



Unless otherwise stated, all answers are given to 3 significant figures and angles are given to 1 decimal place.

1 Number and language

Exercises 1.1–1.5

- 1 a $5: 5^2$
b 2, 2, 2, 2, 3: $2^4 \times 3$
- 2 a $\frac{7}{2}$
b $\frac{5}{13}$
- 3 11.15 a.m.
- 4 Many possible pairs, e.g. 6 and 12, or 6 and 18, or 12 and 18, etc.

Exercise 1.6

- 1 a Irrational
b Rational

Exercises 1.7–1.10

- 1 a $\frac{7}{3}$
b $\frac{5}{2}$

Exercise 1.11

- 1 1700 m



2 Accuracy

Exercises 2.1–2.3

- 1 a 15.0
b 0.04
c 3.049
- 2 a 19 050
b 19 100
c 19 000
d 20 000

Exercise 2.4

- 1 a Approx 7.7 as $\sqrt{49} = 7$ and $\sqrt{64} = 8$
b Approx 5.3 as $\sqrt[3]{125} = 5$ and $\sqrt[3]{216} = 6$

Exercise 2.5

- 1 $119.5 \leq h < 120.5$
- 2 70.5×12.5

Exercise 2.6

- 1 a 355.25, 395.25
b 2741.25, 2891.25
c 4497.75, 5502.75
d $0.\dot{5}$, 1
e 1.98, 2.03 (2 d.p.)
- 2 a 16.4, 16.6
b 28.4375, 29.6475
c 484.7575, 495.2475
d 0.04, 0.16
- 3 27.72, 29.13 (2 d.p.)

Exercise 2.7

- 1 18.7975, 19.6875 km²
- 2 10.460125 km, 12.070 125 km



3 Calculations and order

Exercises 3.1–3.2

1 0.055, 0.505, 0.550, 5.005, 5.500

2 4%, $\frac{2}{9}$, $\frac{3}{8}$, 0.4, 61%, 0.614,

Exercises 3.3–3.5

1 $15 \div (3 + 2) \div 2 = 1.5$

Exercise 3.6

1 a If n is the number of weeks: $2.5n = 15$

b $n = 6$. Therefore after 6 weeks Pavel has 15 packets



4 Integers, fractions, decimals and percentages

Exercises 4.1–4.4

1 a i 3.45

ii $\frac{69}{20}$

b i 7.76

ii $\frac{194}{25}$

Exercises 4.6–4.10

1 $-2\frac{1}{30}$

2 a $\frac{17}{20}$

b $1\frac{1}{4}$

c $8\frac{9}{25}$

Exercise 4.11

1 a $\frac{17}{30}$

b $1\frac{139}{450}$

2 $\frac{38}{99} - \frac{23}{90} = \frac{127}{990}$



5 Further percentages

Exercises 5.1–5.3

- 1 87.5%
- 2 35
- 3 77.7% (1 d.p.)

Exercise 5.5

- 1
 - a \$450
 - b \$620
 - c 340%
 - d 160%
- 2 260
- 3 225
- 4 4 cm



6 Ratio and proportion

Exercises 6.2–6.4

- 1 a $\frac{5}{9}$
b 1 kg
- 2 $80^\circ, 160^\circ$
- 3 4 hrs
- 4 The 375 g packet is better value as 1 g costs 0.325 cents, whilst with the 625 g packet 1 g costs 0.336 cents

Exercise 6.7

- 1 a 10.44 m/s (2 d.p.)
b 37.58 km/h (2 d.p.)
- 2 0.026 people/km²
- 3 401 mm



7 Indices, standard form and surds

Exercises 7.1–7.4

1 $2 \times 7^4 \times 11^2$

2 16^{-1}

3 0.03

4 4

5 6

6 a 2

b 7

Exercises 7.5–7.6

1 4.63×10^8

2 3.67×10^{-10}

3 5

4 2.5×10^2

5 a 1.325×10^6

b 4.748×10^5

6 2.925×10^{10}

Exercise 7.7

1 7

2 15

3 5

4 100

5 7

6 5

7 3

8 12

Exercise 7.8

1 $\frac{1}{4}$

2 1

3 $\frac{1}{2}$

4 $\frac{1}{8}$

5 $\frac{1}{2}$

6 1

7 11

8 1

9 $\frac{1}{32}$

10 $\frac{1}{3^7} = \frac{1}{2187}$

Exercise 7.9



- 1 a $3\sqrt{5}$
b $4\sqrt{5}$
c $\frac{1}{2}$
- 2 a $4\sqrt{3}$
b $5\sqrt{5}$
- 3 a $\frac{4\sqrt{5}}{5}$
b $\frac{3+\sqrt{3}}{2}$
- 4 $(3 + 3\sqrt{5})\text{cm}$



8 Money and finance

Exercise 8.1

1 €6.17

Exercises 8.2–8.4

1 a Option 1: \$1275 extra

Option 2: \$4180 extra

b e.g. The customer may not be able to afford the initial deposit

Exercise 8.5

1 23 years

Exercise 8.6

1 a £162 067.50

b \$153 390.49

2 20.6%



9 Time

Exercise 9.1

- 1 05:51
- 2 a 2 hrs, 21 mins and 54 secs
b 3 minutes
- 3 a 14:50
b 06:50
- 4 604 800 seconds
- 5 13 May
- 6 Tuesday at 23:27



10 Set notation and Venn diagrams

Exercise 10.1

- 1 a Capital cities
- b Student's two capital cities

Exercise 10.2

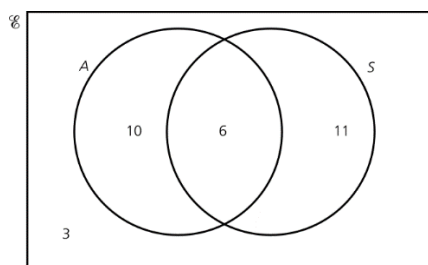
- 1 $B = \{2, 3, 5, 7\}$
- 2 $\{a, b, c\}, \{a, b\}, \{a, c\}, \{b, c\}, \{a\}, \{b\}, \{c\}, \emptyset$

Exercise 10.3

- 1 Girls' names not beginning with the letter A
- 2 a Even numbers up to 20
- b Multiples of 3 up to 18
- c i True
- ii False
- 3 a i Even numbers up to 30
- ii Multiples of 3 up to 30
- iii Multiples of 5 up to 30
- b i $\{6, 12, 18, 24, 30\}$
- ii $\{3, 5, 6, 9, 10, 12, 15, 18, 20, 21, 24, 25, 27, 30\}$
- iii $\{30\}$
- iv $\{5, 15, 25\}$
- 4 a i $\{2, 3, 4, 5, 6, 7, 8, 9, 10, 12\}$
- ii $\{3, 4, 9, 12\}$
- b Z

Exercise 10.4

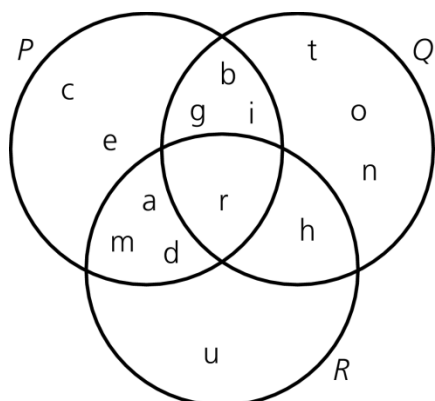
- 1 a



- b i 6
- ii 3



2 a



b i {b, r, i, g, h, t, o, n, d, u, a, m}

ii {r}

Exercise 10.5

1 a i $z = 1$

ii $x = 6$

iii $y = 0$

b 14



11 Algebraic representation and manipulation

Exercises 11.1–11.3

- 1 a $-5x - 20$
b $10x - \frac{1}{2}$
c $14 - x$
- 2 a $6q - 13qr - 6$
b $a^2 + 12a + 32$
c $jk - jm + k^2 - km$

Exercise 11.4

- 1 $21x(2x - y^2)$
2 $m(m^2 - mn - n^2)$

Exercise 11.5

- 1 a 24
b -124

Exercise 11.6

- 1 a $b = \frac{c+d}{a}$
b $q = \frac{p}{(s+r)}$

Exercise 11.7

- 1 $4d^2 - 9$
2 $9e^2 - 49$
3 $4f^2 - 9g^2$
4 $16 - 25h^2$
5 $6x^2 + x - 1$
6 $3x^3 - 8x^2 - 20x + 16$
7 $8x^3 - 14x^2 + 7x - 1$

Exercise 11.8

- 1 $(a + b)(c + 1)$
2 $(3d + 4e)(c + 1)$
3 $(f - 6)(g - 4)$
4 $(p - 2r)(p - 2q)$
5 $(4m + 11)(4m + 11n)$

Exercise 11.9

- 1 $(4m - 11n)(4m + 11n)$
2 $(x^3 - y^3)(x^3 + y^3)$
3 $9(a - 2b)(a + 2b)(a^2 + 4b^2)$
4 $(9m - 4n)(9m + 4n)$



Exercise 11.10

- 1 $(17 - 16)(17 + 16) = 33$
- 2 $(3^2 - 1)(3^2 + 1) = 8 \times 10 = 80$
- 3 $(98 - 2)(98 + 2) = 96 \times 100 = 9600$

Exercise 11.11

- 1
 - a $(a + 3)(a + 2)$
 - b $(b - 5)(b + 2)$
 - c $(c - 8)(c - 2)$
 - d $(d - 9)(d - 9)$ or $(d - 9)^2$
- 2
 - a $(2e + 1)(e + 1)$
 - b $(3f - 2)(f + 1)$
 - c $(2g + 1)(g - 1)$
 - d $(3h + 2)(3h - 2)$
 - e $(j + 2k)(j + 2k)$ or $(j + 2k)^2$

Exercises 11.12–11.13

- 1 $a = \frac{pr}{2xq}$
- 2 $a = \pm \sqrt{\frac{6}{m}}$
- 3 $a = \left(\frac{bt}{2r}\right)^2$
- 4 $a = \frac{2p\sqrt{b}}{t}$
- 5 $a = \left(\frac{3b^2}{2c}\right)^2$

Exercise 11.14

- 1 $r = \frac{C}{2\pi}$
 $r = 2.99$, so the radius is 2.99 cm (3 s.f.)
- 2 $r = \sqrt{\frac{A}{\pi}}$
 $r = 5.0$ cm (1 d.p.)
- 3 $p = \frac{A}{l}$
 $p = 6$ cm
- 4 $h = \frac{A}{2\pi r} - r$
 $h = 6.97$, so the height is 6.97 cm (3 s.f.)
- 5 $h = \frac{V}{\pi r^2}$
 $h = 10.0$, so the height is 10.0 cm (3 s.f.)

Exercise 11.15

- 1 $4a$
- 2 $15de$
- 3 6



4 $4xy$

Exercises 11.16–11.17

1 $\frac{3a+4b}{12}$

2 $\frac{c}{12}$

3 $\frac{10f}{9}$

4 $\frac{-5e}{21}$

Exercise 11.18

1 $\frac{3p+5}{(p+3)(p-1)}$

2 $\frac{a}{b}$

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

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

5 a



12 Algebraic indices

Exercises 12.1–12.2

1 $p^7 \times q^9 \times r$

2 a a^2c^8

b $24b^9$

3 a $108a^{14}$

b $(pq)^{m+3}$

c x^{10}

d 1

Exercise 12.3

1 a $a^{\frac{5}{4}}$

b $a^{\frac{7}{2}}$

2 a $(\sqrt[5]{b})^{-3}$

b $(\sqrt[9]{b})^7$

3 a $a^{-\frac{1}{12}}$

b $a^{-\frac{10}{3}}$

c $a^{-\frac{17}{6}}$



13 Equations and inequalities

Exercise 13.1

- 1 a $c = -11$
b $h = 4$

2 $j = 1$

3 $x = \frac{1}{2}$

Exercise 13.2

- 1 $220^\circ, 90^\circ, 100^\circ, 20^\circ, 110^\circ$

Exercises 13.3–13.5

- 1 a $p = 3, q = 3$
b $a = 3, b = 2$
c $h = 2.5, j = 4$
- 2 10 and 8
- 3 a $x = 8, y = -3$
b Area = 256 cm^2

Exercise 13.6

- 1 a Leda: $x - 2$, Smudge: $x + 3$
b Zach = 7 yrs, Leda = 5 yrs, Spot = 10 yrs
- 2 ± 10
- 3 a $x = 6, y = 5$
b Area = 77 cm^2 , Perimeter = 36 cm

Exercise 13.7

- 1 a $-4, 3$
b $3, 6$
c $-7, -3$
d $-2, -1$
e $-5, 7$
f $6, 7$
g ± 13
h ± 7

Exercise 13.8

- 1 $-3, -1,$
2 $-1, -\frac{1}{3}$
3 $1, -\frac{1}{5}$
4 ± 6
5 ± 3
6 No solution



7 No solution

8 $\pm\frac{1}{2}$

9 $\pm\frac{1}{4}$

10 $\pm\frac{2}{3}$

11 $\pm\frac{8}{5}$

12 No solution

Exercise 13.9

1 \$7

2 base = 12 cm, height = 10 cm

3 5 cm and 12 cm

4 23 and 24

5 6 balls

Exercise 13.10

1 $-3, -\frac{2}{3}$

2 $-3.73, -0.238$

3 $-2.69, 0.186$

4 $-1.18, 0.847$

5 $-5, \frac{3}{2}$

6 $-1, -\frac{1}{4}$

7 $-0.581, 2.58$

8 $\frac{-5 \pm \sqrt{113}}{4}$

9 $-\frac{7}{2}, \frac{1}{5}$

10 -2

Exercise 13.11

1 $x = 7$ $y = 32$

$x = 3$ $y = 8$

2 $x = -4$ $y = -3$

3 $x = 4$ $y = 1$

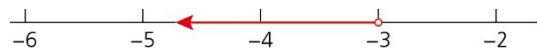
$x = -\frac{1}{2}$ $y = -8$

4 $x = 4$

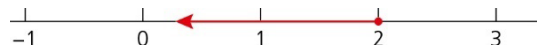
Note: $x \neq 0$ as that would imply some negative lengths

Exercises 13.12–13.13

1 $16 + 2x < 10$

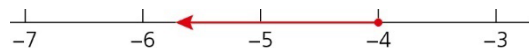


2 $19 \geq 9x + 1$

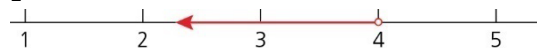




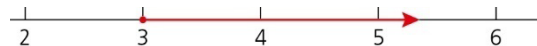
3 $1 - 3x \geq 13$



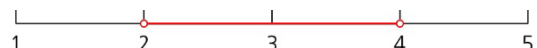
4 $\frac{1}{2}x < 2$



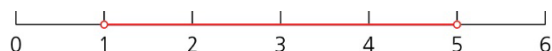
5 $\frac{1}{3}x \geq 1$



6 $8 < 4x < 16$



7 $9 < 9x < 45$



8 $4 < 2x - 6 < 10$



9 $3 \leq 2x + 1 < 9$



10 $10 \leq 2x - 5 \leq 20$





14 Graphing inequalities and regions

Exercise 14.1

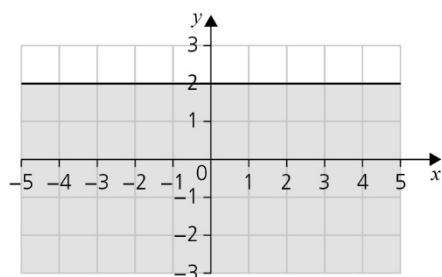
1 $x \geq 1\frac{1}{2}$

2 $x \leq 2$

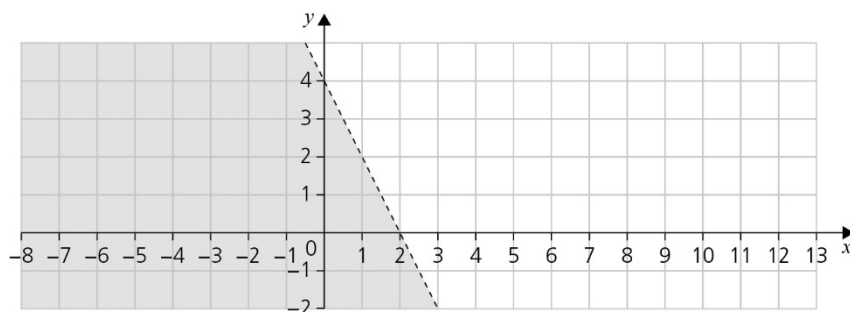
3 $-9 \leq y < -7$

Exercise 14.2

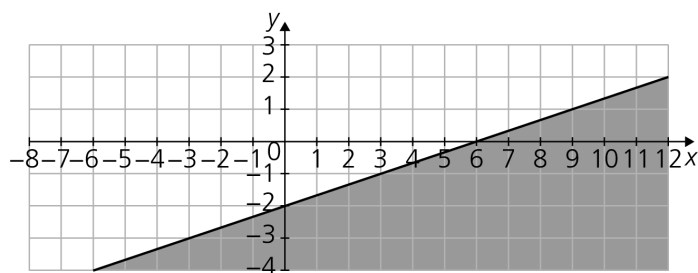
1



2

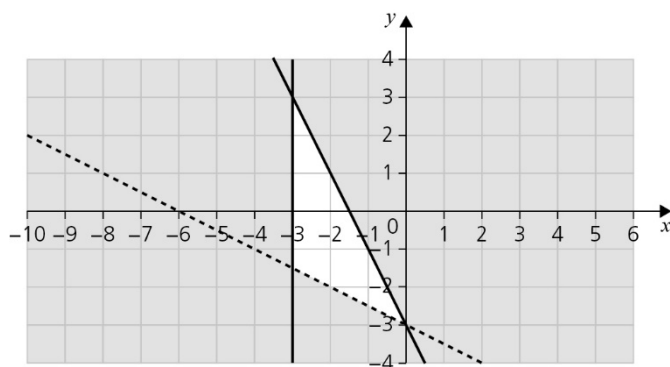


3



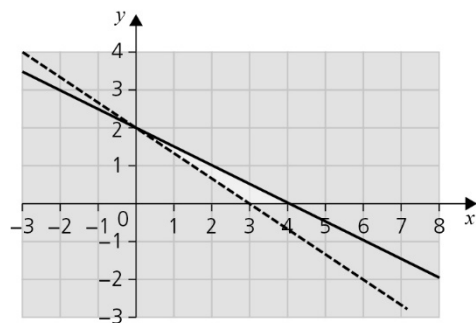
Exercise 14.3

1

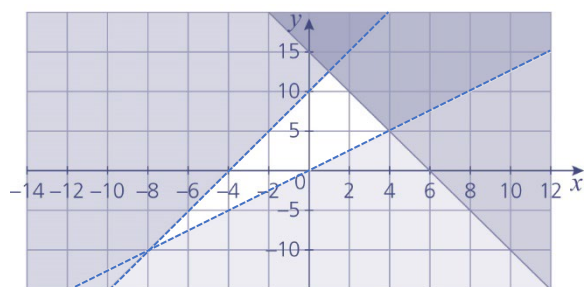




2



3





15 Sequences

Exercise 15.1

- 1 a i $d = 4$
ii $T_{n+1} = T_n + 4$
iii $T_n = 4n + 3$
iv $T_{50} = 203$
b i $d = -3$
ii $T_{n+1} = T_n - 3$
iii $T_n = -3n + 10$
iv $T_{50} = -140$
c i $d = \frac{1}{2}$
ii $T_{n+1} = T_n + \frac{1}{2}$
iii $T_n = \frac{1}{2}n - 4\frac{1}{2}$
iv $T_{50} = 20\frac{1}{2}$

Exercises 15.2–15.3

- 1 $n^2 - 2$
2 $n^3 + 2$

Exercise 15.4

- 1 4, 2
2 0.5, 0.05
3 $1, \frac{1}{10}$
4 a $T_1 = 2, T_2 = 6, T_3 = 18$
b $n = 7$
5 a $\frac{1}{4}$
b 64
c $T_n = 64 \times \left(\frac{1}{4}\right)^{n-1}$
d $\frac{1}{4096}$

Exercise 15.5

- 1 a $u_n = n(n + 1)$
b 42, 56
2 a $u_n = \frac{1}{2}n^3$
b $108, 171\frac{1}{2}$
3 a $u_n = 2^n - 2$
b 62, 126



- 4 a $u_n = 2^n + n^2$
b 100, 177



16 Proportion

Exercise 16.1

- 1 a $d = kp$
b $k = 2$
c 40
d 1
- 2 a $a = \frac{k}{b}$
b $a = \frac{1}{2}$
- 3 a $p = \frac{0.5}{q^2}$ or $p = \frac{1}{2q^2}$
b 0.02
c ± 10
- 4 $p = \frac{k}{r^{\frac{3}{2}}}$

Exercise 16.2

- 1 500

Exercise 16.3

- 1 a 1800 bhp
b 50 kg
- 2 330
- 3 2 N



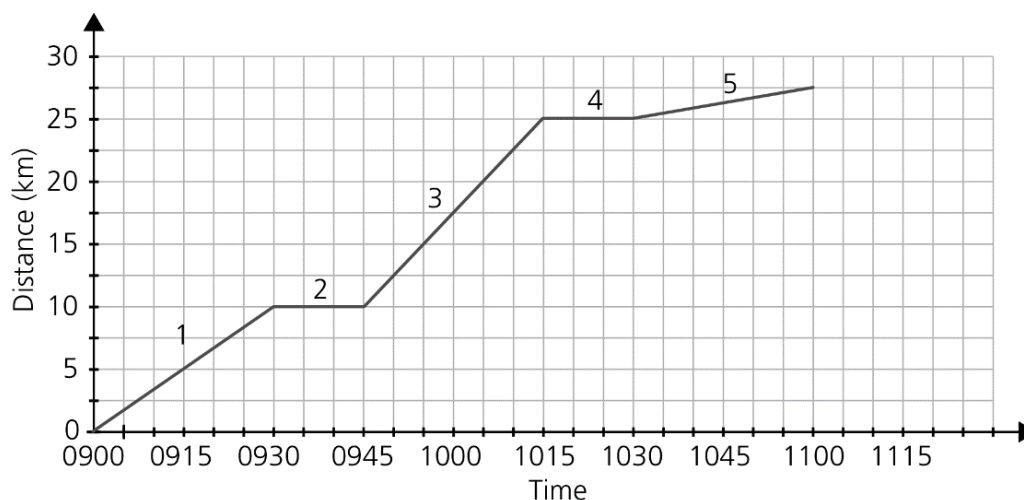
7 Graphs in practical situations

Exercise 17.2

- 1 5 m/s
- 2 124 200 m or 124.2 km
- 3 100 s

Exercises 17.3–17.4

- 1
 - a 2 m/s
 - b 12.5 m/s
 - c 175 m
 - d stationary
 - e $8\frac{1}{3}$ m/s
- 2
 - a 11:00
 - b 10 km
 - c



- d 13.75 km/h

Exercises 17.5–17.6

- 1
 - a acceleration of $\frac{5}{8}$ m/s²
 - b deceleration of $\frac{1}{4}$ m/s²
- 2
 - a Running at a constant speed of 8 m/s
 - b acceleration of 4 m/s²
 - c deceleration of $\frac{4}{3}$ m/s²

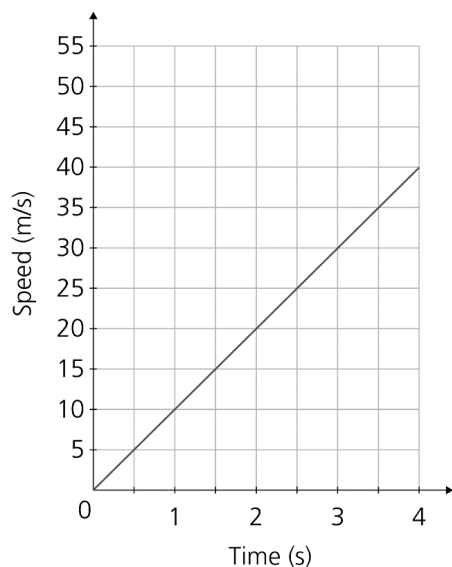


Exercises 17.7–17.8

1 a

Time (s)	0	1	2	3	4
Speed (m/s)	0	10	20	30	40

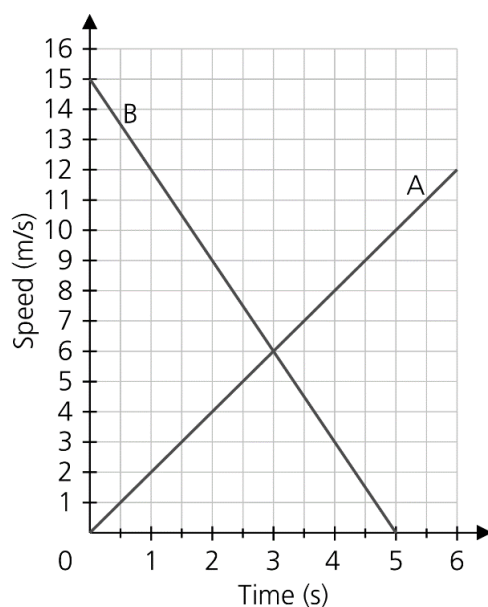
b



c 40 m

d 80 m

2 a



b 3 seconds

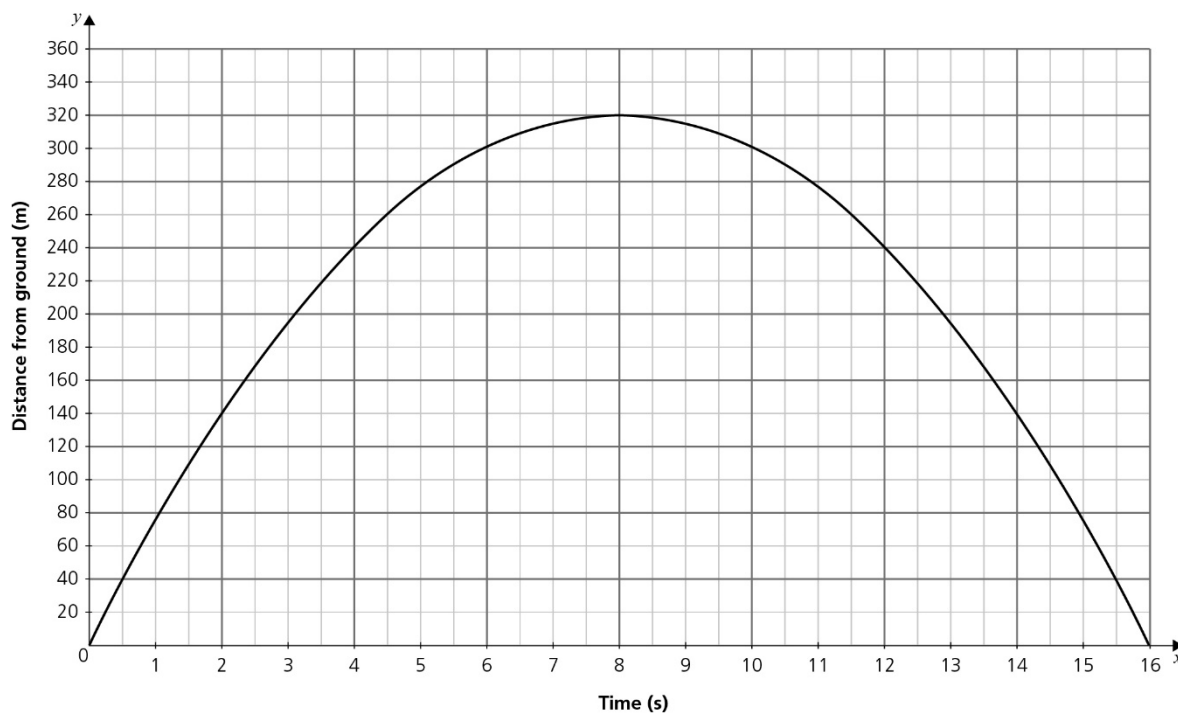
c 20 m



3 a

Time (s)	0	2	4	6	8	10	12	14	16
Distance from ground (m)	0	140	240	300	320	300	240	140	0

b



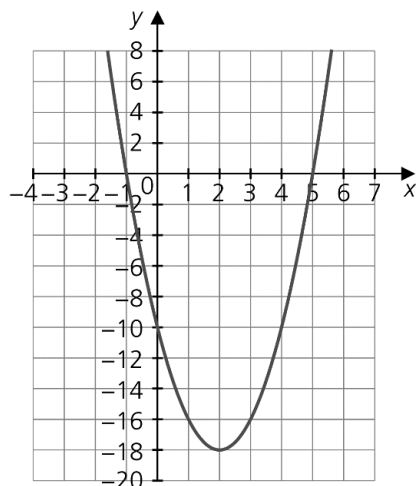
- c i Tangent drawn at $t = 2$. Gradient = 60 therefore speed = 60 m/s (student's answers may vary)
- ii Tangent drawn at $t = 8$. Horizontal line, therefore speed = 0 m/s



18 Graphs of functions

Exercises 18.2–18.3

1 a

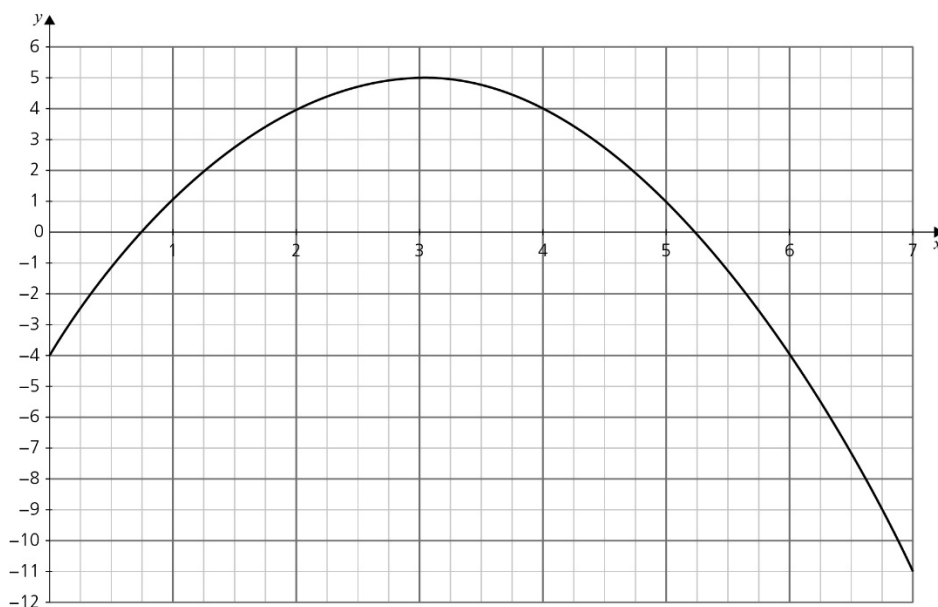


b $x = -1$ or 5

2 $x = 1$ or 3 . Find where the curve intersects the line $y = 16$.

Exercise 18.4

1 a



b $(3, 5)$

2 a i minimum

ii $(6, -4)$

b i minimum

ii $(0, -3)$

c i maximum

ii $(-8, -2)$

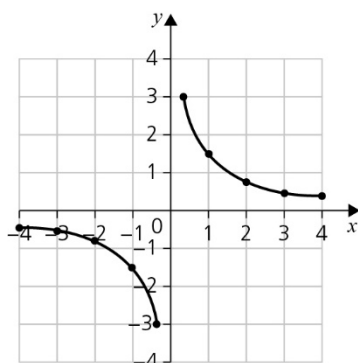


Exercise 18.5

1 a

x	-4	-3	-2	-1	-0.5		0.5	1	2	3	4
y	-0.375	-0.5	-0.75	-1.5	-3		3	1.5	0.75	0.5	0.375

b

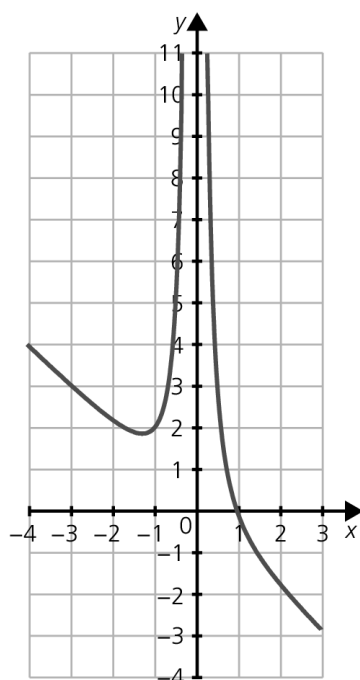


Exercises 18.6–18.7

1 a

x	-4	-3	-2	-1	-0.5		0.5	1	2	3
$f(x)$	4.1	3.1	2.3	2	4.5		3.5	0	-1.8	-2.9

b

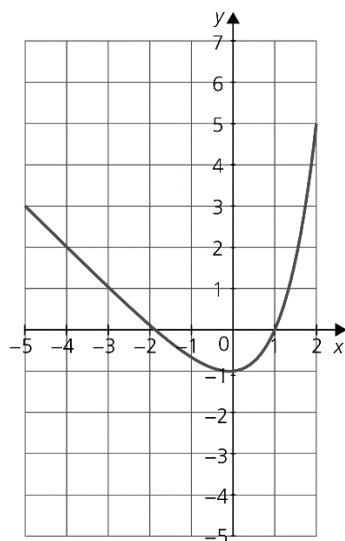




2 a

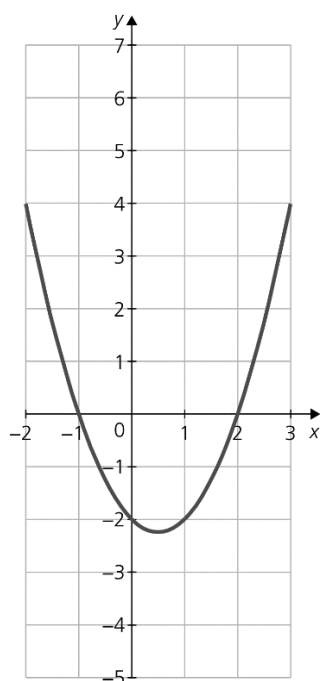
x	-5	-4	-3	-2	-1	0	1	2
$f(x)$	3.0	2.0	1.0	0.1	-0.7	-1	0	5

b



Exercise 18.8

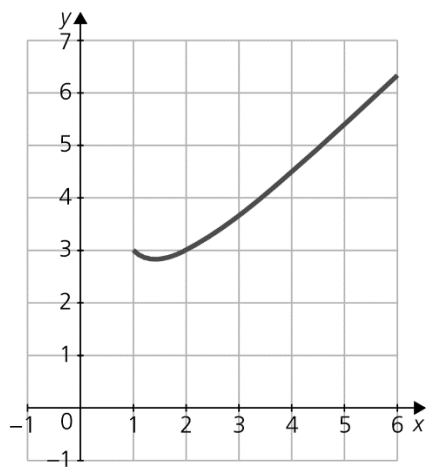
1 a



b Gradient = 3



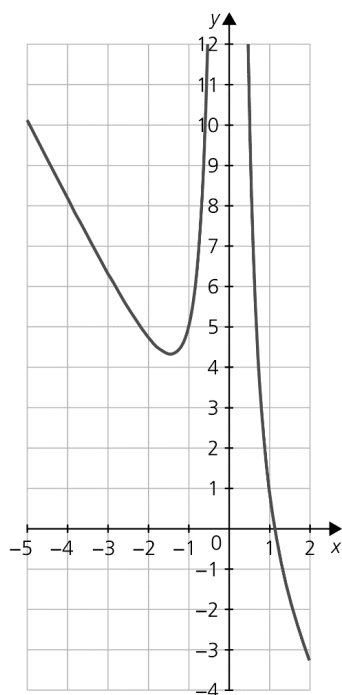
2 a



b Gradient = $\frac{1}{2}$

Exercise 18.9

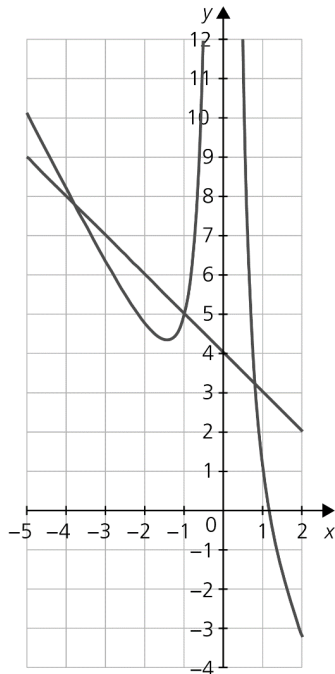
1 a





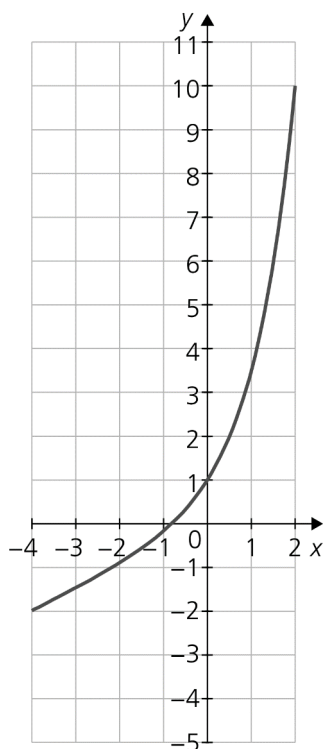
- b** Rearrange the equation to give $\frac{3}{x^2} - 2x = -x + 4$

Superimposing the graph of $y = -x + 4$ gives



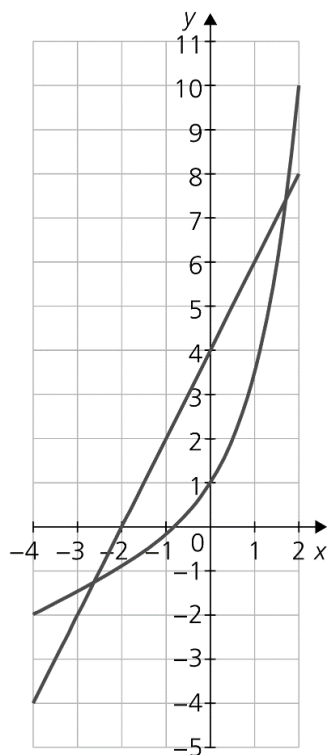
Therefore $x \approx -3.8, -1$ or 0.8

2 a



- b** Rearrange the equation to give $3^x + \frac{1}{2}x = 2x + 4$

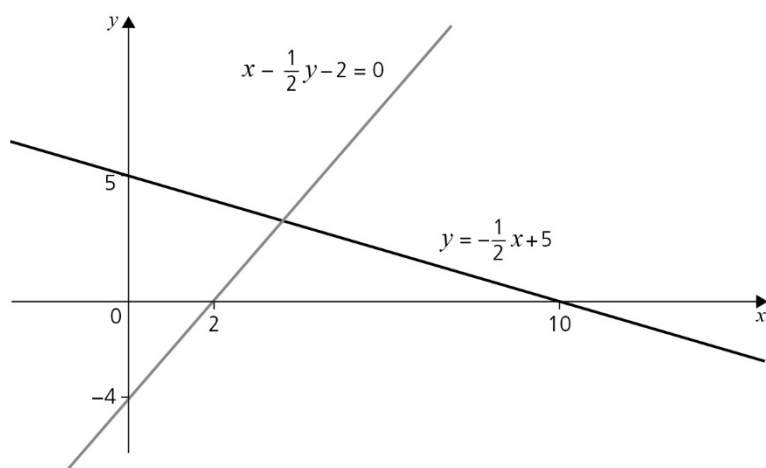
Superimposing the graph of $y = 2x + 4$ gives



Therefore $x \approx -2.6$ or 1.7

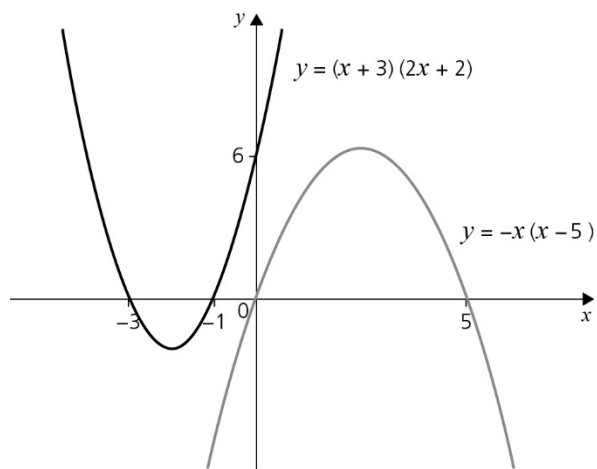
Exercises 18.10–18.11

1





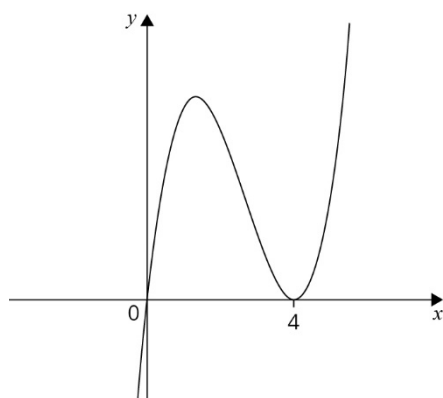
2 a



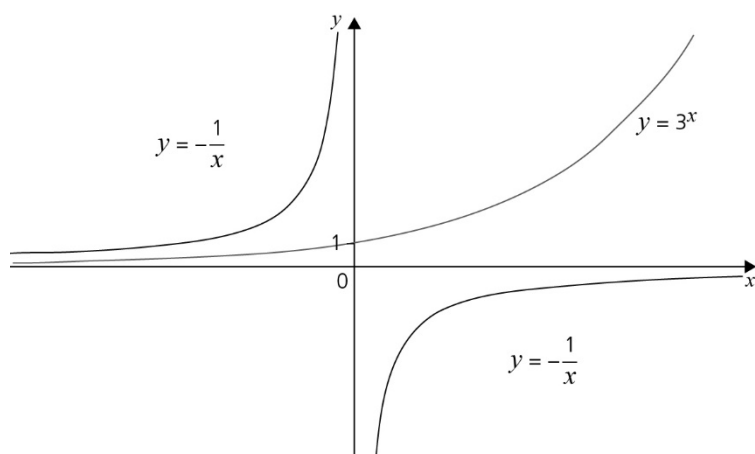
b i $(-2, -2)$

ii $(2\frac{1}{2}, 6\frac{1}{4})$

3



4





19 Differentiation and the gradient function

Exercises 19.1–19.3

- 1 a $6x^2$
b i 24
ii 54
- 2 a x^4
b i 0
ii 16

Exercises 19.4–19.5

- 1 a $\frac{3}{2}x^2$
b 18
c $\frac{2}{5}$
- 2 a $-3x^2 + 2$
b $2x^2 - 1$
c $-10x^3 + \frac{1}{2}x$
- 3 a $4x$
b $3x$
c $2x^2$
- 4 a $\frac{dv}{dr} = 2r - 4$
b $\frac{dp}{dq} = 48q^2 + 16q + 1$
c $\frac{df}{dg} = \frac{g+3}{2}$

Exercise 19.6

- 1 $\frac{d^2y}{dx^2} = 3x$
- 2 $\frac{d^2y}{dx^2} = 40x^3 - 6$
- 3 $\frac{d^2y}{dx^2} = 1 - 3x$
- 4 $\frac{d^2y}{dx^2} = 24x^2 + 12x - 2$

Exercise 19.7

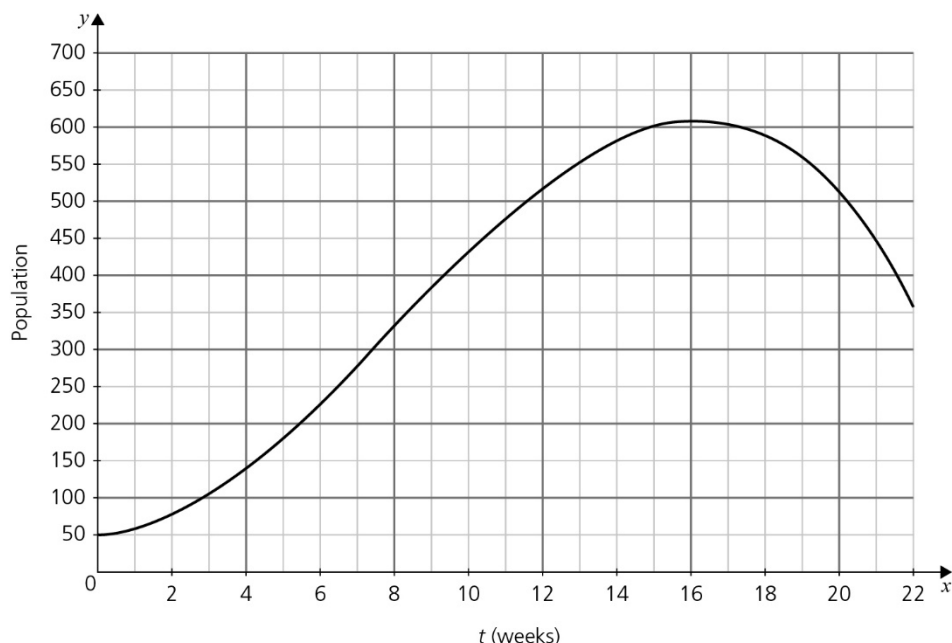
- 1 a i 50
ii 510
- b $\frac{dP}{dt} = 12t + 3 - \frac{3}{4}t^2$
- c i $44\frac{1}{4}$ rabbits/week
ii -57 rabbits/week



d

t (weeks)	0	2	4	6	8	10	12	14	16	18	20	22
Population	50	78	142	230	330	430	518	582	610	590	510	358

e



- f** When $t = 5$ the slope of the graph is positive hence the rate of change of the population with time is positive too. When $t = 20$ the slope of the graph is negative, hence the rate of change of population with time is also negative.

Exercise 19.8

1 $P = \left(7, 29\frac{1}{2}\right)$

2 $Q = (9, -26)$

3 $\left(\frac{1}{2}, \frac{47}{24}\right)$ and $\left(-4, \frac{16}{3}\right)$

4 a $-18\text{ }^{\circ}\text{C}$

b $\frac{dT}{dt} = \frac{3}{40}t^2 - \frac{7}{4}t + 10$

c i $\frac{dT}{dt} = 8.33\text{ }^{\circ}\text{C/min}$ (3 s.f.)

ii $\frac{dT}{dt} = 0\text{ }^{\circ}\text{C/min}$

- d** The freezer's temperature will continue to rise until it reaches room temperature.

As $\frac{dT}{dt} = 0$ after 10 minutes, this suggests that the freezer reaches room temperature after 10 minutes.

Therefore, $T = 19.5$, so the temperature of the room is $19.5\text{ }^{\circ}\text{C}$.

Exercise 19.9

1 a $\frac{dy}{dx} = x^2 - 4$

b $y = 5x - 18$

2 a $\frac{dy}{dx} = -4x + 10$

b $(3, 4)$



Exercise 19.10

1 a $\frac{dy}{dx} = -x^2 + 5x + 6$

b $\left(-1, -\frac{19}{6}\right)$ and $(6, 54)$

c Graph is a negative cubic



therefore $\left(-1, -\frac{19}{6}\right)$ must be the minimum point and $(6, 54)$ the maximum point.



20 Functions

Exercise 20.1

- 1 a $-2 \leq f(x) \leq 2$
b $-8 \leq f(x) \leq 12$

Exercise 20.2

- 1 a 9
b 15
c 4.5
d -3
e -15
f 1.5
- 2 a 3
b 9
c 2
d -13.5
- 3 a 6
b 1.5
c 12.5
d 8.3

Exercise 20.3

- 1 a 6
b 10
c 3.4
d 3.2
- 2 a 4
b -3
c -17
d -3.7
- 3 a -2.5
b -25
c 20
d 5.6

Exercise 20.4

- 1 a 128
b 8.21
c 176
d $7\frac{1}{4}$



e 9

2 a 49

b 287

c 5

d $-\frac{7}{9}$

3 a $-\frac{1}{4}$

b -79

c -24

d $-10\frac{1}{4}$

Exercise 20.5

1 a $3x + 7$

b $6x - 2$

c $6x^2 + 1$

d $\frac{3x}{2} + 7$

2 a $18x^2 - 1$

b $\frac{x^2}{8} - 1$

c $4x - 1$

d $2x^2 - 20x + 49$

Exercise 20.6

1 a $f^{-1}(x) = x - 4$

b $f^{-1}(x) = \frac{x}{5}$

c $g^{-1}(x) = \frac{x+5}{3}$

d $g^{-1}(x) = \frac{2(x+1)}{5}$

e $g^{-1}(x) = \frac{5x+6}{4}$

Exercise 20.7

1 a 3

b 1

2 a 1

b -2

3 6

4 -1

Exercise 20.8

1 a $fg(x) = 2(x + 4)$

b $fg(x) = x$

2 a $pq(x) = 2(x + 1)$



b $pq(x) = 2x + 1$

3 a $jk(x) = \frac{x-1}{2}$

b $jk(x) = 3x - 7$

4 a 6

b no solution



21 Straight-line graphs

Exercises 21.6–21.8

- 1 a gradient = 1
b $y = x - 2$

Exercise 21.9

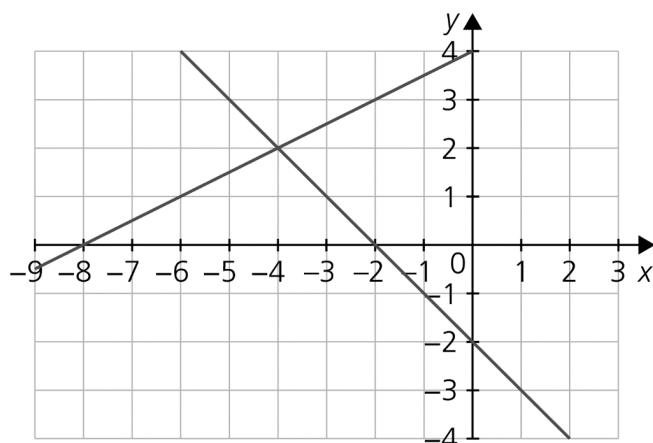
- 1 a gradient = 4 y-intercept = -2
b gradient = -2 y-intercept = -6
2 a gradient = $-\frac{1}{2}$ y-intercept = 3
b gradient = -3 y-intercept = 4

Exercise 21.10

- 1 $y = 3x + 8$
2 $y = -2x + 9$

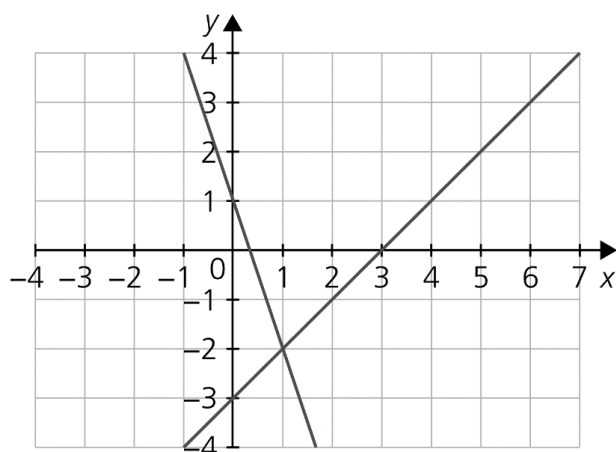
Exercises 21.11–21.12

- 1 a



- b $x = -4$ and $y = 2$

- 2 a



- b $x = 1$ and $y = -2$

Exercise 21.13



- 1 a 6
b (7, 6)
- 2 a 5.39 (3 s.f.)
b $(\frac{1}{2}, 6)$
- 3 a 7.21 (3 s.f.)
b (1, -2)
- 4 a 9.06 (3 s.f.)
b $(0, 1\frac{1}{2})$

Exercise 21.14

- 1 $y = \frac{1}{2}x - 4$
- 2 $y = -2x + 6$
- 3 $y = 7$
- 4 $y = -\frac{1}{2}x$
- 5 $x = \frac{1}{2}$
- 6 $y = -\frac{1}{3}x - 4$

Exercise 21.15

- 1 a 2
b $-\frac{1}{2}$
c $y = -\frac{1}{2}x + 7$
- 2 a $\frac{5}{2}$
b $-\frac{2}{5}$
c $y = -\frac{2}{5}x - \frac{11}{5}$
- 3 a $-\frac{3}{2}$
b $\frac{2}{3}$
c $y = \frac{2}{3}x + \frac{13}{6}$
- 4 a undefined
b 0
c $y = \frac{1}{7}$
- 5 a -3
b $\frac{4}{3}$



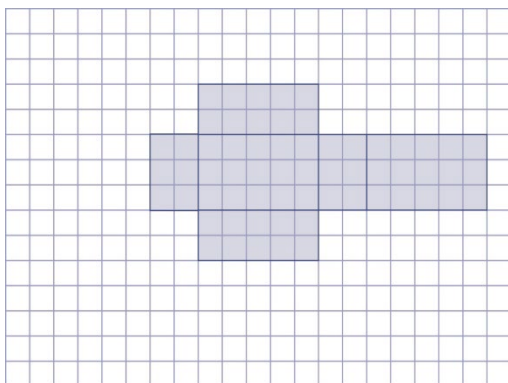
22 Geometrical vocabulary and construction

Exercise 22.2

- 1 Both a rhombus and a square are quadrilaterals / have four sides; all sides are of equal length; both pairs of opposite sides are parallel; diagonals intersect at right angles.

Exercise 22.3

- 1 a Several nets are possible. One is given here:



- b 62 cm^2

Exercise 22.4

- 1 Student's construction

Exercise 22.5

- 1 4.4 km
2 13.4 cm



23 Similarity and congruence

Exercise 23.1

- 1 a 9.52 cm (3 s.f.)
b 15.2 cm (3 s.f.)

Exercise 23.2

- 1 24.5 cm²
2 a i 144 cm²
ii 33.5 cm²
b Rectangle H

Working logically is the best method here.

$$1.2^{2n} \times 100 < 500$$

D 100

$$E \ 100 \times 1.2^2 = 144$$

$$F \ 144 \times 1.2^2 = 207.36$$

$$G \ 207.36 \times 1.2^2 = 298.60$$

$$H \ 298.60 \times 1.2^2 = 429.98$$

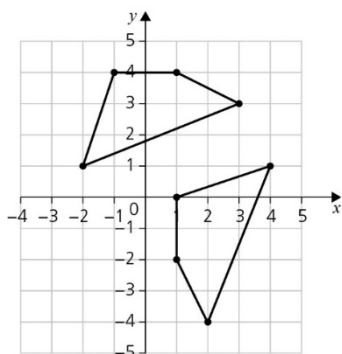
$$I \ 429.98 \times 1.2^2 = 619.17 \text{ Therefore, shape H}$$

Exercises 23.3–23.4

- 1 a 121.5 cm²
b 3
c 2460 (3 s.f.)
2 a 5.4
b 1.75
c 14.2 cm (3 s.f.)
3 a 3
b 50 cm³
4 155 m²

Exercise 23.5

- 1 a



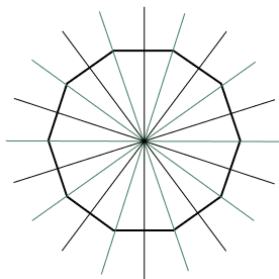
- b (1, -2)



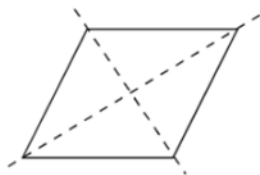
24 Symmetry

Exercise 24.1

- 1 a Student's own drawings. Could be:



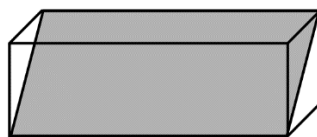
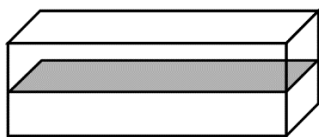
- b Student's own drawings. Could be:



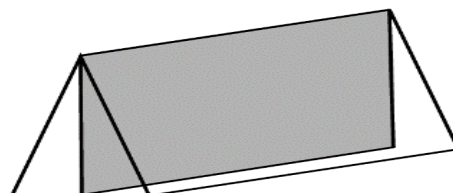
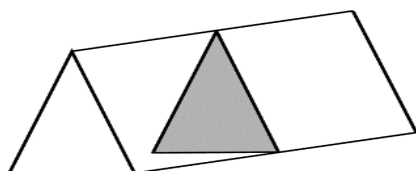
- 2 a 10

- b 2

- 3 a Several answers possible. Two are given below:



- b



- 4 Rotational symmetry of order 4

Exercise 24.2

- 1 a Isosceles

- b 110°

Exercise 24.3

- 1 $p = 52$

Angle $OXZ = 90^\circ$ as it's the angle between a tangent and a radius at a point

Angle $XOZ = 180^\circ - 90^\circ - 38^\circ = 52^\circ$

Triangles OXZ and OYZ are congruent, therefore angle $YOZ = XOZ$

Therefore $p = 52$



25 Angle properties

Exercises 25.1–25.3

- 1 $a = 78$
 $b = 102$
 $c = 143$
 $d = 37$
 $e = 65$

Exercises 25.5–25.6

- 1 $x = 58$ $y = 45$ $z = 32$

Exercise 25.7

- 1 **a** 540°
b 30
c $30^\circ, 240^\circ, 120^\circ, 60^\circ, 90^\circ$
- 2 **a** $y = 360 - x$
b $1080 = x + \frac{7}{2}x + \frac{5}{2}x + \frac{5}{2}x + \frac{7}{2}x + 3x + 3x + 360 - x$
or $360 + 18x = 1080$
c 40
d 320°

Exercise 25.8

- 1 $x = 110$
2 $x = 96$ $y = 48$

Exercise 25.9

- 1 $x^\circ = 46^\circ$ $y^\circ = 56^\circ$
2 $x^\circ = 32^\circ$ $y^\circ = 22^\circ$ $z^\circ = 22^\circ$

Exercise 25.10

- 1 $p = 116$ $q = 95$
2 $x = 55$ $y = z = 90$
3 $a = 41$ $b = 58$ $c = 81$ $d = 99$



26 Measures

Exercises 26.1–26.5

- 1 a 3 600 000 cm³
b i 3 250 000 mm³
ii 0.003 25 m³
c i 825 ml
ii 825 cm³
- 2 a 9.628 km
b 9628 m

27 Perimeter, area and volume

Exercises 27.1–27.5

- 1 12 cm²
2 1.9

Exercises 27.6–27.9

- 1 1426 cm³ (4 s.f.)

Exercise 27.11

- 1 a 45.1 cm
b 36.6 cm²

Exercises 27.14–27.15

- 1 a $\frac{1}{2} \times \frac{4}{3} \pi \times 20^3$ is the volume of the large hemisphere.
 $\frac{1}{2} \times \frac{4}{3} \pi \times (20 - x)^3$ is half the volume of the smaller sphere.
The volume of the bowl is the difference between these two volumes.
- b $\frac{4}{3} \pi (20 - x)^3$
- c $\frac{2}{3} \pi \times 20^3 - \frac{2}{3} \pi (20 - x)^3 = \frac{4}{3} \pi (20 - x)^3$
 $\frac{2}{3} \pi \times 20^3 = 2\pi (20 - x)^3$
 $8000 = 3(20 - x)^3$
- d 6.13 cm

Exercises 27.17–27.19

- 1 a 108 cm³
b 4.5
c 178.7 cm² (4 s.f.)

Exercises 27.20–27.23

- 1 a 3 cm
b 50.3 cm³
c 113 cm²



- 2 a 4.58 cm
b 5.73 cm
c 25.9 cm^3
d 57.3 cm^2
- 3 a $\frac{1000}{3} \pi \text{ cm}^3$
b $\frac{1000}{3} \pi \text{ cm}^3$
c 1147 cm^2 (to nearest cm^2)



28 Bearings

Exercise 28.1

- 1 a Student's scale drawing
b i ≈ 6.8 km
ii $\approx 026^\circ$
- 2 062°



29 Trigonometry

Exercises 29.1–29.3

- 1 5.60 cm
- 2 19.6 cm

Exercises 29.4–29.5

- 1 a 68 km
- b 96.2 km

Exercise 29.6

- 1 a 58.9 m
- b 40°
- c 1 : 1.7
- 2 a 14.0 m
- b 16.6°
- c 47.1 m

Exercises 29.7–29.8

- 1 a $\sin 94^\circ$
- b $\sin 22^\circ$
- 2 a $-\cos 142^\circ$
- b $-\cos 42^\circ$
- 3 a $22^\circ, 158^\circ$
- b $58^\circ, 122^\circ$
- 4 a $\cos 18^\circ$
- b $\cos 44^\circ$

Exercise 29.9

- 1 a $240^\circ, 300^\circ$
- b $120^\circ, 300^\circ$
- 2 $\cos \theta = \sqrt{\frac{5}{6}}$



30 Further trigonometry

Exercises 30.1–30.2

- 1 6.63 cm
- 2 8.05 cm
- 3 11.5 cm
- 4 23.1°
- 5 a 147.7°
b 32.3°

Exercise 30.3

- 1 a 44.0°
b 87.5 m

Exercise 30.4

- 1 43.3 cm^2
- 2 7 cm
- 3 7.9 cm

Exercises 30.5–30.6

- 1 a 11.4 cm
b 23.3 cm
- 2 a 8.54 cm
b 30.3°
c 8.90 cm
d 32.6°
- 3 a 5 cm
b 59.0°
c 7.81 cm
d 30.8°
- 4 a 3.20 cm
b 65.4°
c 3.85 cm

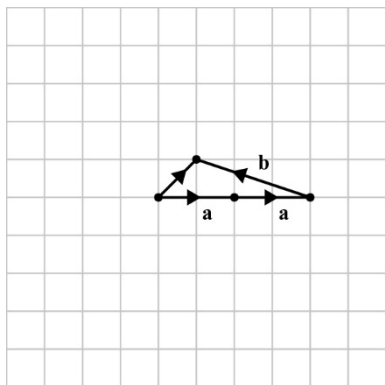


31 Vectors

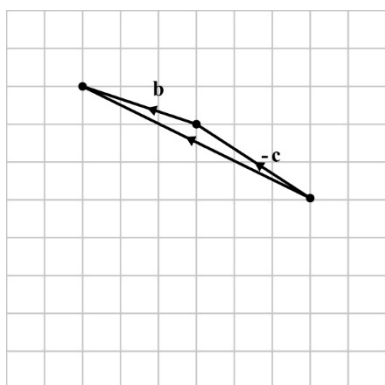
Exercises 31.2–31.3

- 1 a $\begin{pmatrix} 6 \\ 0 \end{pmatrix}$
b $\begin{pmatrix} 9 \\ -5 \end{pmatrix}$
c $\begin{pmatrix} \frac{5}{2} \\ -\frac{1}{2} \end{pmatrix}$
d $\begin{pmatrix} 6 \\ -2 \end{pmatrix}$

- 2 a



- b



Exercise 31.4

- 1 a $\sqrt{5}$
b 2

Exercises 31.5–31.7

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



b $\frac{1}{2}\mathbf{b}$

c $\mathbf{a} + \frac{3}{2}\mathbf{b}$

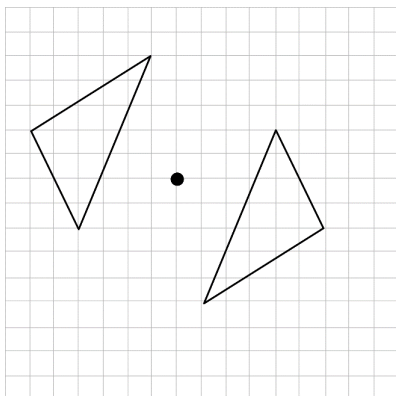
d $\frac{1}{2}\mathbf{a} + \frac{1}{4}\mathbf{b}$



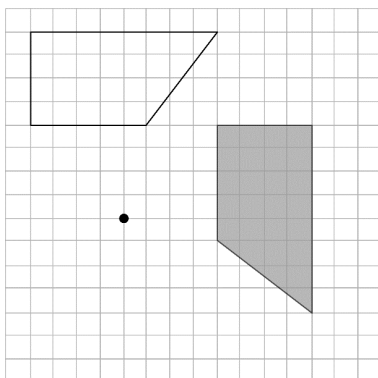
32 Transformations

Exercises 32.3–32.4

1



2



Rotation 90° clockwise or 270° anticlockwise

Exercises 32.5–32.6

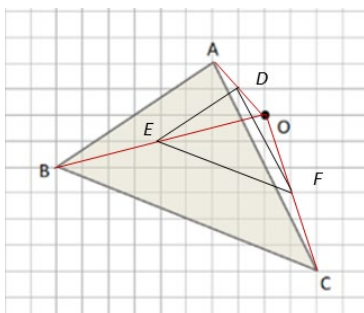
1 $B = \begin{pmatrix} 0 \\ -6 \end{pmatrix}$

$C = \begin{pmatrix} -6 \\ -7 \end{pmatrix}$

$D = \begin{pmatrix} -6 \\ 1 \end{pmatrix}$

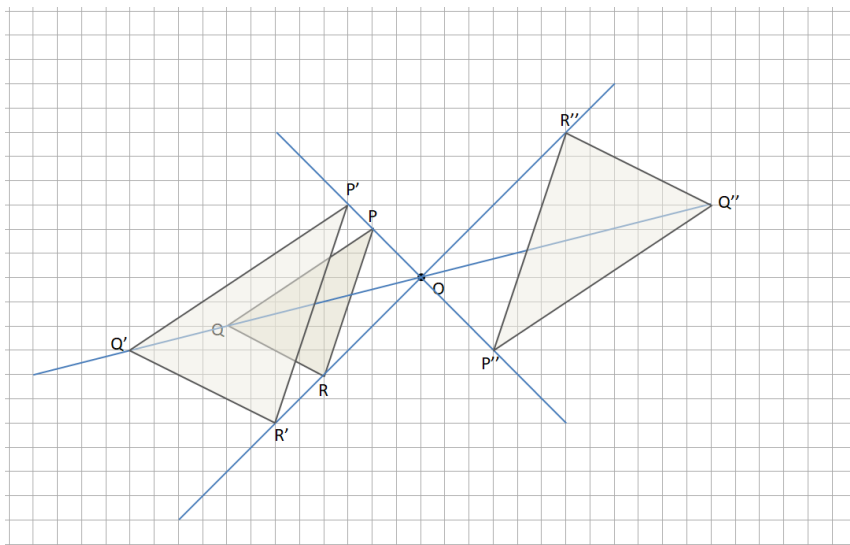
Exercise 32.9

1



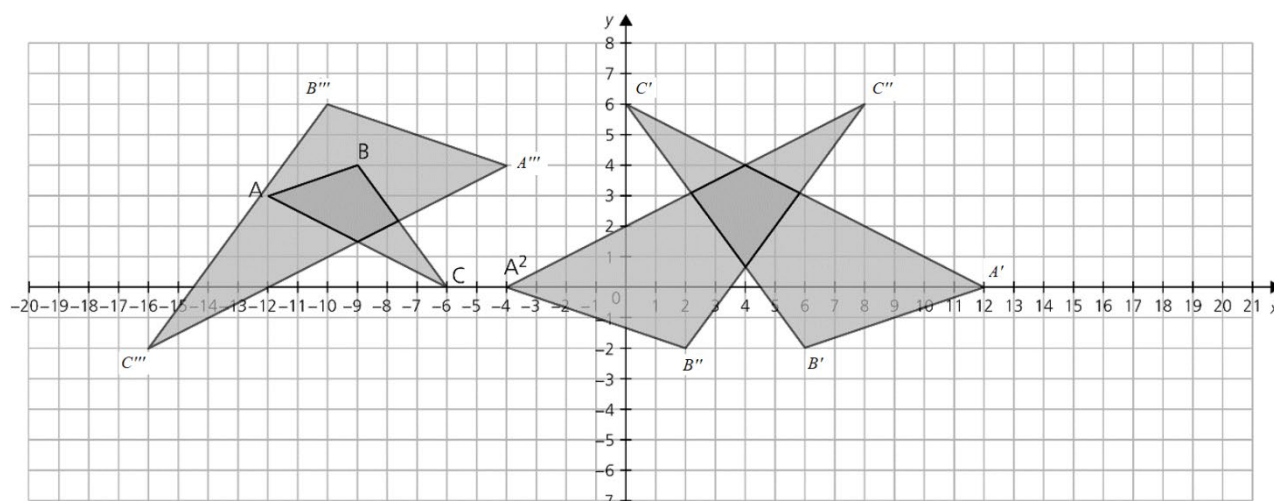


2



Exercise 32.10

1





33 Probability

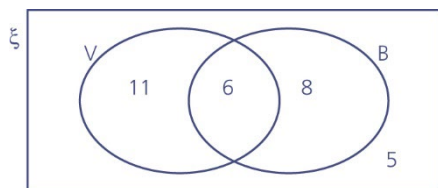
Exercises 33.1–33.5

1 a $\frac{23}{40}$

b $\frac{17}{40}$

2 250

3 a



b i $\frac{6}{30} = \frac{1}{5}$

ii $\frac{16}{30} = \frac{8}{15}$

iii $\frac{5}{30} = \frac{1}{6}$



34 Further probability

Exercise 34.1

- 1 a $\frac{1}{6}$
b $\frac{5}{24}$

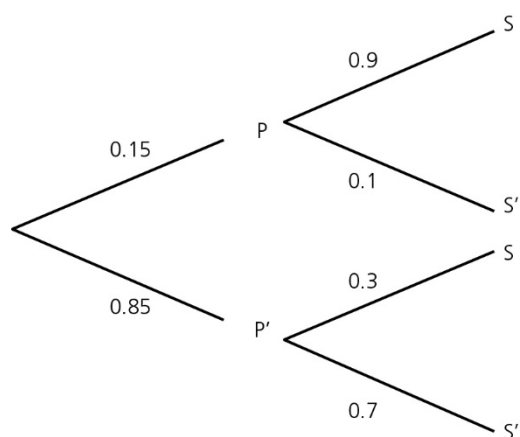
Exercise 34.3

- 1 a $\frac{n(n-1)}{(2n-2)(2n-3)}$
b $\frac{2n(n-2)}{(2n-2)(2n-3)}$
- 2 a $\frac{7}{32}$
b $\frac{26}{32} = \frac{13}{16}$
c $\frac{10}{13}$
d $\frac{13}{19}$

Exercise 34.4

- 1 a $\frac{8}{35}$
b $\frac{23}{70}$
c $\frac{8}{19}$
d $\frac{4}{9}$

- 2 a



- b i 0.39
ii 0.0246 (3 s.f.)



35 Mean, median, mode and range

Exercise 35.2

- 1 a 1.67
b 1
c 1 and 2
d 5

Exercise 35.3

- 1 a 22
b 6 min 44 s

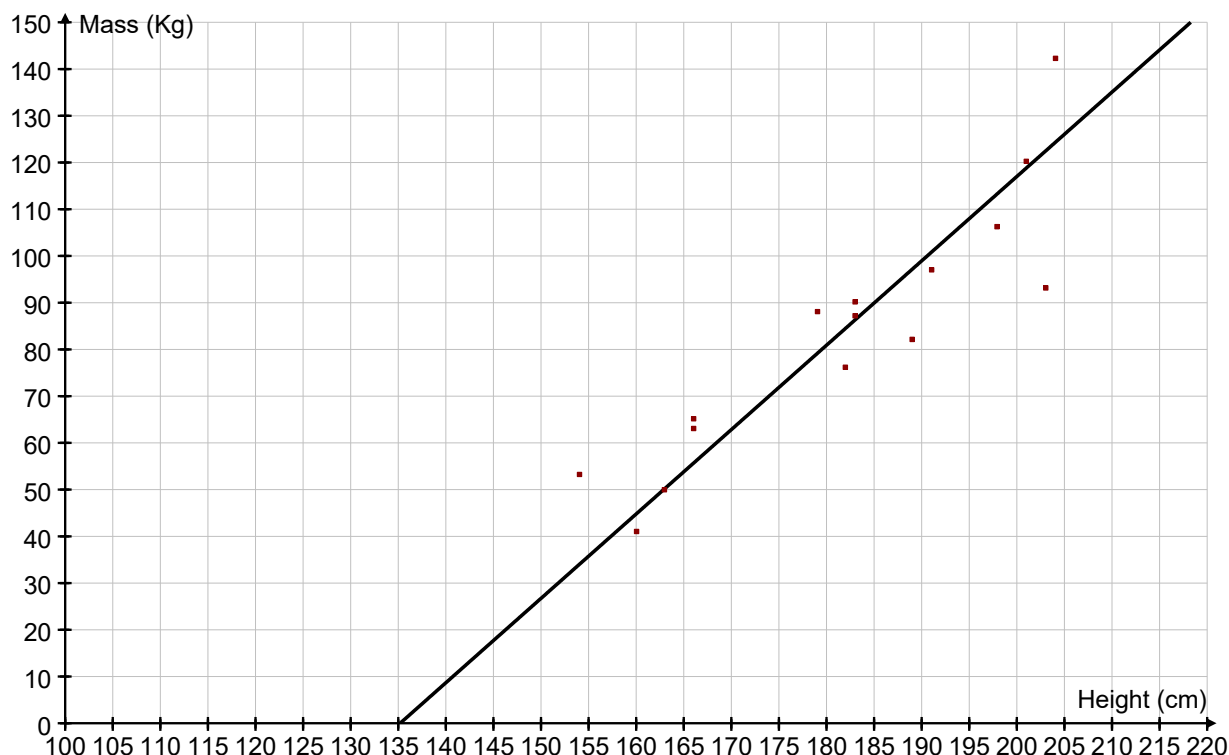


36 Collecting, displaying and interpreting data

Exercises 36.1–36.3

1 a Positive correlation as taller people tend to be heavier.

b



c See graph for line of best fit

d i Positive correlation

ii Student's comparison

2 a

Athletics						Gymnastics				
				5	1					
				4	4	0				
			8	5	3	2	3			
6	4	4	3	3	0	2	1	4	5	5
	8	8	7	7	6	1	0	1	1	4
								8	8	8
								8	8	9
					0	7	8	9		

Key: 6 | 1 | 4 represents 16 year old athlete and 14 year old gymnast

b i 18 years old

ii 23 years old

iii 44 years

iv 28 years

c Several answers are possible, but students must compare the two data sets. For example, the median age of the athletics club members is five years older than the median age of the gymnastics club members.



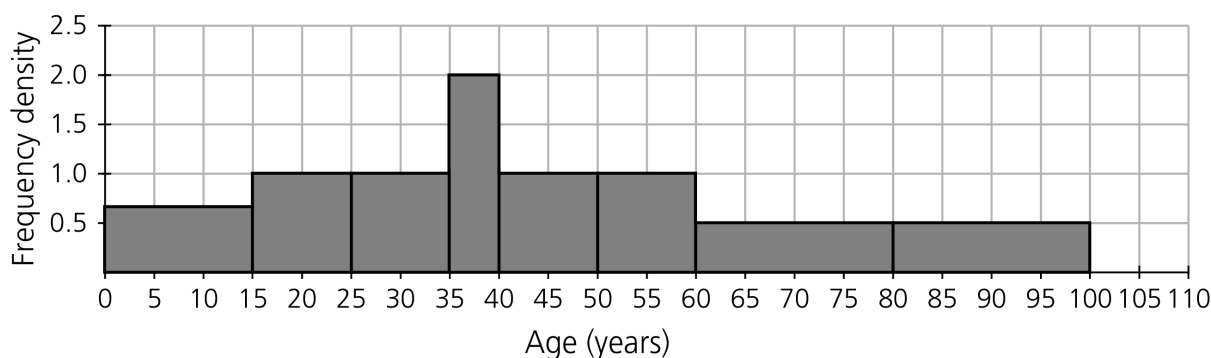
- 3 Student's answers may vary. A back-to-back stem-and-leaf diagram would be most useful to compare the two sets of data. This is because all the data is present and the mean, median and modal results, as well as the range, can be easily calculated too.
- 4 As the totals are different, two pie charts would be most appropriate to compare the two sets of data as the size of the 'pie slices' represent the fraction of the total.

Exercises 36.4–36.5

1 a

Age (years)	$0 \leq A < 15$	$15 \leq A < 25$	$25 \leq A < 35$	$35 \leq A < 40$	$40 \leq A < 50$	$50 \leq A < 60$	$60 \leq A < 80$	$80 \leq A < 100$
Frequency	10	10	10	10	10	10	10	10
Frequency density	0.67	1	1	2	1	1	0.5	0.5

b





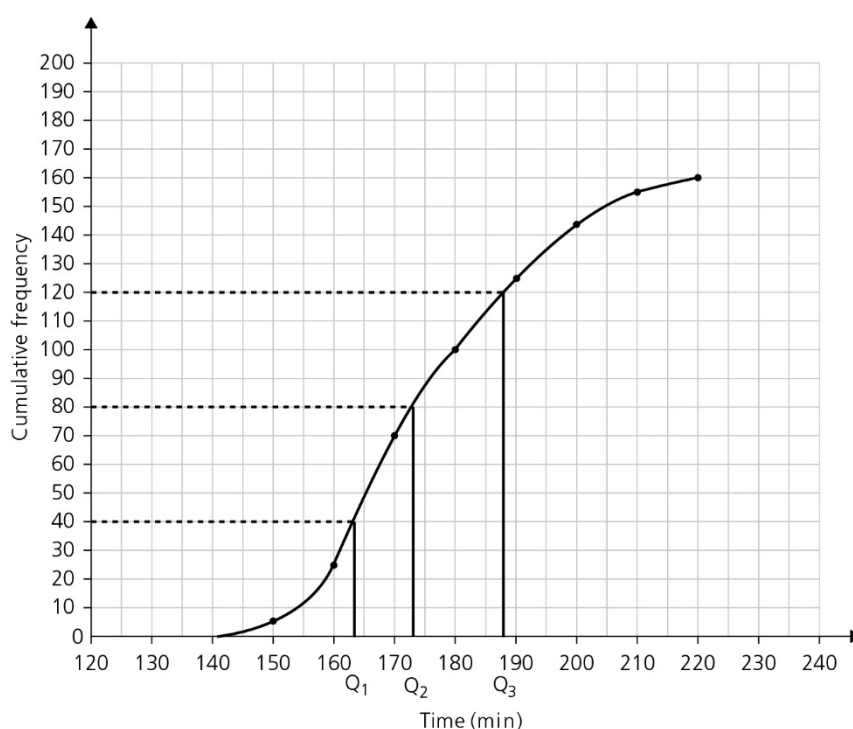
37 Cumulative frequency

Exercises 37.1–37.2

1 a

Time (minutes)	$140 \leq T < 149$	$150 \leq T < 159$	$160 \leq T < 169$	$170 \leq T < 179$	$180 \leq T < 189$	$190 \leq T < 199$	$200 \leq T < 209$	$210 \leq T < 220$
Frequency	5	20	45	30	25	20	10	5
Cumulative frequency	5	25	70	100	125	145	155	160

b



c Median = 173 minutes (see graph)

d i Upper quartile = 187 minutes (see graph)

ii Lower quartile = 163 minutes (see graph)

iii Interquartile range = 24 minutes

e 10% is equivalent to 16 candles. The 10th percentile is ≈ 156 minutes and the 90th percentile is ≈ 198 minutes. Therefore, the middle 80% differ by approximately 42 minutes. The data therefore supports this aim.