE congruent, hence angle ABE = angle EDC.  
**b** Angle DAC = angle BCA so AD and BC are parallel, from above angle ABE = EDC, so AB and DC parallel, hence ABCD has two pairs of parallel sides and is a parallelogram.
- 3** Angle QPR =  $56^\circ$  (base angles of an isosceles triangle).  
Angle QPR = angle PRS =  $56^\circ$  (alternate angles are equal).  
Angle SPR = PRS =  $56^\circ$  (base angles of an isosceles triangle).  
Angle PSR =  $180^\circ - 2 \times 56^\circ = 68^\circ$  (angles in a triangle sum to  $180^\circ$ ).
- 4** Drop a perpendicular from P to base of triangle PQT, label this point M. PQ is hypotenuse of right-angled triangle PQM. PT is hypotenuse of right-angled triangle PTM. Since PQ = PT and both right-angled triangles share side PM they are congruent. Hence angle PQR = angle PTS and PQT is isosceles. PQR is congruent to PTS due to SAS. Therefore, PR = PS, angle PRM = angle PSM, triangle PRS is isosceles.
- 5 a** ASA, so angle ABE = CBE, share side BE, angle BEA = BEC both supplementary to AED (= CED).

- b** In triangles AED and CED, side AE = side CE since triangles AEB and CEB congruent (above). Angle AED = CED and side ED is shared, hence the two triangles are congruent. Hence angle EAD = angle ECD.
- 6** Angle DAC = angle BCA, alternate angles equal, call this 1.  
Angle BAC = angle DCA, alternate angles equal, call this 2.  
Angles in triangle ABC = 1 + 2 + angle ABC.  
Angles in triangle ADC = 1 + 2 + angle ADC.  
Hence angle ABC = angle ADC.

### CHAPTER REVIEW

- 1 a** Congruent by SAS. **b** Congruent by SAS.  
**c** Not necessarily congruent. **d** Congruent by SAS or ASA
- 2 a** A: P is equivalent to B which is  $47^\circ$   
**b** C: PR = AB so is 10 cm
- 3** Let angle QPS =  $a$ . Let angle PQS =  $b$ .  
In triangle PQR three angles are  $a$ ,  $b$  + angle SQR and angle QRP.  
Angle QST = angle QPS =  $a$ . Angle TQR = angle PQS =  $b$ .  
In triangle QST three angles are  $a$ ,  $b$  + angle SQR and angle QTS.  
Hence angle QRP = angle QTS.
- 4** Angle ABE = angle DCE (angles in a triangle sum to  $180^\circ$ ), hence angle EBC = angle ECB (complementary to ABE and DCE).
- 5** Let angle ABC =  $a$ .  
Angle ABC = CAB =  $a$  (base angles of an isosceles triangle).  
Angle ACB =  $180^\circ - 2a$ .  
Angle ACD complementary to angle ACB, so angle ACD =  $2a$ .  
Angle ACD = angle ADC =  $2a$  (base angles of an isosceles triangle).  
Angle ADC = angle EAD =  $2a$  (alternate angles are equal).  
Hence angle EAD =  $2 \times$  angle ABC.
- 6** Angle QPR = angle STR (alternate angles are equal).
- 7** WXY and VXY congruent by SAS – share side XY, angle XYW = angle XYV and side YW = side YV, hence WX = XV.

## 35 Pythagoras' theorem

### BEFORE YOU START ...

- 1 a i** Incorrect because  $\sqrt{100} = \pm 10$   
**ii** Correct, but  $\sqrt{100}$  also = -10  
**iii** Correct **iv** Correct
- b i** Incorrect because  $4^2 = 4 \times 4 = 16$  **ii** Correct
- 2 a iii** is the right angle  
**i** Acute angle **ii** Obtuse angle  
**iv** Reflex angle  
**v** Straight line,  $180^\circ$
- b**  $270^\circ$
- 3** 6 units squared
- 4** Base angles in isosceles triangles are equal so  $x = y$ .



**LAUNCHPAD...**

- 1  $\sqrt{12500} = 111.8$  km  
 2  $\sqrt{80} = 8.94$  m  
 3 No  
 $3.1^2 + 4.2^2 = 27.25$ ;  $5.3^2 = 28.09$ ; so  $5.3^2 \neq 3.1^2 + 4.2^2$

**EXERCISE 35A**

Area of square A	Area of square B	Area of square C
... 9 (for given example)	... 25	... 34

Area of square A plus the area of square B = Area of square C

**WORK IT OUT 35.1**

Student B is right. Student A has multiplied by 2 rather than squaring the lengths; Student C has not taken the square root at the end of the calculation.

**EXERCISE 35B**

- 1 a i 625      ii 28.09      iii 27889  
     iv 18496      v 210.25
- b i 1.73      ii 2.65      iii 2.00  
     iv 4.12      v 7.81
- 2 D
- 3 a 10 cm      b 13.42 cm      c 2.59 cm  
     d 1.62 cm      e 7.21 m
- 4 a By simple geometry the hypotenuse must be shorter than the sum of the other two sides of the triangle, but  $14 > 7 + 6$   
 b Because  $7^2$  cannot equal the sum of the other two sides ( $7^2 + 6^2$ )  
 c  $7 < \text{hypotenuse} < 13$

**WORK IT OUT 35.2**

0.82 m, calculation C is correct.

In calculation A the lengths have been multiplied by 2 not squared.

In calculation B the squares have been added not subtracted.

**EXERCISE 35C**

- 1 a 5.29 cm      b 2.30 cm      c 6.63 cm      d 3.07 cm  
     e 10.43 cm
- 2 A
- 3 The length of the missing side must be less than the hypotenuse.
- 4 118.62 cm
- 5 17.18 m
- 6 a D      b A      c B      d C
- 7 17.32 m

**WORK IT OUT 35.3**

No - Option C is correct.

In Option A the lengths of the sides should have been squared.

In Option B the lengths of the sides have been doubled not squared.

**EXERCISE 35D**

- 1 a Right angled      b Not right angled  
 c Not right angled      d Right angled  
 e Right angled
- 2 a Not right angled      b Not right angled  
 c Right angled      d Right angled  
 e Not right angled
- 3 a 6, 8, 10      9, 12, 15      12, 16, 20  
 b Student's own investigation.
- 4 No. Divide each length by 5, gives a similar triangle with sides 3, 5, 7, which isn't a Pythagorean triple.

**EXERCISE 35E**

- 1 From Pythagoras' theorem in triangle ACD:  
 $AD^2 + 6^2 = 8^2$   
 $AD^2 = 64 - 36 = 28$   
 From Pythagoras' theorem in triangle ABD:  
 $x^2 = AD^2 + 4^2$   
 $x^2 = 28 + 16$   
 $x^2 = 44$   
 $x = 6.63$  cm
- 2 a From Pythagoras' theorem in triangle ABE:  
 $8^2 + BE^2 = 17^2$   
 $BE^2 = 289 - 64$   
 $BE^2 = 225$   
 $BE = 15$  cm
- b From Pythagoras' theorem in triangle BDE:  
 $BD^2 = BE^2 + 20^2$   
 $BD^2 = 225 + 400$   
 $BD^2 = 625$   
 $BD = 25$  cm
- c From Pythagoras' theorem in triangle BCD:  
 $BC^2 + 7^2 = BD^2$   
 $BC^2 = 625 - 49$   
 $BC^2 = 576$   
 $BC = 24$  cm
- 3 From Pythagoras' theorem in triangle BCD:  
 $CD^2 + 8^2 = 10^2$   
 $CD^2 = 100 - 64$   
 $CD^2 = 36$   
 $CD = 6$   
 From Pythagoras' theorem in triangle ABC:  
 $AB^2 = 13^2 + 8^2$   
 $AB^2 = 169 + 64$   
 $AB^2 = 233$   
 $AB = 15.26$  cm

**4 a** From Pythagoras' theorem in triangle ACD:

$$AC^2 = 3.3^2 + 5.6^2$$

$$AC^2 = 10.89 + 31.36$$

$$AC^2 = 42.25$$

$$AC = 6.5 \text{ cm}$$

**b** From Pythagoras' theorem in triangle ABC:

$$BC^2 + 2.5^2 = AC^2$$

$$BC^2 = 42.25 - 6.25$$

$$BC^2 = 36$$

$$BC = 6 \text{ cm}$$

**c** From Pythagoras' theorem in triangle BCE:

$$EC^2 = 1.1^2 + BC^2$$

$$EC^2 = 1.21 + 36$$

$$EC^2 = 37.21$$

$$EC = 6.1 \text{ cm}$$

**5 a**  $EC = \frac{15-6}{2} = 4.5$

From Pythagoras' theorem in triangle BCE:

$$BE^2 + 4.5^2 = 8^2$$

$$BE^2 = 64 - 20.25$$

$$BE^2 = 43.75$$

$$BE = 6.61 \text{ cm}$$

**b** Area of trapezium =  $\frac{1}{2}(6 + 15) \times 6.61$   
= 69.45 cm<sup>2</sup>

**6 a** From Pythagoras' theorem:

$$AD^2 = 10^2 + (8 - 6)^2$$

$$AD^2 = 104$$

$$AD = 10.2 \text{ cm}$$

**b** Perimeter = 10.2 + 6 + 10 + 8  
= 34.2 cm

### EXERCISE 35F

- 1** 16.16 units apart  
**2** 53.18 inches  
**3 a** 36.06 inches wider  
**b** The new television will not fit in the gap as it is 69.28 inches wide.  
**4** 3.6 m  
**5** BD is the same length as a perpendicular line from CD to A and can be calculated as the hypotenuse is 12 cm and the other side 5 cm. The length of BD is 10.91 cm  
**6 a** 8.12 m  
**b** Longest side of smaller sail is 8.14 m

### CHAPTER REVIEW

- 1 a** False    **b** False    **c** True    **d** True  
**2** Using Pythagoras  $18^2 = 12^2 + x^2$   
 So  $18^2 - 12^2 = x^2$   
 So  $\sqrt{18^2 - 12^2} = x$   
 $\sqrt{324 - 144} = x$   
 $\sqrt{180} = x$   
 $x = 13.4 \text{ cm}$

- 3** 95.16 cm  
**4** 2.5 m

## 36 Trigonometry

### BEFORE YOU START ...

- 1 a**  $x = 17.46$     **b**  $x = 4.90$   
**2** 7.28 (to 2 dp)  
**3** 9.71 (to 3 sf)  
**4** 21 cm

### LAUNCHPAD

- 1** 5.78 cm  
**2** sine  
**3 a**  $\frac{1}{\sqrt{2}}$     **b**  $\frac{1}{\sqrt{2}}$     **c** 1  
**4** 19.28 m

### EXERCISE 36A

- 1 a**  $\cos 30^\circ = \frac{4}{x}$ ,  $x = 4.62 \text{ cm}$     **b**  $\sin 45^\circ = \frac{4}{x}$ ,  $x = 5.66 \text{ cm}$   
**c**  $\cos 60^\circ = \frac{10}{x}$ ,  $x = 20.00 \text{ m}$     **d**  $\sin 30^\circ = \frac{9}{x}$ ,  $x = 18.00 \text{ mm}$   
**e**  $\tan 60^\circ = \frac{20}{x}$ ,  $x = 11.55 \text{ m}$   
**2 a** 0.44    **b** 0.75    **c** 0.91    **d** 0.03  
**e** 0.98    **f** 0.33  
**3 a** 0.974    **b** 0.682    **c** -0.342    **d** 0.052  
**e** 0.966    **f** 0.809  
**4 a** 0.5    **b** 3.3    **c** 0.1    **d** 1.2  
**e** 0.3    **f** 28.6

### EXERCISE 36B

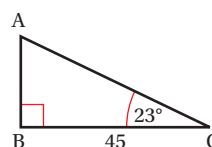
- 1 a** 0.85 m    **b** 4.5 m    **c** 10.65 km    **d** 5.45 cm  
**e** 10.60 cm    **f** 9.57 cm    **g** 14.10 cm    **h** 106.48 cm  
**i** 4.98 cm    **j** 42.88 m    **k** 2.75 m    **l** 139.88 cm

### WORK IT OUT 36.1

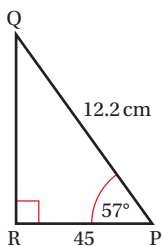
The ladder is safe - Option C gives the correct answer.

### EXERCISE 36C

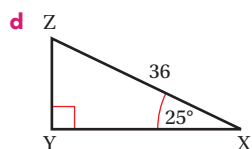
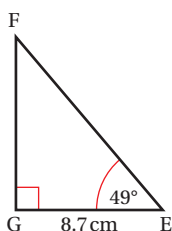
- 1** option C  
**2 a** 43°    **b** 27°    **c** 68°    **d** 15°  
**3 a** 25.9°    **b** 44.9°    **c** 69.5°    **d** 79.6°  
**e** 26.9°    **f** 11.5°  
**4** 24.6°  
**5** 42.1°  
**6 a** AB = 19.1 units



**b** Length QR = 10.23 cm

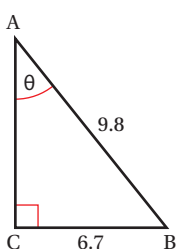


**c** GF = 10.01 cm

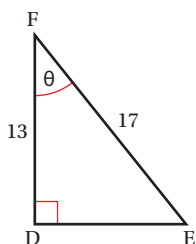


**i** XY = 32.63 units      **ii** YZ = 15.21 units

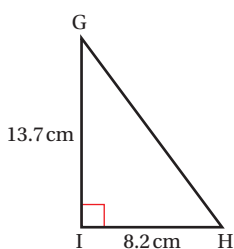
**7 a** 43.1°



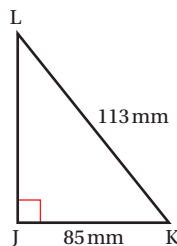
**b** 40.1°



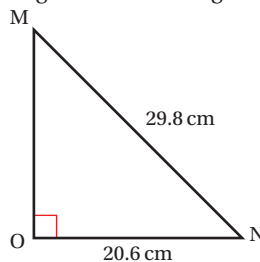
**c** angle G = 30.9°    angle H = 59.1°



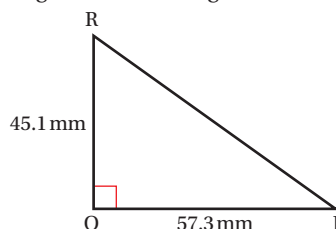
**d** angle K = 41.2°    angle L = 48.8°



**e** angle N = 46.3°    angle M = 43.7°    MO = 24.15 cm



**f** angle P = 38.2°    angle R = 51.8°    length PR = 72.92 mm



**EXERCISE 36D**

**1**

Angle $\theta$	$\sin \theta$	$\cos \theta$	$\tan \theta$
0°	0	1	0
30°	$\frac{1}{2}$	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{3}}$
45°	$\frac{1}{\sqrt{2}}$	$\frac{1}{\sqrt{2}}$	1
60°	$\frac{\sqrt{3}}{2}$	$\frac{1}{2}$	$\sqrt{3}$
90°	1	0	$\tan 90^\circ$ is undefined

**2 a** 1      **b**  $\sqrt{2}$       **c**  $\sqrt{3}$

**EXERCISE 36E**

- 1 a** 35° angle of depression
- b** 20° angle of elevation
- c** 40° angle of elevation
- d** 64° angle of elevation
- 2** 560.2 m
- 3** 31.5 m
- 4** option A

- 5 a 567.1 m      b 575.9 m  
 6 3.7 m  
 7 35.8 m  
 8 34.3 m  
 9 a 27.6 m (to 1 dp)  
 b It will reduce by  $13.9^\circ$  to  $46.1^\circ$   
 10 a 6.99 m      b 4.72 m  
 11 44.5 m  
 12 a She would use the tan ratio to get a height of 3.64 m (and then add the height of her eye above the ground).  
 b  $10.3^\circ$

### CHAPTER REVIEW

- 1 option A  
 2 10.9 m  
 3 4.3 m  
 4  $78.5^\circ$   
 5 a  $h$  is the side opposite the angle. 1.2 m is the side adjacent.  

$$\tan 35^\circ = \frac{h}{1.2}$$
 So  $\tan 35^\circ \times 1.2 = h$   
 $h = 0.84$  m  
 b  $\tan 35^\circ = \frac{H}{2.4}$   
 so  $\tan 35^\circ \times 2.4 = H$   
 $H = 1.68$  m (double  $h$ )  
 6 56.41 m  
 7 As the triangles are similar angle  $B = x$ . In triangle ABC  

$$\sin x = \frac{3.2}{4} = 0.8$$

## 37 Graphs of other functions and equations

### BEFORE YOU START ...

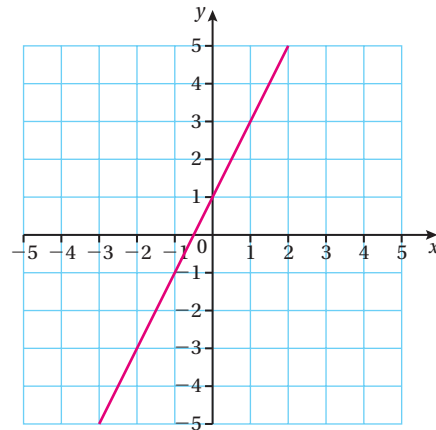
- 1 a 3      b (0,1)      c  $x = -5$   
 d  $2y - 6x = -4$  becomes  $y = 3x - 2$  (make  $y$  the subject and divide both sides by 2)  
 2 The gradient is 3 identical to  $y = 3x + 1$  therefore, the two lines are parallel.

$x$	-2	-1	0	1	2
$y$	13	4	1	4	13

- 3 a  $x = -4$        $x = 2$       b  $x = -1, x = -4$   
 4 a 8      b 64      c 5      d -3

### LAUNCHPAD

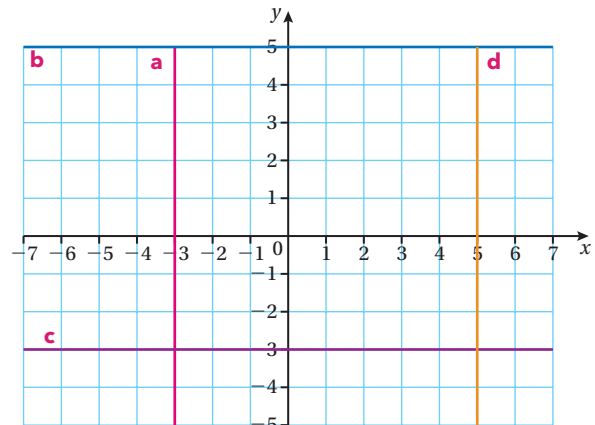
- 1 Three points will give a good fit, although a straight line requires two points to be defined.  
 2  $y = 2x + 1$  is a linear equation with a gradient of 2 and a  $y$ -intercept of 1; using two points on the line (0, 1) and (1, 3).



- 3 a  $y = -x^2 + 1$   
 b the coefficient of  $x^2$  is negative which means the parabola will have a vertex that is a maximum  
 c Maximum      d Vertex (0, 1)      e  $x = -1$  and  $x = 1$   
 4 a cubic equation  
 b at least 5 values, including half values of  $x$   
 5 a  $\frac{1}{0}$  cannot be calculated, undefined  
 b  $y$  gets smaller      c  $\frac{1}{60}$

### EXERCISE 37A

- 1 B  
 2 a D  
 b B  
 c B, C and/or D  
 d C  
 e A  
 3 A  $y = x - 6$   
 B  $y = -x$   
 C  $y = 6x$   
 D  $y = x$   
 4 a A  $x = -6$   
 B  $y = 7$   
 C  $y = -3$   
 D  $y = -4$   
 E  $x = -2$   
 F  $x = 4$   
 b  $y = 7$   
 5

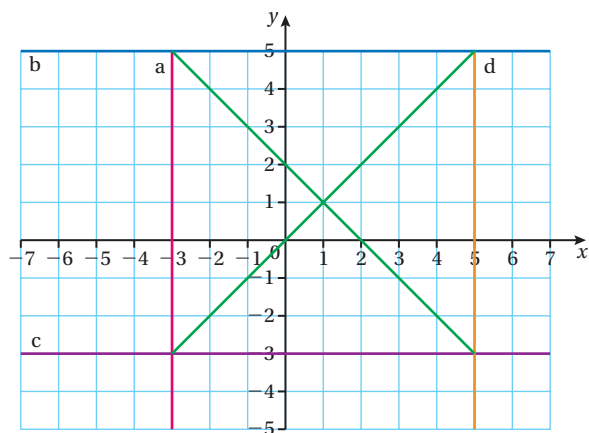


6 A square is created where the lines intersect, because all four sides are 8 units long, there are two pairs of parallel lines and four angles of  $90^\circ$ .

7 a  $x = 1$  and  $y = 1$

b A

c i

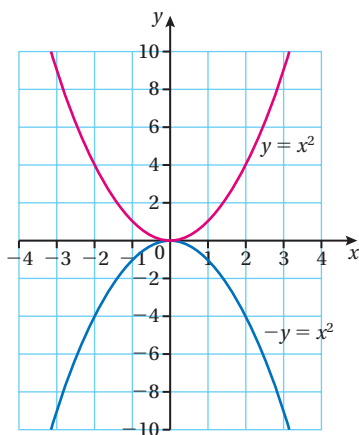


ii  $y = x$  and  $y = -x + 2$

### EXERCISE 37B

1 a  $y = x^2$  and  $y = -x^2$

$x$	-3	-2	-1	0	1	2	3
$y = x^2$	9	4	1	0	1	4	9
$y = -x^2$	-9	-4	-1	0	-1	-4	-9

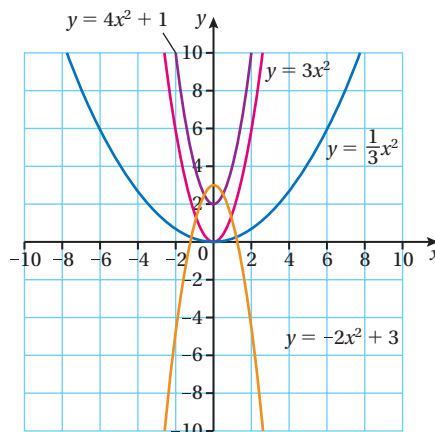


- b  $y = x^2$  goes down to a minimum turning point and up  
 $y = -x^2$  goes up to a maximum turning point and down
- c The negative sign produces a reflection of  $y = x^2$  about the  $x$ -axis.

2 B

3 a

$x$	-3	-2	-1	0	1	2	3
i $y = 3x^2$	27	12	3	0	3	12	27
ii $y = \frac{1}{3}x^2$	3	$\frac{4}{3}$	$\frac{1}{3}$	0	$\frac{1}{3}$	$\frac{4}{3}$	3
iii $y = 4x^2 + 1$	37	17	5	1	5	17	37
iv $y = -2x^2 + 3$	-15	-5	1	3	1	-5	-15



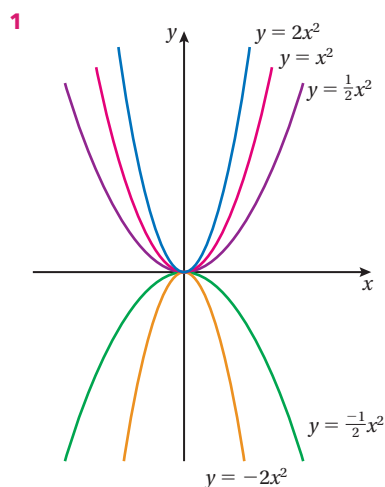
- b In graph iii the constant value of 1 gives the  $y$ -intercept of  $(0, 1)$ .  
 In graph iv the constant value of 3 gives a  $y$ -intercept of  $(0, 3)$ .

### EXERCISE 37C

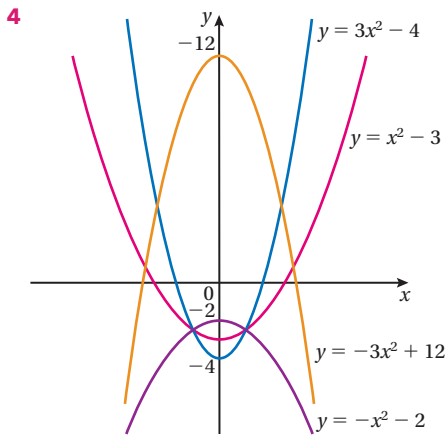
Graph	Turning point	Axis of symmetry	$y$ intercept	$x$ intercepts
a	$(0, 2)$ Minimum	$x = 0$	$(0, 2)$	none
b	$(0, 0)$ Minimum	$x = 0$	$(0, 0)$	$(0, 0)$
c	$(0, 6)$ Maximum	$x = 0$	$(0, 6)$	$(2.5, 0)$ $(-2.5, 0)$
d	$(0, 6)$ Maximum	$x = 0$	$(0, 6)$	$(3.5, 0)$ $(-3.5, 0)$
e	$(0, 1)$ Minimum	$x = 0$	$(0, 1)$	None
f	$(0, 9)$ Maximum	$x = 0$	$(0, 9)$	$(2, 0)$ $(-2, 0)$

- 2 a False      b True      c False      d True  
 e False      f True      g True      h True

### EXERCISE 37D



- 2 The coefficient of  $x^2$  widens or narrows the basic parabola of  $y = x^2$ . The fractional value widens the graph.
- 3 a  $x = 2$  and  $x = -2$       b  $x = 3$  and  $x = -3$



- 5 a  $y = 6x^2$     b  $y = x^2 + 4$     c  $y = \frac{1}{2}x^2$     d  $y = -x^2 + 2$   
 e  $y = x^2 - 1$     f  $y = -7x^2$

**EXERCISE 37E**

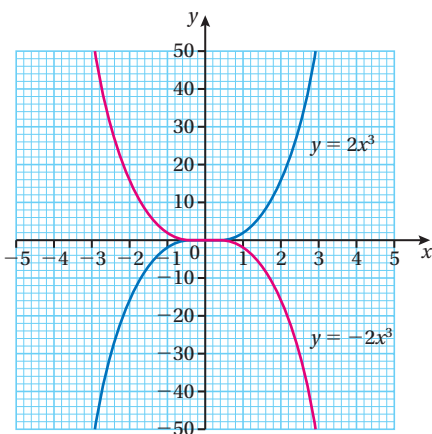
1

x	-3	-2	-1	0	1	2	3
$y = -x^3$	27	8	1	0	-1	-8	-27

$y = x^3$  ranges from negative values for negative values of  $x$  to positive values for positive values of  $x$  and  $y = -x^3$  ranges from positive values for negative values of  $x$  to negative values for positive values of  $x$ .

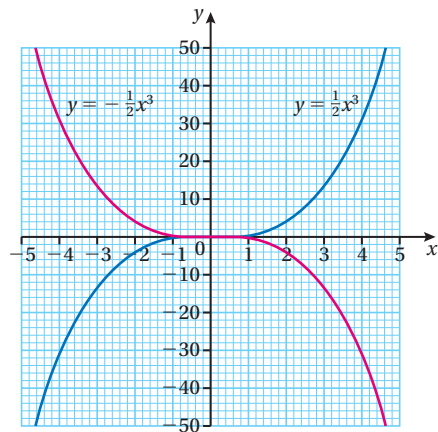
2 a

x	-3	-2	-1	0	1	2	3
$y = -2x^3$	54	16	2	0	-2	-16	-54
$y = 2x^3$	-54	-16	-2	0	2	16	54



b

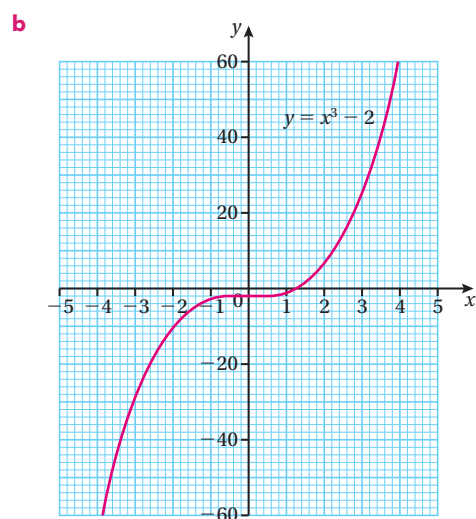
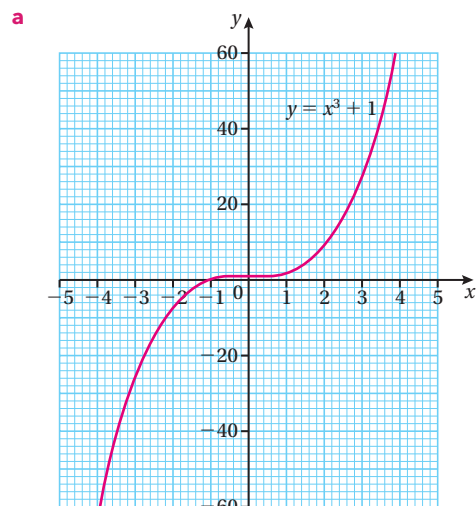
x	-3	-2	-1	0	1	2	3
$y = -\frac{1}{2}x^3$	13.5	4	0.5	0	-0.5	-4	-13.5
$y = \frac{1}{2}x^3$	-13.5	-4	-0.5	0	0.5	4	13.5



3 Given the graph of  $y = 4x^3$  if this graph is reflected about the  $y$ -axis this will produce the graph  $y = -4x^3$

4

x	-3	-2	-1	0	1	2	3
$y = x^3 + 1$	-26	-7	0	1	2	9	28
$y = x^3 - 2$	-29	-10	-3	-2	-1	6	25



- 5 a  $y = x^3 + 1$  y intercept (0, 1)    b  $y = x^3 - 2$  y intercept (0, -2)  
 6 Line A is  $y = x^3 + 5$  Line B is  $y = x^3 - 6$

### EXERCISE 37F

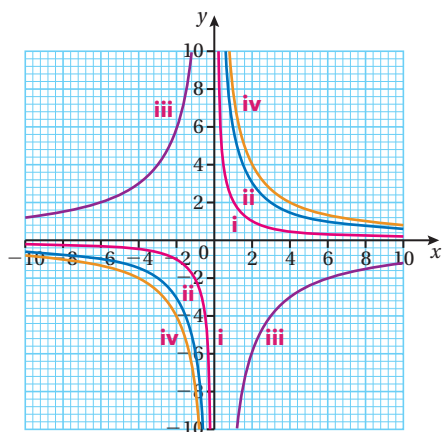
1 a

$x$	-4	-2	-1	1	2	4
$a y = \frac{2}{x}$	-0.5	-1	-2	2	1	0.5

$x$	-6	-3	-1	1	3	6
$b y = \frac{6}{x}$	-1	-2	-6	6	2	1

$x$	-10	-8	-6	-4	-2	2	4	6	8
$c .xy = -12$	1.2	1.5	2	3	6	-6	-3	-2	-1.5

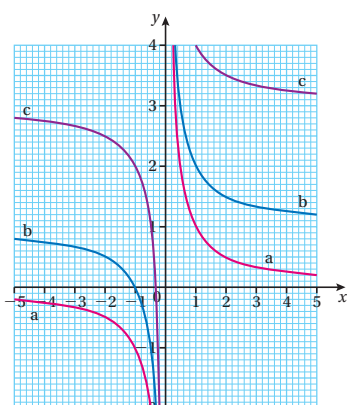
$x$	-8	-6	-4	-2	1	2	4	6	8
$d y = \frac{8}{x}$	-1	-1.33	-2	-4	8	4	2	1.33	1



2 The constant in the equations affects the graph – when it is positive it moves the graph further away from the origin. When it is negative it moves it away from the origin and the orientation changes to the 3<sup>rd</sup> and 4<sup>th</sup> quadrant.

3

$x$	-5	-4	-3	-2	-1	0	1	2	3	4	5
$a y = \frac{1}{x}$	-0.2	-0.25	-0.333	-0.5	-1	Not defined	1	0.5	0.333	0.25	0.2
$b y = \frac{1}{x} + 1$	0.8	0.75	0.667	0.5	0	Not defined	2	1.5	1.333	1.25	1.2
$c y = \frac{1}{x} + 3$	2.8	2.75	2.667	2.5	2	Not defined	4	3.5	3.333	3.25	3.2



4 The constant in  $y = \frac{a}{x} + c$  moves the graph  $y = \frac{a}{x}$  the graph in a vertical direction

5 Neo is correct  $y = x$  is a line of reflective symmetry for the graph  $y = \frac{1}{x}$

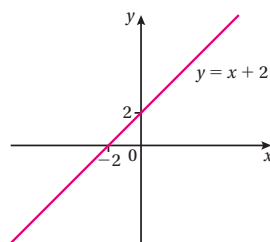
### EXERCISE 37G

1 a True      b True      c True      d True

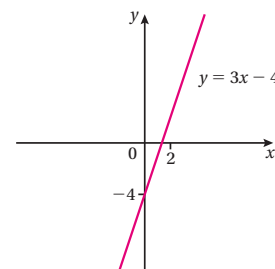
e False. The graph of  $y = -2x^2 + 4$  goes up to a **maximum** turning point with a  $y$ -intercept at  $(0, 4)$ .

f True

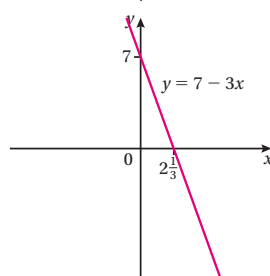
2 a



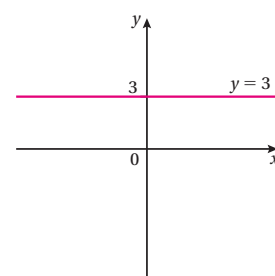
b



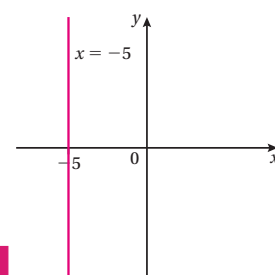
c



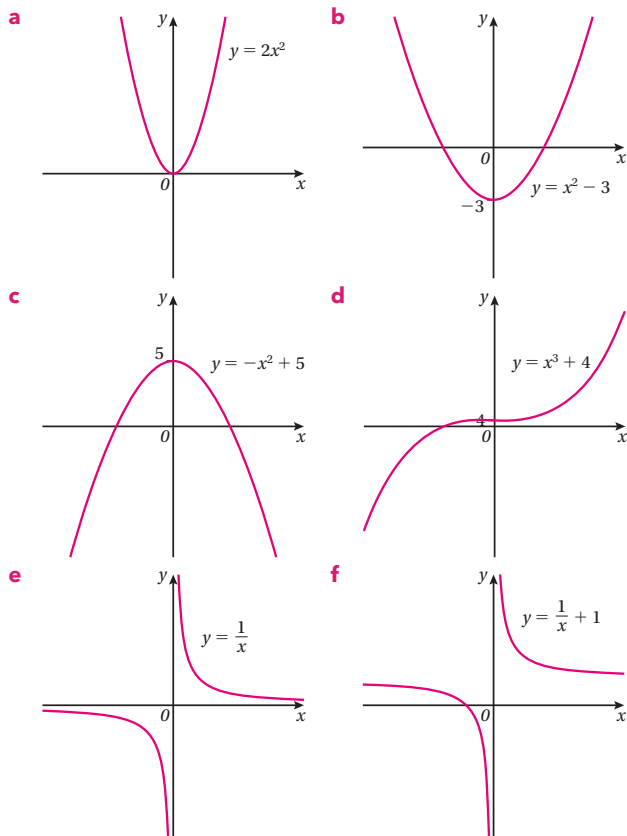
d



e



$x$	-3	-2	-1	0	1	2	3
<b>a</b> $y = 2x^2$	18	4	2	0	2	4	18
<b>b</b> $y = x^2 - 3$	6	1	-2	-3	-2	1	6
<b>c</b> $y = -x^2 + 5$	-4	1	4	5	4	1	-4
<b>d</b> $y = x^3 + 4$	-23	-4	3	4	5	12	31
<b>e</b> $y = \frac{1}{x}$	-0.333	-0.5	-1	Not Defined	1	0.5	0.333
<b>f</b> $y = \frac{1}{x} + 1$	0.667	0.5	0	Not defined	2	1.5	1.333

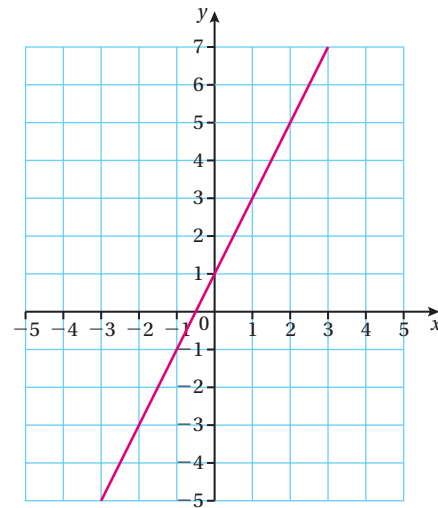


- 4 a**  $x = 4$  and  $x = -4$   $x$ -intercepts  $(-4, 0)$  and  $(4, 0)$   
**b**  $x = 0$  and  $x = 2$   $x$ -intercepts  $(0, 0)$  and  $(2, 0)$   
**5**  $(-3, 0)$  and  $(5, 0)$   
**6 a** **viii**  $y = -4$   
**b i**  $y = x^2 - 2$   
**c iii**  $xy = 1$   
**d iv**  $y = -x$   
**e ii**  $y = 3x - 4$   
**f vii**  $x = 4$   
**g ix**  $y = -x^2$   
**h v**  $y = 2x^3$   
**i vi**  $y = 3x^3 + 3$

### CHAPTER REVIEW

**1 a**  $y = 2x + 1$

$x$	-2	-1	0	1	2	3
$y$	-3	-1	1	3	5	7

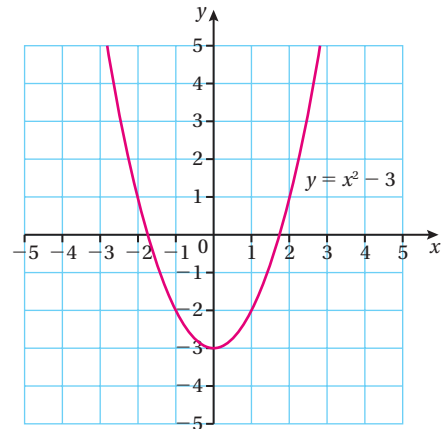


**b i** when  $x = -1.5$   $y = -2$       **ii** when  $y = 6$   $x = 2.5$

**2 a**

$x$	-2	-1	0	1	2
$y$	1	-2	-3	-2	1

**b**

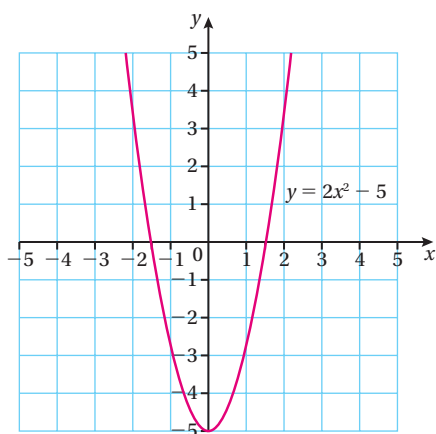


**c**  $x = 1.9$  (1 dp) and  $x = -1.9$  (1 dp)



3 a  $y = 2x^2 - 5$

x	-2	-1	0	1	2
y	3	-3	-5	-3	3

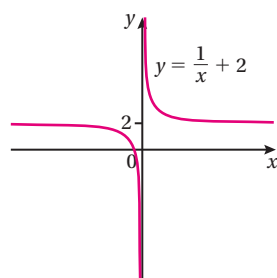
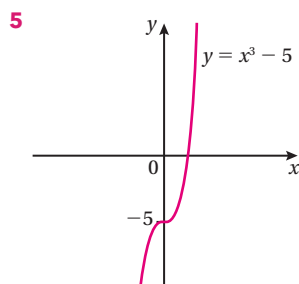


b minimum point (0, -5)

c  $x = 0$

d  $x = 1.6$  (1 dp) and  $x = -1.6$  (1 dp)

4 a  $y = \frac{1}{x}$       b  $y = x^3$



6 (1, 0) and (-3, 0)

## 38 Growth and decay

### BEFORE YOU START ...

- 1 a 0.05      b 1.9      c 0.004      d 0.125  
 2 a £204      b \$1.6      c £2.52      d \$741  
 e £1532.30  
 3 a \$53.68      b £36.93      c £7.28      d \$156.40

### LAUNCHPAD

- 1 £520  
 2 £573.76  
 3 a 3.1 g      b 28 years

### WORK IT OUT 38.1

Student B and Student C are correct. Student A has used simple percentage increase, but it should be compound

## EXERCISE 38A

1

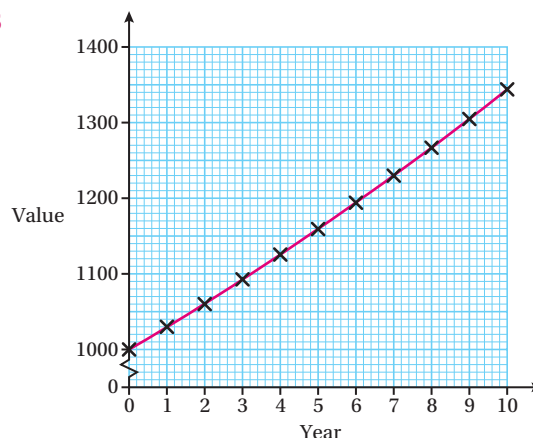
Investment (£)	Interest Rate (%)	1 year	2 years	6 years	n years
250	2	£255	£260	£280	$£250 \times (1 + 0.02n)$
1500	4.5	£1567.50	£1635	£1905	$£1500 \times (1 + 0.045n)$
50	3	£51.50	£53	£59	$£50 \times (1 + 0.03n)$

2 a £306      b £318.36      c £351.50

3 option C

4 option C

5



6 Option C

7 a 5 444 617      b 844 617      c 4 447 500

These population levels are too accurate, they should be rounded, most likely to the nearest 10 000.

8 £668.68

9 4 months. Working needs to be shown

Month 1  $£200 + 8\% = £216$

Month 2  $£216 + 8\% = £233.28$

Month 3  $£233.28 + 8\% = £251.94$

Month 4  $£251.94 + 8\% = £272.10$

10 After 1 year 40 mussels, 2 years 720, 3 years 13 700, 4 years 260 000, 5 years 4 940 000, 6 years 94 000 000 million, 7 years 2560 million, 8 years 51 200 million, 9 years 1 024 000 million, 10 years 20 480 000 million.

With no outside influences the biologist should be concerned as the predicted spread is large. They should carry out further studies. It is unlikely that the initial 2 mussels are the only ones in the lake.

11 Over 5 years simple interest will get a total of 30%, compound interest 30.70% - compound better.

Over 4 years simple interest will get a total of 24%, compound interest 23.88% - simple better.

12 a no      b £213.13

c one more month with £200 saving plus interest will cover this (£2789.48)

13 a Cost rose by 160%      b £1.69

c annually rise of 3.3%      d over £1 in 2023

- 14 a** \$12 899.46  
**b** Rate of 6.29% (2 dp)
- 15** £296 023.73
- 16** Model B is best. Model A 12.476%, Model B 12.4864%  
 Model C 12.3%
- 17** 15 hours

### WORK IT OUT 38.2

Student B and Student C are correct, but Student C has used the most efficient method. Student A has used simple percentage increase instead of compound.

### EXERCISE 38B

- 1** option D  
**2** option A  
**3 a** £10120    **b** £8565.57    **c** £5645.41  
**4**

Initial Cost	Depreciation Rate	1 year	2 years	6 years
£400	2%	£392	£384.16	£354.34
£2500	15%	£2125	£1806.25	£942.87
£50 000	3.5%	£48 250	£46 561.25	£40 376.98

- 5** 724 g  
**6** Graph B  
**7 a** 20% drop    **b** 1342    **c** 20 hours  
**8** 685.7 Pa  
**9 a** 7 137 564    **b** 10 years  
**10** 5% loss each year; 8 years to cost less than two-thirds of today's price.

### CHAPTER REVIEW

- 1 a** £85    **b** £765    **c** £153  
**d** £38.25    **e** £153
- 2**  $5000 \times 1.032^3 = £5495.52$
- 3** £2903.69  
**4** £4188.80  
**5** 9