

All answers were written by the authors.

## 1 Number

### Exercise 1.1

- 1 a) Integers:  $-7, 27, 1534, 0, -12$   
b) Natural numbers:  $27, 1534$
- 2 a)  $\frac{17}{20}$  is a fraction, so it is rational  
b)  $0.46$  is a terminating decimal, so it is rational  
c)  $\sqrt{\frac{2}{25}} = \frac{\sqrt{2}}{5}$  and  $\sqrt{2}$  is irrational, so  $\sqrt{\frac{2}{25}}$  is irrational  
d)  $\pi$  is irrational, so  $5\pi$  is irrational  
e)  $3.141\,59$  is a terminating decimal, so it is rational  
f)  $-0.\dot{2}3\dot{4}$  is a recurring decimal, so it is rational  
g)  $\sqrt{\frac{4}{25}} = \frac{2}{5}$  which is a fraction, so it is rational  
h)  $\sqrt{225} = 15$  which is a integer, so it is rational  
i)  $2\sqrt{3} + \sqrt{3} = 3\sqrt{3}$  and  $3\sqrt{3}$  is irrational, so  $2\sqrt{3} + \sqrt{3}$  is irrational
- 3 a)  $\sqrt{169} = 13$  which is a integer, so it is rational  
b)  $0.49$  is a terminating decimal, so it is rational  
c)  $\sqrt{3}$  is irrational, so  $5 + \sqrt{3}$  is irrational  
d)  $-2.718$  is a terminating decimal, so it is rational  
e)  $\pi$  is irrational, so  $5\pi + 2$  is irrational  
f)  $\frac{4\pi}{3\pi} = \frac{4}{3}$  which is a fraction, so it is rational  
g)  $\sqrt{27} = 3\sqrt{3}$  and  $3\sqrt{3}$  is irrational, so  $\sqrt{27}$  is irrational

h)  $\sqrt{1\frac{7}{9}} = \sqrt{\frac{16}{9}} = \frac{4}{3}$  which is a fraction, so it is rational

i)  $\sqrt{2}$  is irrational, so  $-6\sqrt{2}$  is irrational

4 a)  $\pi$  is an example of an irrational number between 3 and 4

b)  $\sqrt{110}$  is an example of an irrational number between 10 and 11

c)  $\sqrt{390}$  is an example of an irrational number between 19 and 20

5 a)  $\frac{1}{5}$

b) 4

c)  $\frac{3}{2}$

d)  $\frac{5}{7}$

## Exercise 1.2

1 a) 1, 2, 4, 8

b) 1, 3, 5, 15

c) 1, 3, 9, 27

d) 1, 2, 3, 6, 9, 18, 27, 54

2 2, 3, 5, 7, 11, 13, 17, 19, 23, 29

3 a) 2, 3

b) 2, 5

c) 5, 11

d) 2, 3, 7

4 a)  $2^4 \times 3$

b)  $2^3 \times 3^2$

c)  $2 \times 3 \times 5 \times 7$

d)  $2 \times 5^2 \times 7$

e)  $3 \times 5^2$

f)  $5^2 \times 11$

- g)  $2^3 \times 3 \times 5$   
h)  $2 \times 3^2 \times 11$
- 5 a)  $3^2 \times 5 \times 11$   
b)  $2^2 \times 5 \times 13$   
c)  $2^2 \times 3^3 \times 5^2$   
d)  $2 \times 7^2 \times 11$   
e)  $2^2 \times 3 \times 5 \times 7$   
f)  $3^2 \times 5^3$   
g)  $2^4 \times 7$   
h)  $2^3 \times 5 \times 7^2$
- 6 a) i)  $5^2$   
ii)  $2^2 \times 3^2$   
iii)  $2^2 \times 5^2$   
iv)  $2^4 \times 3^2$   
b) Prime factors are all in pairs
- 7 a)  $2^5 \times 3$   
b)  $k = 6$
- 8 a)  $2^3 \times 7^2$   
b)  $k = 7$

### Exercise 1.3

- 1 a) i)  $18 = 2 \times 3^2$ ,  $24 = 2^3 \times 3$   
ii) HCF = 6  
iii) LCM = 72  
b) i)  $64 = 2^6$ ,  $100 = 2^2 \times 5^2$   
ii) HCF = 4  
iii) LCM = 1600

- c) i)  $50 = 2 \times 5^2$ ,  $350 = 2 \times 5^2 \times 7$   
ii) HCF = 50  
iii) LCM = 350
- d) i)  $72 = 2^3 \times 3^2$ ,  $126 = 2 \times 3^2 \times 7$   
ii) HCF = 18  
iii) LCM = 504
- 2 a) HCF = 9, LCM = 189  
b) HCF = 10, LCM = 100  
c) HCF = 12, LCM = 336  
d) HCF = 2, LCM = 1600  
e) HCF = 7, LCM = 294
- 3 a) i)  $260 = 2^2 \times 5 \times 13$ ,  $300 = 2^2 \times 3 \times 5^2$   
ii) HCF = 20  
iii) LCM = 3900  
b) i)  $340 = 2^2 \times 5 \times 17$ ,  $425 = 5^2 \times 17$   
ii) HCF = 85  
iii) LCM = 1700  
c) i)  $756 = 2^2 \times 3^3 \times 7$ ,  $2100 = 2^2 \times 3 \times 5^2 \times 7$   
ii) HCF = 84  
iii) LCM = 18 900  
d) i)  $1980 = 2^2 \times 3^2 \times 5 \times 11$ ,  $2376 = 2^3 \times 3^3 \times 11$   
ii) HCF = 396  
iii) LCM = 11 880
- 4 a) HCF = 252, LCM = 49 896  
b) HCF = 504, LCM = 42 336
- 5 a) 15  
b) 900
- 6 12 mm by 12 mm
- 7 10:02:56 p.m.
- 8 10:15 a.m.

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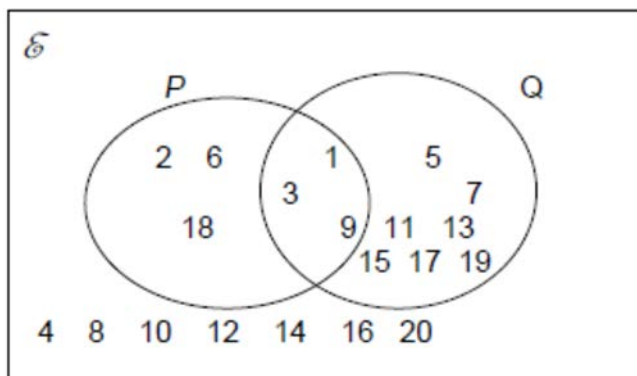
## 2 Sets

### Exercise 2.1

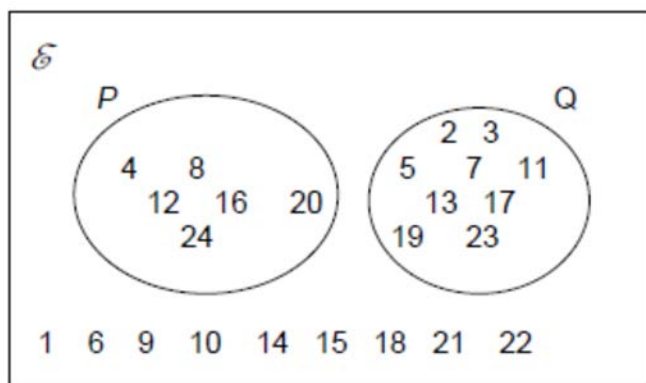
- 1 11, 12, 13, 14, 15, 16, 17, 18
- 2 2, 3, 5, 7, 11
- 3 1, 2, 3, 4, 6, 12
- 4 8, 16, 24, 32, 40, 48
- 5 a, e, i, o, u

### Exercise 2.2

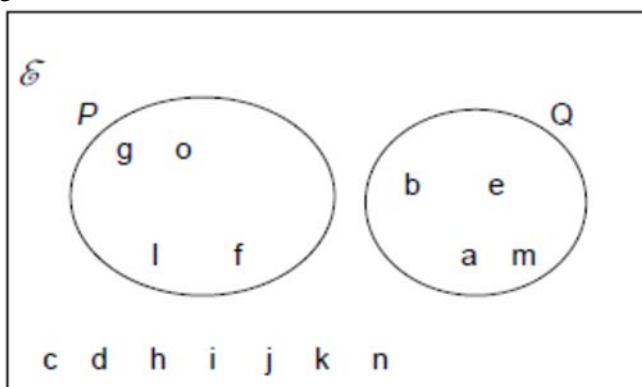
1



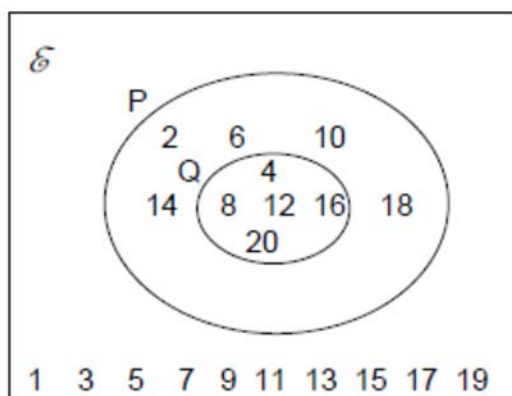
2



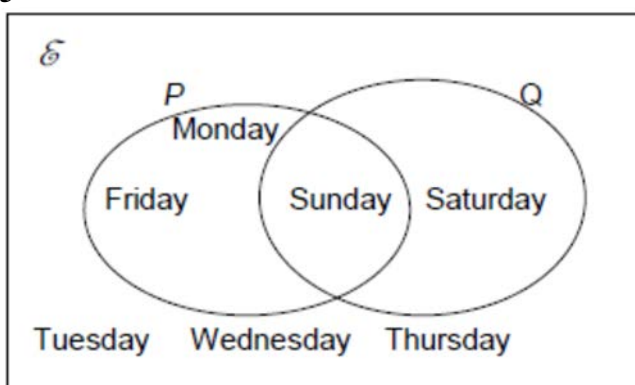
3



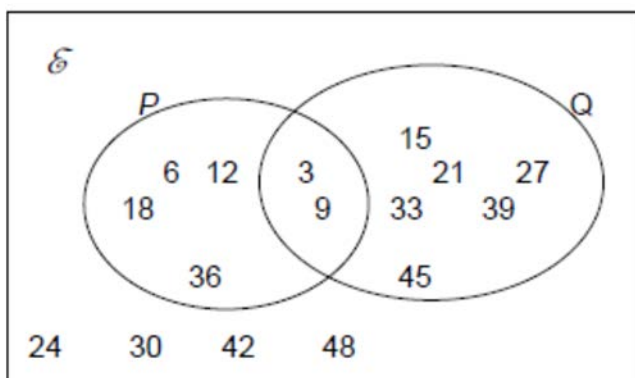
4



5



6



## Exercise 2.3

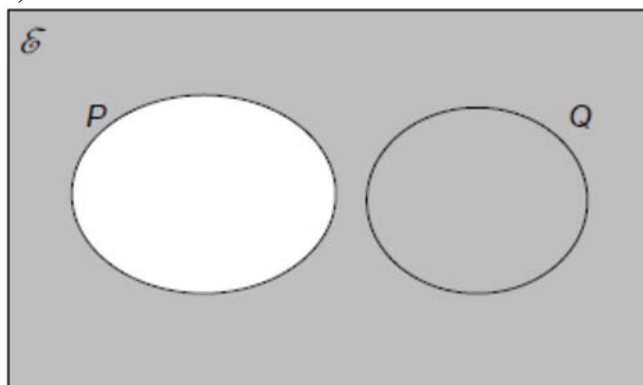
- 1     a)     {1, 3, 9}  
       b)     {1, 2, 3, 5, 6, 7, 9, 11, 13, 15, 17, 18, 19}
- 2     a)      $\emptyset$   
       b)     {2, 3, 4, 5, 7, 8, 11, 12, 13, 16, 17, 19, 20, 23, 24}
- 3     a)      $\emptyset$   
       b)     {a, b, e, f, g, l, m, o}
- 4     a)     {4, 8, 12, 16, 20}  
       b)     {2, 4, 6, 8, 10, 12, 14, 16, 18, 20}
- 5     a)     {Sunday}  
       b)     {Sunday, Monday, Friday, Saturday}
- 6     a)     {3, 9}  
       b)     {3, 6, 9, 12, 15, 18, 21, 27, 33, 36, 39, 45}

## Exercise 2.4

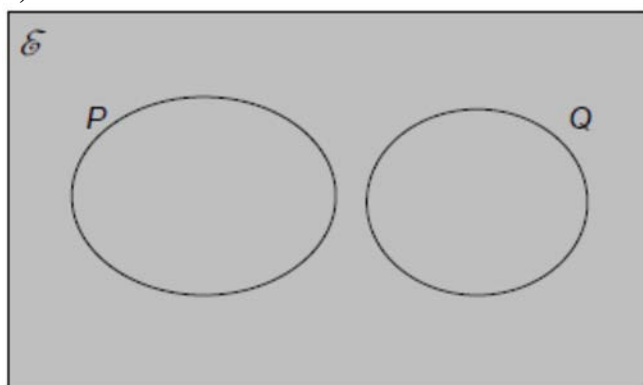
- 1     a)     2, 4, 6, 8, 10, 12, 14, 16, 18, 20  
       b)     4, 8, 10, 12, 14, 16, 20
- 2     a)     1, 4, 6, 8, 9, 10, 12, 14, 15, 16, 18, 20, 21, 22, 24  
       b)     1, 6, 9, 10, 14, 15, 18, 21, 22
- 3     a)     c, d, f, g, h, i, j, k, l, n, o  
       b)     c, d, h, i, j, k, n
- 4     a)     1, 2, 3, 5, 6, 7, 9, 10, 11, 13, 14, 15, 17, 18, 19  
       b)     1, 3, 5, 7, 9, 11, 13, 15, 17, 19
- 5     a)     Monday, Tuesday, Wednesday, Thursday, Friday  
       b)     Tuesday, Wednesday, Thursday
- 6     a)     6, 12, 18, 24, 30, 36, 42, 48  
       b)     24, 30, 42, 48

## Exercise 2.5

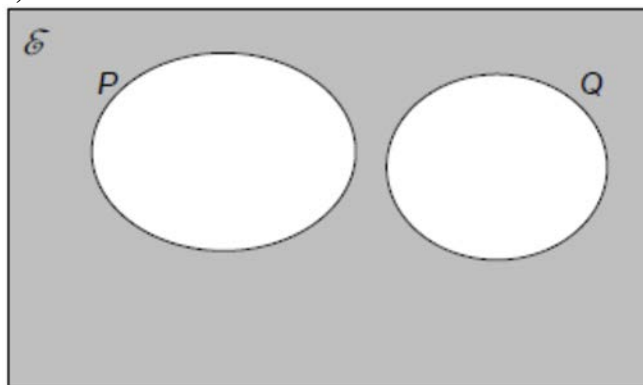
1 a)



b)



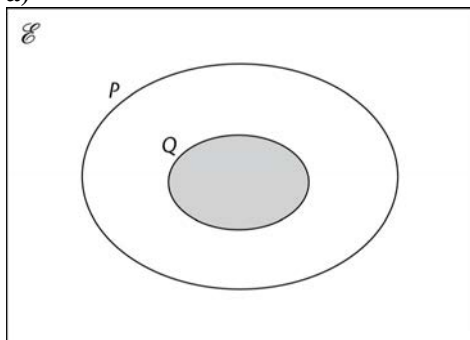
c)



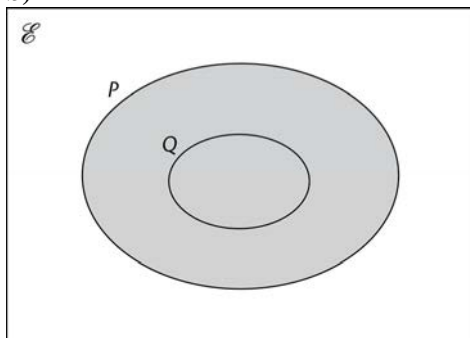


2

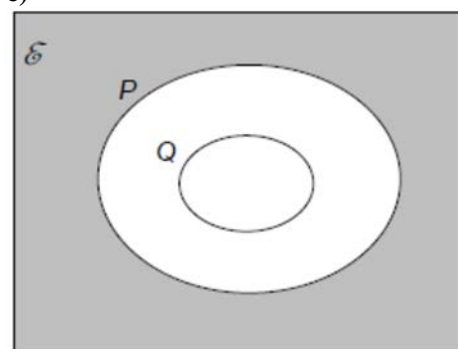
a)



b)

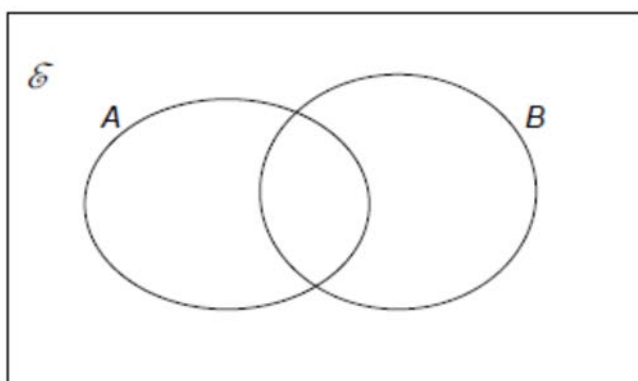


c)



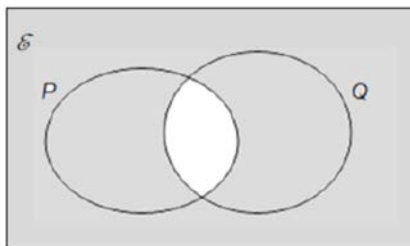
3

a)



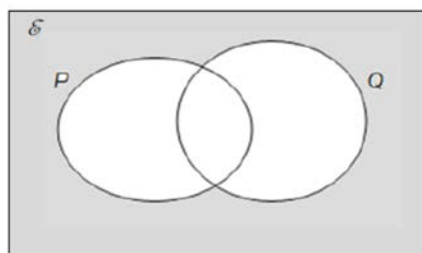
b) {squares}

4 a) i) and ii)



b) They are the same

5 a) i) and ii)



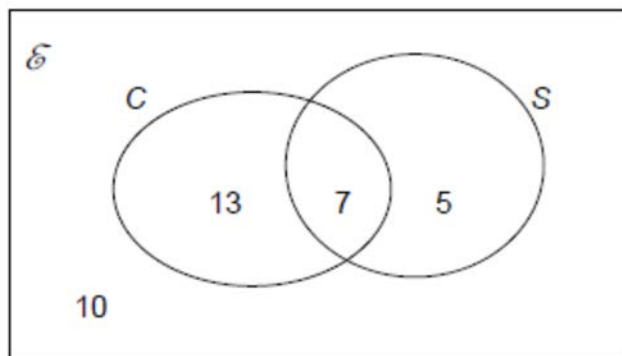
b) They are the same

### Exercise 2.6

1  $\emptyset, \{p\}, \{q\}, \{r\}, \{p, q\}, \{p, r\}, \{q, r\}, \{p, q, r\}$

2 64

3 a)

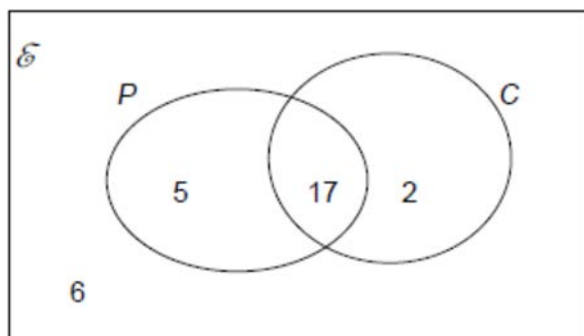


b) i) 13

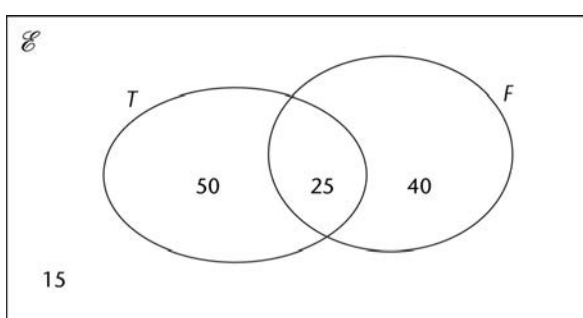
ii) 10

4 a) 17

b)



5 a)

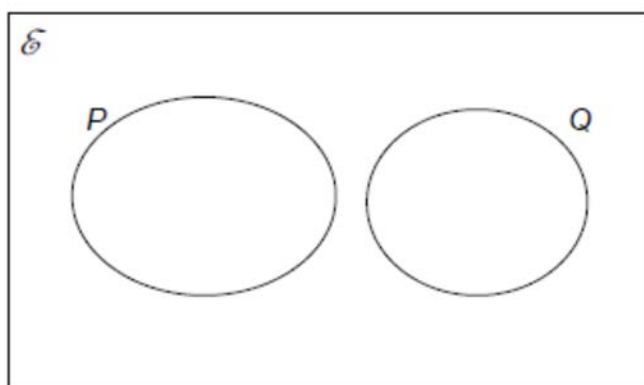


b) 25

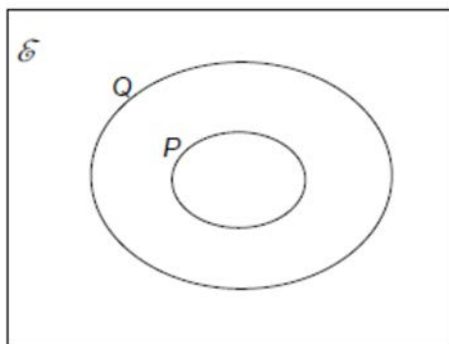
6 12

7 39

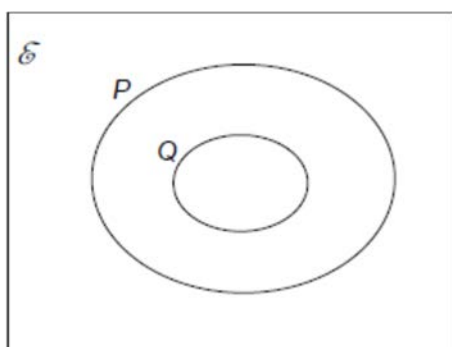
8



9

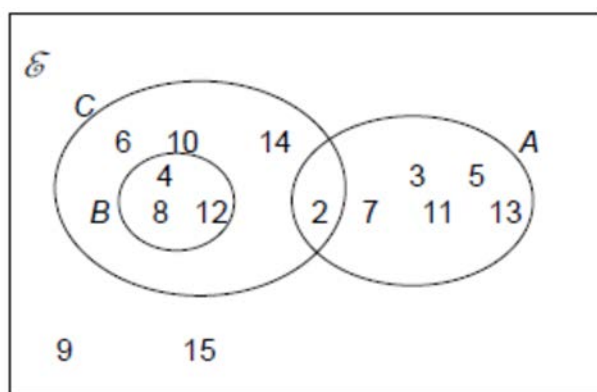


10

11      $-2, -1, 0, 1, 2, 3$ 

## Exercise 2.7

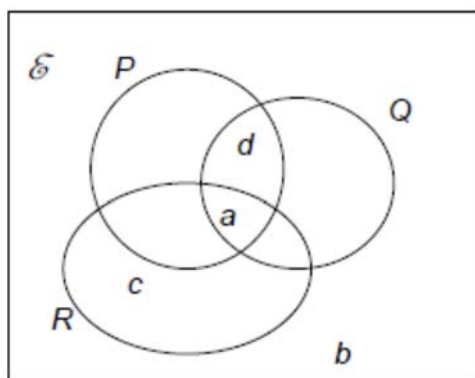
1     a)



b)     i)     7

ii)     5

2 i) – iv)

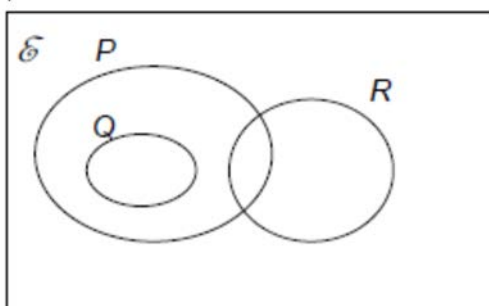
3 a)  $B \cap C \cap A'$ b)  $(P \cap R) \cup (Q \cap R)$  or  $(P \cup Q) \cap R$ 4 a)  $T \cap F$ 

b) E

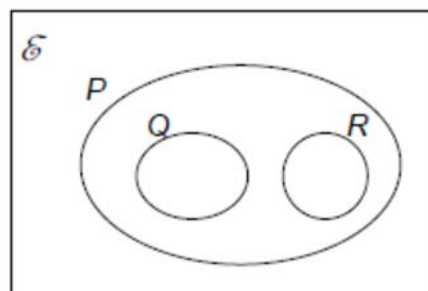
5 a) 9

b) 1

6



or

7 a)  $P \cap Q = \emptyset$ b)  $R \subseteq Q$ c)  $R \cup Q = Q$ d)  $n(R \cap Q) = n(R)$ e)  $n(P) + n(R) = n(P \cup R)$

*All answers were written by the authors.*

### 3 Powers and roots

#### Exercise 3.1

- 1**
- a) 49
  - b) 144
  - c) 25
  - d) 100
  - e) 81
  - f) 64
  - g) 121
  - h) 9
  - i) 36
  - j) 16
- 2**
- a) 7
  - b) 11
  - c) 9
  - d) 6
  - e) 5
  - f) 13
  - g) 12
  - h) 15
  - i) 10
  - j) 14

- 3**      **a)**      169  
         **b)**      121  
         **c)**      196  
         **d)**      36  
         **e)**      81
- 4**      **a)**      9  
         **b)**      12  
         **c)**      4  
         **d)**      10  
         **e)**      8
- 5**      **a)**      23  
         **b)**      16  
         **c)**      18  
         **d)**      29  
         **e)**      28
- 6**      **a)**      400  
         **b)**      625  
         **c)**      169  
         **d)**      576  
         **e)**      1089
- 7**      **a)**      11  
         **b)**      13  
         **c)**      33  
         **d)**      5  
         **e)**      41  
         **f)**      27  
         **g)**      0  
         **h)**      63

- 8**
- a) 360
  - b) 525
  - c) 185
  - d) 1325

### Exercise 3.2

- 1**
- a) 64
  - b) 125
  - c) 27
  - d) 1000
  - e) 8
- 2**
- a) 1
  - b) 4
  - c) 10
- 3**
- a) 343
  - b) 729
  - c) 8000
  - d) 15 625
  - e) 3.375
  - f) 19.683
  - g) 157.464
- 4**
- a) 7
  - b) 9
  - c) 11
  - d) 100
  - e) 6
  - f) 12
  - g) 8



- 5**     **a)**     3.83  
         **b)**     6.13  
         **c)**     8.09  
         **d)**     10.32  
         **e)**     19.60
- 6**     3.56 cm
- 7**     **a)**     1544.804 416  
         **b)**     3164.0625  
         **c)**     0.168 07
- 8**     **a)**     4.1  
         **b)**     5.3  
         **c)**     0.5
- 9**     **a)**     400  
         **b)**     69.672 96  
         **c)**     0.648

All answers were written by the authors.

## 4 Fractions, decimals and percentages

### Exercise 4.1

1 a) Improper fraction

b) Mixed number

c) Proper fraction

d) Mixed number

e) Proper fraction

2 a)  $1\frac{3}{8}$

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

c)  $2\frac{1}{4}$

d)  $3\frac{1}{2}$

e)  $2\frac{1}{7}$

f)  $3\frac{1}{3}$

g)  $2\frac{3}{8}$

h)  $5\frac{3}{4}$

i)  $3\frac{3}{10}$

j)  $4\frac{1}{9}$

3 a)  $\frac{9}{8}$

b)  $\frac{21}{8}$

c)  $\frac{15}{4}$

d)  $\frac{11}{2}$

e)  $\frac{29}{9}$

f)  $\frac{12}{5}$

g)  $\frac{11}{3}$

h)  $\frac{21}{10}$

i)  $\frac{19}{8}$

j)  $\frac{34}{7}$

## Exercise 4.2

1 a) 48

b) 64

c) 25

d) 144

e) 165

2 468

3 15 630

4 \$126

5  $\frac{7}{10}$  of \$120 = \$84 and  $\frac{7}{8}$  of \$104 = \$91;  
so  $\frac{7}{8}$  of \$104 is more

6  $\frac{3}{8}$  of \$192 = \$72 and  $\frac{2}{5}$  of \$180 = \$72;  
so they are both the same

## Exercise 4.3

1 a)  $\frac{1}{4} = \frac{2}{8} = \frac{3}{12} = \frac{5}{20}$

b)  $\frac{1}{5} = \frac{2}{10} = \frac{4}{20} = \frac{7}{35}$

c)  $\frac{2}{5} = \frac{4}{10} = \frac{10}{25} = \frac{12}{30}$

d)  $\frac{2}{9} = \frac{4}{18} = \frac{8}{36} = \frac{6}{27}$

e)  $\frac{1}{7} = \frac{2}{14} = \frac{5}{35}$

f)  $\frac{4}{9} = \frac{16}{36} = \frac{32}{72}$

2 a)  $\frac{4}{5}$

b)  $\frac{1}{6}$

c)  $\frac{5}{7}$

d)  $\frac{3}{4}$

e)  $\frac{2}{3}$

f)  $\frac{5}{6}$

g)  $\frac{1}{2}$

h)  $\frac{3}{5}$

i)  $\frac{2}{3}$

j)  $\frac{1}{2}$

**k)**  $\frac{1}{6}$

**l)**  $\frac{1}{2}$

**m)**  $\frac{4}{5}$

**n)**  $\frac{8}{9}$

**o)**  $\frac{5}{7}$

**p)**  $\frac{2}{3}$

**3**  $\frac{3}{8}$

**4**  $\frac{8}{15}$

**5** **a)**  $\frac{9}{25}$

**b)**  $\frac{21}{50}$

**c)**  $\frac{2}{5}$

### Exercise 4.4

**1**  $\frac{7}{10}$

**2**  $\frac{29}{100}$

**3**  $\frac{17}{20}$

**4**  $\frac{7}{100}$

$$5 \quad \frac{39}{125}$$

$$6 \quad \frac{7}{125}$$

$$7 \quad \frac{1}{125}$$

$$8 \quad \frac{1}{50}$$

$$9 \quad \frac{109}{200}$$

$$10 \quad \frac{269}{2000}$$

### Exercise 4.5

- 1     a)     0.375  
       b)     0.3125  
       c)     0.275  
       d)     0.316  
       e)     0.0375

- 2     a)      $0.\dot{6}$   
       b)      $0.8\dot{3}$   
       c)      $0.08\dot{3}$   
       d)      $0.2\dot{6}$   
       e)      $0.4\dot{8}$

- 3     a)      $\frac{2}{9}$   
       b)      $\frac{3}{9}$   
       c)      $\frac{5}{9}$

**4**     **a)**      $0.\dot{0}7\dot{4}$

**b)**      $0.18\dot{5}$

**c)**      $0.\dot{3}7\dot{0}$

**d)**      $0.1\dot{8}$

**e)**      $0.\dot{5}\dot{4}$

**5**     **a)**      $\frac{4}{9}$

**b)**      $\frac{5}{11}$

**c)**      $\frac{11}{15}$

### Exercise 4.6

**1**     **a)**      $\frac{7}{20}$

**b)**      $\frac{13}{20}$

**c)**      $\frac{2}{25}$

**d)**      $1\frac{1}{5}$

**2**     **a)**     0.16

**b)**     0.27

**c)**     0.83

**d)**     0.07

**e)**     0.31

**f)**     0.04

**g)**     0.17

**h)**     0.02

- i) 1.5  
j) 2.5  
k) 0.09  
l) 0.125
- 3** a) 0.01  
b) 0.17  
c) 0.04  
d) 1.6  
e) 0.125  
f) 0.625  
g) 0.15  
h) 0.425  
i) 0.3125
- 4** a) 1%  
b) 17%  
c) 4%  
d) 160%  
e) 12.5%  
f) 62.5%  
g) 15%  
h) 42.5%  
i) 31.25%
- 5** a) 16.7%  
b) 83.3%  
c) 8.3%  
d) 41.7%  
e) 4.3%



- 6** Any three fractions equivalent to  $\frac{2}{5}$
- 7** Any three fractions equivalent to  $\frac{1}{8}$
- 8** **a)** 1.6  
**b)**  $1\frac{3}{5}$
- 9** 58%
- 10** 22%
- 11** Red:  $22\% = 0.22$ ; Silver:  $\frac{3}{20} = 0.15$ ; Black:  $\frac{6}{25} = 0.24$ . So black is the most popular.
- 12** Class P:  $\frac{3}{7} = 0.428\dots$ ; Class Q:  $45\% = 0.45$ . So class Q has the higher proportion of boys.

All answers were written by the authors.

## 5 Ordering

### Exercise 5.1

- 1     a)  $-5^{\circ}\text{C}, -2^{\circ}\text{C}, 0^{\circ}\text{C}, 3^{\circ}\text{C}, 7^{\circ}\text{C}$   
      b)  $-2^{\circ}\text{C}, -1^{\circ}\text{C}, 1^{\circ}\text{C}, 2^{\circ}\text{C}, 5^{\circ}\text{C}$   
      c)  $-9^{\circ}\text{C}, -7^{\circ}\text{C}, -3^{\circ}\text{C}, 4^{\circ}\text{C}, 7^{\circ}\text{C}$   
      d)  $-8^{\circ}\text{C}, -2^{\circ}\text{C}, 4^{\circ}\text{C}, 7^{\circ}\text{C}, 9^{\circ}\text{C}$   
      e)  $-7^{\circ}\text{C}, -4^{\circ}\text{C}, -2^{\circ}\text{C}, 3^{\circ}\text{C}, 5^{\circ}\text{C}$
- 2     a) 31 cm, 1600 mm, 2.42 m, 284 cm, 9 m  
      b) 105 mm, 3.2 m, 423 cm, 6100 mm, 804 cm
- 3     a) 874 g, 1.7 kg, 4000 g, 9.4 kg, 52 000 g  
      b) 0.174 kg, 2104 g, 2.79 kg, 3.4 kg, 4123 g
- 4     a) 51 cl, 80 cl, 1600 ml, 2.4 litres, 9 litres  
      b) 51.5 ml, 1 litre, 1500 ml, 180 cl, 3.1 litres

### Exercise 5.2

- 1     a)  $>$   
      b)  $<$   
      c)  $<$   
      d)  $>$   
      e)  $>$   
      f)  $>$   
      g)  $>$   
      h)  $<$

### Exercise 5.3

- 1**
- a) 197, 321, 358, 411, 426, 462
  - b) 4621, 6317, 9981, 39 171, 59 042, 89 125
  - c) 12, 75, 124, 415, 631, 1792
  - d) 1611, 4257, 5218, 6641, 7034, 9425
  - e) 1 010 701, 1 020 504, 1 030 504, 1 040 501, 1 050 403, 1 060 504
- 2**
- a) 0.102, 0.123, 0.201, 0.231, 0.456
  - b) 0.003, 0.01, 0.056, 0.066, 0.1
  - c) 0.004 04, 0.0044, 0.0404, 0.044, 0.404
  - d) 0.112, 0.149, 0.2, 0.51, 0.71
  - e) 0.009 16, 0.090 11, 0.091, 0.0946, 0.913
- 3**
- a) 3.001, 3.102, 3.12, 3.201, 3.21
  - b) 0.12, 1.21, 2.12, 12.1, 121
  - c) 7.015, 7.023, 7.105, 7.41, 7.69
  - d) 5.001, 5.0102, 5.02, 5.0201, 5.321
  - e) 0.0012, 0.01, 0.0121, 1.201, 12.02
  - f) 8.01, 8.04, 8.079, 8.1, 8.79

### Exercise 5.4

- 1**
- a)  $<$
  - b)  $<$
  - c)  $>$
  - d)  $>$
  - e)  $<$
  - f)  $>$

- 2
- a)  $\frac{11}{20}, \frac{3}{5}, \frac{7}{10}, \frac{3}{4}$
- b)  $\frac{7}{12}, \frac{3}{4}, \frac{5}{6}, \frac{7}{8}$
- c)  $\frac{3}{10}, \frac{2}{5}, \frac{1}{2}, \frac{2}{3}, \frac{13}{15}$
- d)  $\frac{7}{16}, \frac{1}{2}, \frac{5}{8}, \frac{3}{4}, \frac{13}{16}$
- e)  $\frac{3}{8}, \frac{2}{5}, \frac{17}{40}, \frac{9}{20}, \frac{1}{2}$
- f)  $\frac{17}{32}, \frac{11}{16}, \frac{3}{4}, \frac{7}{8}$

### Exercise 5.5

- 1  $\frac{7}{10}, \frac{4}{5}, 0.83, \frac{17}{20}, 88\%$
- 2  $35\%, \frac{3}{8}, \frac{2}{5}, \frac{5}{12}, 0.45$
- 3  $30\%, \frac{3}{5}, \frac{2}{3}, 0.7, \frac{3}{4}$
- 4 City:  $35\% = 0.35$ ; United:  $\frac{3}{8} = 0.375$ ; Rovers:  $0.4$
- 5 Soccer:  $\frac{2}{7} = 0.285\dots$ ; Gymnastics:  $28\% = 0.28$ ; Rugby:  $0.27$

All answers were written by the authors.

## 6 The four operations

### Exercise 6.1

1

	Start temperature/ $^{\circ}\text{C}$	Move/ $^{\circ}\text{C}$	End temperature/ $^{\circ}\text{C}$
a)	4	Up 3	7
b)	-2	Down 4	-6
c)	10	Down 14	-4
d)	-5	Down 3	-8
e)	-10	Up 8	-2
f)	10	Down 19	-9
g)	-4	Up 6	2
h)	3	Up 7	10
i)	-3	Down 6	-9
j)	-10	Up 2	-8

2 a) Floor 4

b) Floor 2

3 a)  $18^{\circ}\text{C}$

b)  $20^{\circ}\text{C}$

c)  $14^{\circ}\text{C}$

d)  $48^{\circ}\text{C}$

e)  $18^{\circ}\text{C}$

**f)**      $25^{\circ}\text{C}$

**g)**      $18^{\circ}\text{C}$

**h)**      $50^{\circ}\text{C}$

**4**      $147^{\circ}\text{C}$

**5**      $-\$166$

**6**      $19\,855\text{ m}$

**7**      $64.6^{\circ}\text{C}$

**8**      $66.2^{\circ}\text{C}$

**9**      $9.9\text{ ft.}$

## Exercise 6.2

**1**      $-1$

**2**      $4$

**3**      $1$

**4**      $9$

**5**      $1$

**6**      $3$

**7**      $4$

**8**      $6$

**9**      $1$

**10**     $-4$

### Exercise 6.3

- 1      14
- 2      6
- 3      16.5
- 4      -11
- 5      -2
- 6      -12
- 7      10
- 8      16
- 9      -18
- 10     60
- 11     -28
- 12     -3
- 13     7
- 14     56
- 15     10.5
- 16     -21
- 17     4
- 18     2
- 19     28
- 20     -12

### Exercise 6.4

- 1      14
- 2      18
- 3      22
- 4      27
- 5      80

- 6**      3
- 7**      55
- 8**      54
- 9**      100
- 10**     10
- 11**     10
- 12**     7
- 13**     1
- 14**     9
- 15**     0
- 16**     2.5
- 17**     7
- 18**     12
- 19**     64
- 20**     -6
- 21**     -8
- 22**     24
- 23**     -21
- 24**     4
- 25**     -4
- 26**     28
- 27**     -12
- 28**     a)      Hassan has worked out addition before division.  
             b)      10
- 29**     a)      She has worked out multiplication before power.  
             b)      12



- 30**
- a)**
- i)**  $(3 + 6) \times 5 - 1 = 44$
- ii)**  $3 + 6 \times 5 - 1 = 32$
- iii)**  $3 + 6 \times (5 - 1) = 27$
- b)**
- i)**  $6 + (4^2 - 16) \div 2 = 6$
- ii)**  $(6 + 4^2 - 16) \div 2 = 3$
- iii)**  $(6 + 4)^2 - 16 \div 2 = 92$
- c)**
- i)**  $12 - 8 \div (4 + 4) = 11$
- ii)**  $(12 - 8) \div 4 + 4 = 5$
- iii)**  $12 - 8 \div 4 + 4 = 14$
- d)**
- i)**  $(18 + 12) \div 6 - 3 = 2$
- ii)**  $18 + 12 \div 6 - 3 = 17$
- iii)**  $18 + 12 \div (6 - 3) = 22$
- iv)**  $(18 + 12) \div (6 - 3) = 10$

### Exercise 6.5

- 1** 1794
- 2** 13 363
- 3** 8596
- 4** 22 560
- 5** 11 534
- 6** 28 290
- 7** 20 828
- 8** 27 430
- 9** 27 392
- 10** 46 800
- 11** 1176
- 12** 6300

## Exercise 6.6

- 1**     **a)**     14.553  
         **b)**     1455.3  
         **c)**     14.553  
         **d)**     14.553  
         **e)**     145 530
- 2**     **a)**     1054  
         **b)**     10.54  
         **c)**     1.054  
         **d)**     10.54  
         **e)**     105.4
- 3**     **a)**     1.5  
         **b)**     0.48  
         **c)**     0.08  
         **d)**     0.014  
         **e)**     0.03  
         **f)**     0.0063
- 4**     **a)**     63  
         **b)**     35.99  
         **c)**     26.16  
         **d)**     1.872  
         **e)**     3.822  
         **f)**     9.968
- 5**     **a)**     0.56  
         **b)**     0.05  
         **c)**     0.36  
         **d)**     0.58

### Exercise 6.7

- 1      47
- 2      38
- 3      54
- 4      33
- 5      17
- 6      16
- 7      19
- 8      32
- 9      34
- 10     32
- 11     69
- 12     12 (with 8 spare seats)

### Exercise 6.8

- 1      a)      532.5  
         b)      0.5325  
         c)      53.25  
         d)      532.5  
         e)      53 250
- 2      a)      1.928  
         b)      0.1928  
         c)      192.8  
         d)      0.019 28  
         e)      192.8
- 3      a)      40  
         b)      4  
         c)      8

- d) 30  
e) 500  
f) 5
- 4** a) 31  
b) 780  
c) 3.7  
d) 0.425  
e) 365  
f) 0.75
- 5** a) 2.6  
b) 20  
c) 20  
d) 130

### Exercise 6.9

- 1** a)  $\frac{6}{7}$   
b)  $\frac{1}{2}$   
c)  $\frac{11}{12}$   
d)  $\frac{19}{20}$   
e)  $\frac{23}{40}$   
f)  $\frac{23}{20}$  or  $1\frac{3}{20}$
- 2** a)  $\frac{1}{7}$   
b)  $\frac{1}{2}$

c)  $\frac{5}{12}$

d)  $\frac{1}{4}$

e)  $\frac{7}{24}$

f)  $\frac{13}{36}$

**3** a)  $1\frac{7}{10}$

b)  $1\frac{7}{10}$

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

d)  $6\frac{4}{5}$

e)  $1\frac{7}{10}$

**4** a)  $4\frac{2}{5}$

b)  $1\frac{1}{6}$

c)  $\frac{1}{2}$

d)  $\frac{3}{4}$

e)  $\frac{9}{10}$

**5** a)  $5\frac{7}{10}$

b)  $3\frac{1}{8}$

c)  $3\frac{1}{12}$

d)  $7\frac{3}{8}$

e)  $4\frac{7}{12}$

6 a)  $7\frac{11}{18}$

b)  $\frac{1}{26}$

c)  $5\frac{13}{20}$

d)  $1\frac{11}{14}$

e)  $\frac{5}{6}$

### Exercise 6.10

1 2

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

3 3

4 9

5 2

6 10

7  $2\frac{2}{3}$

8  $\frac{8}{9}$

9  $2\frac{2}{5}$

10  $\frac{3}{5}$

11  $\frac{1}{6}$

**12**      $\frac{2}{5}$

**13**      $\frac{2}{9}$

**14**      $\frac{2}{9}$

**15**      $\frac{1}{2}$

**16**      $\frac{1}{3}$

**17**      $\frac{5}{12}$

**18**      $\frac{3}{22}$

**19**      $\frac{5}{12}$

**20**      $\frac{1}{4}$

**21**      $9\frac{3}{4}$

**22**      $5\frac{1}{2}$

**23**     7

**24**     8

**25**      $5\frac{1}{3}$

### Exercise 6.11

**1**     27

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

**3**      $\frac{2}{9}$

**4**      $\frac{4}{9}$

**5**      $\frac{2}{9}$

**6**      $\frac{1}{5}$

**7**     2

**8**      $\frac{1}{12}$

**9**     7

**10**     $2\frac{2}{3}$

**11**     $\frac{2}{3}$

**12**    2

**13**     $\frac{4}{7}$

**14**     $1\frac{3}{4}$

**15**     $1\frac{3}{5}$

**16**     $\frac{2}{15}$

**17**     $\frac{9}{14}$

**18**     $15\frac{3}{4}$

**19**     $3\frac{22}{27}$

**20**     $6\frac{3}{5}$



*All answers were written by the authors.*

## 7 Indices 1

### Exercise 7.1

- 1      a)  $6^4$   
         b)  $7^3$   
         c)  $8^5$   
         d)  $4^4$   
         e)  $2^6$   
         f)  $10^2$
- 2      a)  $5^2 \times 4^3$   
         b)  $3^2 \times 5^3$   
         c)  $2^3 \times 3^2 \times 4^5$   
         d)  $7^3 \times 8^2 \times 9^3$
- 3      a) 64  
         b) 64  
         c) 81  
         d) 100 000

### Exercise 7.2

- 1       $5^5$   
2       $6^9$   
3       $10^7$   
4       $3^{11}$   
5       $8^5$   
6       $4^5$   
7       $9^9$   
8       $6^8$

**9**       $4^8$

**10**      $5^7 \times 6^2$

**11**      $2^9 \times 3^8$

**12**      $7^8 \times 8^5$

**13**      $5^8$

**14**      $6^9$

**15**      $8^8$

### Exercise 7.3

**1**      **a)**       $10^3$

**b)**       $3^3$

**c)**       $8^2$

**d)**       $7^2$

**e)**      6

**2**      **a)**       $3^3$

**b)**       $2^2$

**c)**       $5^4$

**d)**       $4^3$

**e)**       $2^7$

**f)**       $6^6$

### Exercise 7.4

**1**      **a)**       $\frac{1}{6}$

**b)**       $\frac{1}{9}$

**c)**      1

**d)**       $\frac{1}{25}$

e)  $\frac{1}{1000}$

2 a) 2

b) 9

c)  $\frac{3}{2} = 1\frac{1}{2}$

d)  $\frac{16}{9} = 1\frac{7}{9}$

e)  $\frac{125}{8} = 15\frac{5}{8}$

3 a) 3

b) 5

c) 36

d)  $\frac{1}{8}$

### Exercise 7.5

1 a)  $n^{\frac{1}{3}}$

b)  $x^{\frac{1}{6}}$

c)  $m^{\frac{5}{3}}$

d)  $p^{\frac{4}{5}}$

2 a)  $\frac{1}{4}$

b) 2

c) 1

d)  $\frac{1}{16}$

e) 8



- 3**      **a)**      2
- b)**       $\frac{1}{8}$
- c)**      16
- d)**      64
- e)**      8
- 4**      **a)**       $\frac{1}{9}$
- b)**      3
- c)**      1
- d)**       $\frac{1}{81}$
- e)**      27
- 5**      **a)**      3
- b)**      81
- c)**       $\frac{1}{27}$
- d)**       $\frac{1}{3}$
- e)**      1
- 6**      **a)**      8
- b)**       $\frac{1}{4}$
- c)**      1
- d)**       $\frac{1}{16}$
- e)**      32

**7**     **a)**     4

**b)**      $\frac{1}{2}$

**c)**     1

**d)**     64

**e)**      $\frac{1}{128}$

**8**     **a)**     28

**b)**     6

**c)**      $\frac{1}{4}$

**d)**     5

**9**     **a)**     12

**b)**     64

**c)**      $\frac{1}{3}$

**d)**     27

**10**    **a)**     9

**b)**     16

**c)**      $\frac{16}{3} = 5\frac{1}{3}$

**d)**     15

**11**    **a)**     125

**b)**     6

**c)**     100

**d)**      $\frac{343}{3} = 114\frac{1}{3}$

**12**     **a)**     1000

**b)**      $\frac{455}{4} = 113\frac{3}{4}$

**c)**      $\frac{2}{25}$

**d)**      $-\frac{24}{5} = 4\frac{4}{5}$

*All answers were written by the authors.*

## 8 Standard form

### Exercise 8.1

- 1**
- a)  $7 \times 10^3$
  - b)  $8.4 \times 10^4$
  - c)  $5.63 \times 10^2$
  - d)  $6.5 \times 10^6$
  - e)  $7.23 \times 10^5$
  - f)  $2.7 \times 10^1$
  - g)  $5.34 \times 10^4$
  - h)  $6.93 \times 10^2$
  - i)  $4.39 \times 10^3$
  - j)  $4.123 \times 10^8$
  - k)  $8 \times 10^6$
  - l)  $3.92 \times 10^7$
- 2**
- a)  $3 \times 10^{-3}$
  - b)  $5.6 \times 10^{-2}$
  - c)  $8 \times 10^{-4}$
  - d)  $6.3 \times 10^{-6}$
  - e)  $8.2 \times 10^{-5}$
  - f)  $6.0 \times 10^{-3}$
  - g)  $3.8 \times 10^{-7}$
  - h)  $7.8 \times 10^{-1}$



i)  $3.69 \times 10^{-3}$

j)  $6.58 \times 10^{-4}$

k)  $5.6 \times 10^{-10}$

l)  $7.23 \times 10^{-6}$

**3** a) 50 000

b) 370 000

c) 0.0007

d) 6 900 000

e) 0.0061

f) 47 300

g) 27 900 000

h) 0.000 0483

i) 0.0103

j) 989 000 000

k) 0.000 002 61

l) 370

m) 3690

n) 0.000 607

o) 0.000 000 548

p) 1 980 000 000

**4**  $7.2 \times 10^9$

## Exercise 8.2

- 1**
- a)  $8 \times 10^7$
  - b)  $1.2 \times 10^{11}$
  - c)  $5.6 \times 10^6$
  - d)  $3 \times 10^3$
  - e)  $5.2 \times 10^7$
  - f)  $4 \times 10^5$
  - g)  $7.2 \times 10^5$
  - h)  $5 \times 10^5$
  - i)  $5.6 \times 10^{-6}$
  - j)  $2.5 \times 10^{-9}$
  - k)  $6.4 \times 10^4$
  - l)  $6.997 \times 10^6$
  - m)  $5.83 \times 10^5$
  - n)  $4.56 \times 10^9$
  - o)  $7.158 \times 10^6$
  - p)  $6.88 \times 10^{-4}$
- 2**
- a)  $2.356 \times 10^{13}$
  - b)  $1.5 \times 10^5$
  - c)  $1.45 \times 10^{11}$
  - d)  $1.073 \times 10^{-6}$
  - e)  $3.25 \times 10^4$

- f)**  $2.03 \times 10^9$
- g)**  $2.704 \times 10^{13}$
- h)**  $9.61 \times 10^{-8}$
- i)**  $3.692 \times 10^6$
- j)**  $8.019 \times 10^5$
- k)**  $5.202 \times 10^{-3}$
- l)**  $6.7484 \times 10^{-3}$
- m)**  $-4.2368 \times 10^{-3}$
- n)**  $7.3164 \times 10^8$

*All answers were written by the authors.*

## 9 Estimation

### Exercise 9.1

- 1      a)      2.4 m to 3.5 m  
         b)      5 m to 7 m
- 2      8.5 m to 10 m
- 3      12 m to 15 m

### Exercise 9.2

- 1      a)      4.6  
         b)      5.5  
         c)      4.6  
         d)      8.4  
         e)      0.5  
         f)      0.1  
         g)      82.2  
         h)      3.0  
         i)      6.2  
         j)      0.5  
         k)      5.2  
         l)      48.0  
         m)      0.9  
         n)      7.7  
         o)      10.0
- 2      a)      5.48  
         b)      12.08  
         c)      0.21  
         d)      0.57

- e) 9.02
- f) 78.04
- g) 7.01
- h) 0.07
- i) 1.52
- j) 2.13
- k) 9.42
- l) 0.84
- m) 0.28
- n) 0.85
- o) 7.09
- p) 18.63
- q) 7.11
- r) 8.08
- s) 4.66
- t) 3.73
- 3** a) 9.34
- b) 17.16
- c) 2.94
- d) 53.96
- 4** a) 0.1
- b) 0.4
- c) 0.4
- d) 0.4
- 5** 7.4

- 6**     **a)**     0.333  
         **b)**     0.286  
         **c)**     0.273  
         **d)**     0.308  
         **e)**     4.667
- 7**     7.3
- 8**     850
- 9**      $17.7 \text{ cm}^2$
- 10**     $40.32 \text{ cm}^2$
- 11**     $112.0 \text{ cm}^3$
- 12**    6670 km

### Exercise 9.3

- 1**     **a)**     4  
         **b)**     6  
         **c)**     8  
         **d)**     4  
         **e)**     6  
         **f)**     60  
         **g)**     50  
         **h)**     30  
         **i)**     300  
         **j)**     5000
- 2**     **a)**     4000  
         **b)**     30  
         **c)**     900  
         **d)**     60  
         **e)**     0.002

- f) 6
- g) 5
- h) 0.003
- i) 0.003
- j) 0.05
- 3** a) 18
- b) 180
- c) 5700
- d) 98 000
- e) 50
- f) 0.17
- g) 0.039
- h) 0.0061
- i) 0.031
- j) 0.99
- 4** a) 8.26
- b) 69.8
- c) 16 300
- d) 208
- e) 12 500
- f) 7.10
- g) 50.9
- h) 0.416
- i) 0.0386
- j) 3.14
- 5** 1600
- 6** The actual number was 35 085, which is 35 000 to 2 significant figures.

## Exercise 9.4

- 1  $200 \times 0.9 = \$180$
- 2  $6 \times 9 = 54 \text{ cm}^2$
- 3  $20 \times 30 = 600\text{c} = \$6$
- 4  $\text{Volume} = 4 \times 2 \times 2 = 16 \text{ cm}^3$
- 5  $60 \div 10 = 6 \text{ cm}$
- 6  $3000 \div 8 = 375 \text{ km (or 380 km or 400 km)}$
- 7  $20 \times 20 = \$400$
- 8  $200 \times 0.7 = \$140$
- 9  $3 \times 3 \times 3 = 27 \text{ m}^2$
- 10
  - a)  $6 \times 2 = 12$
  - b)  $20 \div 4 = 5$
  - c)  $40 \times 20 = 800$
  - d)  $10 \div 4 = 2.5$
  - e)  $2 \times 0.8 = 1.6$
  - f)  $3 \times 8 = 24$
  - g)  $100 \times 3 = 300$
  - h)  $5 \times 0.03 = 0.15$
- 11
  - a)  $4 \times 10 \times 20 = 800$
  - b)  $0.9 \times 5 = 4.5$
  - c)  $60 \times 10 = 600$
  - d)  $200 \times 60 \times 3 = 36\,000$
  - e)  $10 \times 0.07 = 0.7$
  - f)  $0.2 \times 0.8 = 0.16$
  - g)  $50 \times 80 = 4000$
  - h)  $7^2 = 49$
  - i)  $40 \times 20 \times 30 = 24\,000$
  - j)  $900 \times 40 = 36\,000$



- k)**  $3 \times 10 = 30$
- l)**  $50 \times (20 + 40) = 3000$
- 12 a)**  $4 \times 80 = 320$ ; estimate is smaller because the rounded values of both numbers are smaller than the actual values.
- b)**  $200 \div 10 = 20$ ; estimate is bigger because the rounded value of the number being divided is bigger than the actual value being divided and the rounded value of the number it is divided by is smaller than the actual value.
- c)**  $20 \times 900 = 18\,000$ ; estimate is bigger because the rounded values of both numbers are bigger than the actual values.
- 13 a)**  $5 \times 7 = 35 \text{ cm}^2$
- b)** Greater because the rounded values of both lengths are greater than the actual lengths.
- 14 a)**  $20 \div 6 \approx 3.3 \text{ cm}$  (or 3 cm)
- b)** Greater because the rounded value of the area is greater than the actual area and the rounded value of the length is less than the actual length.

### Exercise 9.5

- 1**  $30 \div 5 = 6$
- 2**  $270 \div 90 = 3$
- 3**  $45 \div 9 = 5$
- 4**  $49 \div 7 = 7$
- 5**  $(2 \times 3) \div 3 = 2$
- 6**  $\frac{15 \times 20}{60} = 5$
- 7**  $\sqrt{5 \times 5} = 5$
- 8**  $\frac{\sqrt{8 \times 2}}{2} = 2$
- 9**  $(0.4 \times 80) \div 8 = 4$
- 10**  $1 \div 5 = 0.2$
- 11**  $30 \times \sqrt{121} = 330$
- 12**  $\frac{60 \times 10}{10 \times 5} = 12$
- 13**  $45 \div 0.09 = 500$

14  $\sqrt{81} = 9$

15  $\frac{1000}{10} = 100$

16  $\frac{2}{20} = 0.1$

17  $\frac{30}{40} = 0.75$

18  $\frac{280 \times 100}{700} = 40$

19  $\frac{600 \times 0.8}{4 \times 2} = 60$

20  $\frac{7}{0.05 \times 40} = 3.5$

21  $\sqrt{36 \times 81} = 54$

### Exercise 9.6

1 a)  $3\frac{1}{2}$  minutes

b) 3 weeks

c) 3 kg

d) 2 m

2 a) 5.7 m

b) 2.8 mm or 3 mm

c) 6650 km or 6600 km

d) 67.6 kg or 68 kg

e)  $0.097 \text{ cm}^2$

All answers were written by the authors.

## 10 Limits of accuracy

### Exercise 10.1

- 1
- a)
    - i) 26.5 cm, 27.5 cm
    - ii) 29.5 cm, 30.5 cm
    - iii) 127.5 cm, 128.5 cm
  - b)
    - i) 5 cm, 15 cm
    - ii) 25 cm, 35 cm
    - iii) 145 cm, 155 cm
  - c)
    - i) 5.55 cm, 5.65 cm
    - ii) 0.75 cm, 0.85 cm
    - iii) 11.95 cm, 12.05 cm
  - d)
    - i) 1.225 m, 1.235 m
    - ii) 0.445 m, 0.455 m
    - iii) 9.075 m, 9.085 m
  - e)
    - i) 10.615 s, 10.625 s
    - ii) 9.805 s, 9.815 s
    - iii) 48.095 s, 48.105 s
- 2
- a) 56.5 kg and 57.5 kg
  - b) 4.65 m and 4.75 m
  - c) 467.5 ml and 468.5 ml
  - d) 34.905 s and 34.915 s
  - e) 0.6335 kg and 0.6345 kg
- 3
- Each pole is between 99.5 cm and 100.5 cm.
- He can be sure of reaching a height of  
 $10 \times 99.5 = 995$  cm or 9.95 m.
- 4
- a) Greatest perimeter = 36 cm
  - b) Smallest area =  $51.75 \text{ cm}^2$

## Exercise 10.2

- 1**     **a)**     61.2 s  
         **b)**     24.51 s  
         **c)**     12.4 m  
         **d)**     1.747 kg  
         **e)**     185 mm
- 2**     **a)**     61 s  
         **b)**     24.49 s  
         **c)**     12.38 m  
         **d)**     1.745 kg  
         **e)**     183 mm
- 3**     **a)**     704 g  
         **b)**     6.7 cm  
         **c)**     4.4 s  
         **d)**     0.16 s  
         **e)**     9000 m
- 4**     **a)**     702 g  
         **b)**     6.5 cm  
         **c)**     4.2 s  
         **d)**     0.14 s  
         **e)**     8800 m
- 5**     50.80 cm
- 6**     **a)**     29.20 s  
         **b)**     1.06 s
- 7**     Upper bound = 26.5 cm; lower bound = 23.5 cm
- 8**     **a)**     Upper bound = 13.8; lower bound = 13.6  
         **b)**     Upper bound = 3.6; lower bound = 3.4
- 9**     No; 595.5 mm is greater than 59.5 cm.

## Exercise 10.3

- 1 75 mm
- 2
  - a) Upper bound =  $20.507\,175\text{ m}^2$ ; lower bound =  $20.415\,675\text{ m}^2$
  - b) Upper bound =  $40.1625\text{ m}^2$ ; lower bound =  $38.8825\text{ m}^2$
- 3
  - a) Upper bound =  $1141.7575\text{ cm}$ ; lower bound =  $1131.2875\text{ cm}$
  - b) Upper bound =  $12.676\,725\text{ m}$ ; lower bound =  $12.579\,325\text{ m}$
  - c) Upper bound =  $146.625\text{ km}$ ; lower bound =  $138.425\text{ km}$
  - d) Upper bound =  $11.707\,275\text{ m}$ ; lower bound =  $11.630\,375\text{ m}$
- 4
  - a) Upper bound =  $5.61\text{ cm/s}$ ; lower bound =  $5.08\text{ cm/s}$
  - b) Upper bound =  $10.7\text{ m/s}$ ; lower bound =  $10.5\text{ m/s}$
- 5
  - a)  $11.7\text{ cm}$
  - b)  $10.6\text{ cm}$
- 6 Upper bound =  $844\text{ people/square km}$ ; lower bound =  $830\text{ people/square km}$
- 7 Upper bound =  $536.25\text{ cm}^2$ ; lower bound =  $490.25\text{ cm}^2$
- 8
  - a) Upper bound =  $87.95\text{ cm}^3$ ; lower bound =  $81.37\text{ cm}^3$
  - b) Upper bound =  $1702\text{ g}$ ; lower bound =  $1566\text{ g}$
- 9 Upper bound =  $84.5$ ; lower bound =  $20.2$
- 10 Don Quarrie's time is between  $9.85\text{ s}$  and  $9.95\text{ s}$ .  
 Calvin Smith's time is between  $9.925\text{ s}$  and  $9.935\text{ s}$ .  
 So Quarrie could have run faster, e.g.  $9.85\text{ s}$  is faster than  $9.925\text{ s}$ .  
 However, Smith could have run faster, e.g.  $9.935\text{ s}$  is faster than  $9.95\text{ s}$ .
- 11 Min Volume:  $79.5 \times 74.5 \times 89.5$   
 $= 530\,086.125\text{ cm}^3 = 530.08\text{.. litres}$   
 Max Volume:  $80.5 \times 75.5 \times 90.5$   
 $= 550\,036.375\text{ cm}^3 = 550.03\text{.. litres}$   
 Min volume  $< 550\text{ litres} < \text{Max volume}$ ; so yes.

*All answers were written by the authors.*

## 11 Ratio and proportion

### Exercise 11.1

- 1**
- a) 2:1
  - b) 1:3
  - c) 5:1
  - d) 2:3
  - e) 1:5
  - f) 5:4
  - g) 3:1
  - h) 1:12
  - i) 1:9
  - j) 1:9
- 2**
- a) 1:3
  - b) 1:20
  - c) 3:10
  - d) 10:3
  - e) 4:1
- 3**
- a) 1:20
  - b) 3:20
  - c) 16:3
  - d) 3:20
- 4**
- a) 1:3:5
  - b) 3:6:4
  - c) 1: 4:5
- 5**
- a) 1:5:10
  - b) 1:4:6
  - c) 12:15:20
- 6** 5:8:10

## Exercise 11.2

- 1**     **a)**     1:3  
         **b)**     1:5  
         **c)**     1:2.5  
         **d)**     1:1.75  
         **e)**     1:7.5  
         **f)**     1:125  
         **g)**     1:0.2  
         **h)**     1:500 000
- 2**     **a)**     1:4  
         **b)**     1:2.4  
         **c)**     1:50  
         **d)**     1:250 000  
         **e)**     1:0.4
- 3**     1:250 000
- 4**     1:6

## Exercise 11.3

- 1**     **a)**     24 babies  
         **b)**     9 helpers
- 2**     **a)**     6 litres  
         **b)**     4 litres
- 3**     **a)**     30 ml  
         **b)**     10 teaspoons
- 4**     **a)**     100 ml  
         **b)**     36 ml
- 5**     **a)**     150 g  
         **b)**     48 g
- 6**     \$120

### Exercise 11.4

- 1     a)     15 litres  
       b)     25 litres
- 2     a)     50 ml  
       b)     250 ml
- 3     Amit \$320; Bree \$800; Chris \$480
- 4     400 g copper; 200 g zinc
- 5     20 boys
- 6     800 m
- 7     0.5 litres
- 8     Blue 312; Orange 156; Green 104
- 9     a)     400 g  
       b)     80 g

### Exercise 11.5

- 1     a)      $\frac{8}{3}$   
       b)     440 m
- 2     a)      $\frac{12}{27}$  or  $\frac{4}{9}$   
       b)     96 km
- 3     a)      $\frac{175}{50}$  or  $\frac{7}{2}$   
       b)     \$315
- 4     a)      $\frac{5}{7}$   
       b)     20 rungs
- 5     a)      $\frac{15}{27}$  or  $\frac{5}{9}$   
       b)     195 g
- 6     a)      $\frac{0.9}{2.5}$  or  $\frac{9}{25}$   
       b)     178.2 kg



**Exercise 11.6**

- 1**     a)      $\frac{48}{32}$  or  $\frac{3}{2}$   
          b)     12 minutes
- 2**     a)      $\frac{12}{8}$  or  $\frac{3}{2}$   
          b)     4 weeks
- 3**     a)      $\frac{3}{4}$   
          b)     24 hours
- 4**     a)      $\frac{40}{50}$  or  $\frac{4}{5}$   
          b)     55 minutes
- 5**     a)      $\frac{20}{12}$  or  $\frac{5}{3}$   
          b)     9 days
- 6**     a)      $\frac{2}{3}$   
          b)     9 hours
- 7**     a)      $\frac{3}{4}$   
          b)     16 kilometres per hour
- 8**     a)      $\frac{14}{18}$  or  $\frac{7}{9}$   
          b)     27 weeks
- 9**     a)      $\frac{8}{6}$  or  $\frac{4}{3}$   
          b)     13.5 hours
- 10**   a)      $\frac{15}{9}$  or  $\frac{5}{3}$   
          b)     12 days

*All answers were written by the authors.*

## 12 Rates

### Exercise 12.1

- 1 20 minutes
- 2 500 kg/minute
- 3 1164 litres
- 4 \$239.40
- 5 a) \$8.64  
b) \$138.24

### Exercise 12.2

- 1 50 km/hour
- 2 4.5 m/s
- 3 12 km/hour
- 4 18 km/hour
- 5 11.4 seconds

### Exercise 12.3

- 1 80 N/m<sup>2</sup>
- 2 8.75 g/cm<sup>3</sup>
- 3 7500 people/km<sup>2</sup>
- 4 11 000 people/km<sup>2</sup>, correct to the nearest thousand
- 5 6 g
- 6 20 square miles
- 7 19.81 g
- 8 28.19 square miles
- 9 12 N

*All answers were written by the authors.*

## 13 Percentages

### Exercise 13.1

- 1      a)  $\frac{3}{4}$
- b)  $\frac{3}{25}$
- c)  $\frac{3}{50}$
- d)  $\frac{4}{5}$
- 2      a) 0.27
- b) 0.86
- c) 0.03
- d) 0.08
- e) 1.5
- f) 1.4
- g) 2.5
- h) 1.74
- i) 0.027
- j) 0.036
- k) 0.128
- l) 0.173

### Exercise 13.2

- 1      a) \$20
- b) \$0.60
- c) \$0.72
- d) \$6
- e) \$18
- f) \$1

- g) \$60  
h) \$5.40  
i) \$2.58  
j) \$2  
k) \$15  
l) \$0.34
- 2 \$90
- 3 15% of \$20 = \$3; 20% of \$15 = \$3. Both amounts are the same.
- 4 \$1
- 5 \$400
- 6 160
- 7 108
- 8 78
- 9 \$1150
- 10 \$295.32
- 11 a) 299.25  
b) 20.25  
c) \$230.40  
d) 351.5 m  
e) 113.16  
f) \$170.28  
g) 20.28  
h) 2.76  
i) \$2.56  
j) \$2.10
- 12 \$157.50
- 13 46 seats (round 45.05 up to nearest integer)

### Exercise 13.3

- 1**     **a)**     12%  
         **b)**     8%  
         **c)**     40%  
         **d)**     25%  
         **e)**     40%  
         **f)**     15%
- 2**     **a)**     16%  
         **b)**     24%  
         **c)**     25%  
         **d)**     30%  
         **e)**     73%  
         **f)**     8%  
         **g)**     90%  
         **h)**     20%  
         **i)**     5%  
         **j)**     130%
- 3**     56%
- 4**     24%
- 5**     15%
- 6**     20%
- 7**     32%
- 8**     55%
- 9**     **a)**     12.5%  
         **b)**     26.7%  
         **c)**     47.5%  
         **d)**     85%  
         **e)**     79.2%  
         **f)**     66.4%
- 10**    42.5%
- 11**    14.7%

- 12**     93.3%
- 13**     59.4%
- 14**     93.3%
- 15**     42%

### Exercise 13.4

- 1**     20%
- 2**     12%
- 3**     52%
- 4**     27%
- 5**     15%

### Exercise 13.5

- 1**     **a)**     \$480  
         **b)**     \$580  
         **c)**     \$424  
         **d)**     \$720
- 2**     **a)**     \$140  
         **b)**     \$170  
         **c)**     \$194  
         **d)**     \$80
- 3**     \$30 000
- 4**     \$12 480
- 5**     \$10.40
- 6**     \$1290
- 7**     1.68 m
- 8**     \$173.90
- 9**     \$327.60
- 10**    \$2655

### Exercise 13.6

- 1**     **a)**     1.13  
         **b)**     1.2  
         **c)**     1.68  
         **d)**     1.08  
         **e)**     1.02  
         **f)**     1.175  
         **g)**     2.5
- 2**     **a)**     0.86  
         **b)**     0.8  
         **c)**     0.55  
         **d)**     0.93  
         **e)**     0.97  
         **f)**     0.77  
         **g)**     0.835
- 3**     \$4.78
- 4**     \$29.40
- 5**     \$32.40

### Exercise 13.7

- 1**     75 tonnes
- 2**     40
- 3**     \$50
- 4**     56 500
- 5**     \$12 500
- 6**     \$14 200
- 7**     \$8800
- 8**     \$27 000
- 9**     \$24 000
- 10**    \$480

### Exercise 13.8

- 1     a)     \$915  
       b)     \$10 140
- 2     \$28
- 3     \$1475
- 4     22.7%
- 5     Bob's Budget Bargains by 0.65%
- 6     60%
- 7     7.83%

### Exercise 13.9

- 1     \$285.84
- 2     a)     \$12.58  
       b)     \$1548.10  
       c)     \$730.81  
       d)     \$2924.26
- 3     \$1754.79
- 4     a)     \$3646.52  
       b)     \$9621.41  
       c)     \$4231.80
- 5     \$16 488
- 6     \$38 774
- 7     a)     180 419 dubs  
       b)     365 760 dubs
- 8     a)     \$4051.69  
       b)     \$5033.40
- 9     SI: \$680; CI: \$665.50. Difference = \$14.50
- 10    5 years: \$1469.33; 4 years: \$1411.58. So 5 years at 8% is better.
- 11    5 years



*All answers were written by the authors.*

## 14 Using a calculator

### Exercise 14.1

- 1 0.368 to 3 s.f.
- 2  $-4.03$  to 3 s.f.
- 3  $-22.572$
- 4 0.191 to 3 s.f.
- 5 5
- 6 3.84
- 7 4.5
- 8 9.2
- 9 4.48
- 10 1.20 to 3 s.f.
- 11 1.23 to 3 s.f.
- 12 34.123
- 13 1.3
- 14 3.45 to 3 s.f.
- 15 2.68 to 3 s.f.
- 16 2.65 to 3 s.f.
- 17 1.78 to 3 s.f.
- 18 1.85 to 3 s.f.
- 19 17.4 to 3 s.f.
- 20 3.77 to 3 s.f.
- 21 0.0673 to 3 s.f.
- 22 1.44 to 3 s.f.

## Exercise 14.2

- 1
  - a)  $2.35 \times 10^{13}$
  - b)  $4.69 \times 10^5$
  - c)  $1.87 \times 10^{11}$
  - d)  $2.55 \times 10^{-6}$
  - e)  $2.61 \times 10^5$
  - f)  $2.76 \times 10^8$
  - g)  $3.17 \times 10^{11}$
  - h)  $7.67 \times 10^{-7}$
- 2  $6.4 \times 10^{10} \text{ km}^2$
- 3
  - a)  $6.32 \times 10^7$
  - b) 259 people/km<sup>2</sup> or 260 people/km<sup>2</sup>
- 4
  - a)  $1.5 \times 10^4$  seconds
  - b)  $4.35 \times 10^9 \text{ km}$
- 5
  - a)  $4.299 \times 10^9$
  - b) 99 people/km<sup>2</sup> or 100 people/km<sup>2</sup>
- 6
  - a)  $1.5 \times 10^{11}$
  - b) 495 seconds ( 8 minutes 15 seconds)

## Exercise 14.3

- 1
  - a)  $40 \times 20 = 800$ ; so could be correct.
  - b) Wrong. Dividing by a number greater than 1 reduces the value.
  - c) Wrong.  $8000 \times 10 = 80\,000$ .
  - d) Wrong.  $12 \times 9 = 108$ .
  - e)  $5 \times 20 = 100$ ; so he is correct (since  $17.99 < 20$ ).
- 2
  - a) Negative  $\div$  negative = positive.
  - b)  $12.4 \times 1 = 12.4$ , so the answer should be less than 12.4
  - c)  $30 \times 4 = 120$ , so  $30 \times 40 = 1200$
  - d)  $8 = \sqrt{64}$  and  $9 = \sqrt{81}$ , so the answer should lie between 8 and 9.
  - e) The square of a number between 0 and 1 is smaller than the number.

- f)  $16 \div 8 = 2$ .
- g) Dividing 125 by a number between 0 and 1 has an answer that is greater than 125.
- h) Positive  $\times$  negative = negative.
- i) The last digit should be  $7 + 2 = 9$ .
- j) Dividing 76 by a number between 0 and 1 has an answer that is greater than 76.

### Exercise 14.4

- 1 5.55 litres
- 2 0.57 m to 2 d.p.
- 3
  - a) \$62.50
  - b) \$8.37 (as  $8 \times 8.38 > 67$ )
  - c) \$11.41 (as  $12 \times 11.42 > 137$ )
  - d) \$27.94
- 4 \$99.60

### Exercise 14.5

- 1
  - a) 1.75 hours
  - b) 2.2 hours
  - c) 0.65 hours
- 2
  - a) 5.25 minutes
  - b) 3.45 minutes
  - c) 0.7 minutes
- 3
  - a) 3 hours 30 minutes
  - b) 1 hour 18 minutes
  - c) 4 hours 51 minutes
- 4
  - a) 3 minutes 45 seconds
  - b) 2 minutes 24 seconds
  - c) 1 minutes 54 seconds
- 5 2 hours 40 minutes

*All answers were written by the authors.*

## 15 Time

### Exercise 15.1

- 1**
- a) 11.45 a.m.
  - b) 5.53 a.m.
  - c) 1.40 a.m.
  - d) 9.20 a.m.
  - e) 12.10 a.m.
  - f) 10.41 a.m.
  - g) 2.32 a.m.
  - h) 4.30 a.m.
  - i) 11.20 a.m.
  - j) 12.48 a.m.
- 2**
- a) 1.45 p.m.
  - b) 3.53 p.m.
  - c) 9.40 p.m.
  - d) 10.59 p.m.
  - e) 12.10 p.m.
  - f) 2.40 p.m.
  - g) 5.23 p.m.
  - h) 7.40 p.m.
  - i) 8.19 p.m.
  - j) 12.03 p.m.
- 3**
- a) 01 50
  - b) 14 40
  - c) 11 49
  - d) 18 30
  - e) 00 02
  - f) 03 20
  - g) 14 08

- h) 00 49
  - i) 09 35
  - j) 23 02
- 4**
- a) 3.45 a.m.
  - b) 2.56 p.m.
  - c) 11.40 p.m.
  - d) 11.59 a.m.
  - e) 12.55 p.m.
  - f) 4.35 a.m.
  - g) 3.16 p.m.
  - h) 9.40 p.m.
  - i) 1.59 a.m.
  - j) 2.52 p.m.

## Exercise 15.2

- 1** 15 30
- 2** 6 hours and 45 minutes
- 3** 10.35 a.m.
- 4** 2 hours and 35 minutes
- 5** 1 hour and 45 minutes
- 6** 2 hours and 33 minutes
- 7**
  - a)
    - i) 1 hour and 25 minutes
    - ii) 2 hours
    - iii) 2 hours and 30 minutes
    - iv) 3 hours and 40 minutes
  - b)
    - i) 12 10
    - ii) 13 55
- 8** 7.05 p.m.
- 9** 7.55 a.m.
- 10** 09 50

### Exercise 15.3

- 1**      **a)**      5 hours 24 minutes  
         **b)**      3 hours 16 minutes  
         **c)**      2 hours 50 minutes  
         **d)**      12 hours 46 minutes
- 2**      **a)**      4.25 hours  
         **b)**      1.83 hours  
         **c)**      0.75 hours  
         **d)**      10.65 hours  
         **e)**      3.63 hours
- 3**      **a)**      4 minutes 42 seconds  
         **b)**      5 minutes 15 seconds  
         **c)**      25 minutes 18 seconds  
         **d)**      24 seconds
- 4**      18 36 or 6.36 p.m.
- 5**      42.64 km/h
- 6**      19 24 or 7.24 p.m.
- 7**      16 05 or 4.05 p.m.
- 8**      7 hours

All answers were written by the authors.

## 16 Money

### Exercise 16.1

Other comparisons are possible but the same conclusion should be reached.

- 1 25.8 cents/litre, 43.5 cents/litre; 5 litres is best value.
- 2 \$1.33/litre, \$1.35/litre, \$1.14/litre, \$1.30/litre; 1 litre is best value.
- 3 3.17 cents/ml, 2.89 cents/ml; 200 ml is best value.
- 4 0.33 cents/ml, 0.16 cents/ml, 0.15 cents/ml;  $12 \times 330$  ml is best value
- 5 0.12 cents/gram, 0.1175 cents/gram; 1.2 kg is best value
- 6 0.757 cents/gram, 0.671 cents/gram; 325 g is best value
- 7 0.762 cents/gram, 0.796 cents/gram; 680 g is best value
- 8 A: \$18.75, B: \$19; restaurant A is best value

### Exercise 16.2

- 1 a) 24 340.80 PKR  
b) \$34.51
- 2 a) 1164.80 AED  
b) €204.33
- 3 a) 114 862.50 JPY  
b) 161.03 AUD
- 4 a) 22 941 MUR  
b) £68.65
- 5 a) Internet  
b) i) 705 PKR  
ii) \$6.95
- 6 a) i) 1.54 Singapore dollars  
ii) €0.65  
b) €155.77 (accept €155 to €156)

All answers were written by the authors.

## 17 Exponential growth and decay

### Exercise 17.1

- 1      \$877
- 2      \$6337
- 3      a)      25  
         b)      9506
- 4      3525
- 5      a)       $m = 50 \times 0.9^t$   
         b)      (i)      36.45 g  
                 (ii)      17.4 g
- 6      \$35 500
- 7      a)      100 g  
         b)      i)      3  
                 ii)      0
- 8      \$34 696
- 9      a)       $v = 9000 \times 0.88^t$   
         b)      i)      \$6133  
                 ii)      \$3237
- 10    a)       $P = 60 \times 1.05^t$   
         b)      (i)      76 577 000  
                 (ii)      2.97 billion



All answers were written by the authors.

## 18 Surds

### Exercise 18.1

- 1**
- a)  $2\sqrt{3}$ , I
  - b)  $10\sqrt{10}$ , I
  - c)  $3\sqrt{5}$ , I
  - d)  $10\sqrt{3}$ , I
  - e)  $5\sqrt{3}$ , I
  - f) 4, R
  - g)  $6\sqrt{10}$ , I
  - h) 2, R
  - i)  $20\sqrt{10}$ , I
  - j)  $15\sqrt{5}$ , I
  - k)  $2\sqrt{10}$ , I
  - l)  $3\sqrt{6}$ , I
  - m)  $7\sqrt{2}$ , I
  - n)  $20\sqrt{2}$ , I
  - o)  $11\sqrt{3}$ , I
  - p) 9, R
  - q) 100, R
  - r) 3, R
  - s)  $30\sqrt{2}$ , I
  - t) 10, R
- 2**
- a) 8
  - b)  $2\sqrt{3}$
  - c) 13
- 3**
- a) 8

- b)  $2 + 2\sqrt{7}$
- c)  $8 - 2\sqrt{7}$
- 4 a)  $7 - 2\sqrt{5}$
- b)  $-1 + 4\sqrt{5}$
- c)  $14 + 6\sqrt{5}$
- 5 a)  $13 - \sqrt{11}$
- b)  $-5 + 3\sqrt{11}$
- c)  $27 + 8\sqrt{11}$
- 6 a)  $5\sqrt{3} + 6$
- b)  $37 + 20\sqrt{3}$
- c)  $34 - 24\sqrt{2}$
- 7 a)  $6\sqrt{5} - 10$
- b)  $3\sqrt{3} - 15$
- c)  $56 - 24\sqrt{5}$
- d)  $84 - 30\sqrt{3}$
- 8  $60 + 43\sqrt{2}$
- 9 37

## Exercise 18.2

- 1 a)  $\frac{\sqrt{2}}{2}$
- b)  $\frac{2\sqrt{5}}{5}$
- c)  $\frac{5\sqrt{7}}{7}$
- d)  $\frac{11\sqrt{2}}{6}$

e)  $\frac{9\sqrt{5}}{10}$

f)  $\frac{\sqrt{7}}{7}$

g)  $\frac{3\sqrt{2}}{2}$

h)  $\frac{5\sqrt{11}}{11}$

i)  $\frac{7\sqrt{2}}{10}$

j)  $\frac{9\sqrt{2}}{8}$

2 a)  $\frac{3\sqrt{2}}{2}$

b)  $\frac{\sqrt{3}}{5}$

c)  $\frac{4\sqrt{3}}{5}$

d)  $\frac{2\sqrt{6}}{3}$

e)  $2\sqrt{5}$

f)  $\frac{3\sqrt{2}}{2}$

g)  $\frac{5\sqrt{2}}{2}$

h)  $\frac{6\sqrt{5}}{5}$

i)  $5\sqrt{2}$

j)  $\frac{\sqrt{10}}{5}$

k)  $\frac{2\sqrt{10}}{15}$

- l)  $\frac{7\sqrt{2}}{10}$
- m)  $\frac{\sqrt{6}}{3}$
- n)  $\frac{12\sqrt{10}}{35}$
- 3** a)  $3 + 3\sqrt{2}$
- b)  $\frac{1 + 3\sqrt{5}}{2}$
- c)  $\frac{4\sqrt{3} + \sqrt{6}}{2}$
- d)  $\frac{5\sqrt{6} + 6\sqrt{2}}{6}$
- 4** a)  $2 + \sqrt{3}$
- b)  $2(4 + \sqrt{11})$  or  $8 + 2\sqrt{11}$
- c)  $3(3 - \sqrt{5})$  or  $9 - 3\sqrt{5}$
- d)  $\frac{3 - \sqrt{7}}{2}$
- 5** a)  $\frac{7 - \sqrt{3}}{2}$
- b)  $\frac{6 - \sqrt{3}}{3}$
- c)  $-24 + 11\sqrt{5}$
- d)  $5 - \sqrt{7}$
- 6** a)  $\frac{47}{2} + \frac{21}{2}\sqrt{5}$
- b)  $-6 + 5\sqrt{5}$
- c)  $12 - \sqrt{5}$
- d)  $13 - 4\sqrt{5}$

*All answers were written by the authors.*

## 19 Introduction to algebra

### Exercise 19.1

- 1**
- a) 9
  - b) 6
  - c) 3
  - d) 11
  - e) 10
  - f) 12
  - g) 10
  - h) 19
  - i) 2
  - j) 17
  - k) 28
  - l) 14
  - m) 1
  - n) 8
  - o) 8
  - p) 40
  - q) 40
  - r) 18
  - s) 2
  - t) 25
  - u) 3
  - v) 10
  - w) 20
  - x) 12
  - y) 100
  - z) 8
- 2**
- a) 5

- b)  $-1$   
c)  $15$   
d)  $5$   
e)  $11$   
f)  $4$   
g)  $9$   
h)  $90$   
i)  $15$   
j)  $27$
- 3** a)  $19$   
b)  $39$   
c)  $4$   
d)  $6\frac{1}{2}$   
e)  $14.5$
- 4** a)  $10$   
b)  $10$   
c)  $232$
- 5** a)  $4$   
b)  $6$   
c)  $8.5$   
d)  $8$

## Exercise 19.2

- 1** a)  $V = -21$   
b)  $P = 55$   
c)  $T = 2$   
d)  $M = 10$   
e)  $R = 24$   
f)  $L = 2\frac{1}{6}$  or  $\frac{13}{6}$

**g)**  $D = \frac{8}{25}$

**h)**  $A = 34$

**i)**  $P = 38$

**j)**  $B = 4$

**2**  $M = 0.56$

**3** **a)**  $S = 720$

**b)**  $S = 30.625$

**4**  $A = 111.5$

**5**  $E = 22.1$

**6**  $f = 42$

*All answers were written by the authors.*

## 20 Algebraic manipulation

### Exercise 20.1

- 1  $5x$
- 2  $3y + 2z$
- 3  $2x + 2y$
- 4  $3a + 2b$
- 5  $5x$
- 6  $7p$
- 7  $6b$
- 8  $3p$
- 9  $4s$
- 10  $a^2 + b^2$
- 11  $3a + 3b$
- 12  $m + 2n$
- 13  $2x + y$
- 14  $x^2 - 2x - 15$
- 15  $12pq$
- 16  $8b - 4a$
- 17  $8a$
- 18  $6a + 9b$
- 19  $3x$
- 20  $3c + 4d$



## Exercise 20.2

- 1  $4ab$
- 2  $2ac + 6ab$
- 3 0
- 4  $6ab - 4ac$
- 5  $2b^2 - a^2$
- 6  $2x^2 - 4xy + y^2$
- 7  $2b^2 - a^2$
- 8  $9a^2 + 2ab - 6b^2$
- 9  $ab + bc$
- 10  $pq - 3p^2$
- 11 Cannot be simplified
- 12  $2ab + bc$
- 13  $-2a^3$
- 14 Cannot be simplified
- 15  $3a^3 + 7a^2$
- 16  $3ab^2 + 3a^2b$
- 17  $2x^2$
- 18  $13a^3 - 6a^2$
- 19  $abc$
- 20  $11ab \text{ cm}^2$

## Exercise 20.3

- 1  $2a + 2b$
- 2  $8x + 4$
- 3  $2p + 6$
- 4  $9x - 3$
- 5  $4x - 6$

- 6  $21y + 7z$   
7  $12 - 32a$   
8  $20a + 30b$   
9  $15e - 40f$   
10  $2 - 2x$   
11  $5p - 5q$   
12  $a^2 + 2a$   
13  $y^2 - y$   
14  $3y - 2y^2$   
15  $2x - x^2$   
16  $-2y - y^2$   
17  $3c^2 + 12c$   
18  $-10x^2 + 6x$   
19  $6i + 8j - 10k$   
20  $20m - 12n + 8p$

### Exercise 20.4

- 1  $12a + 3 = 3(4a + 1)$   
2  $9a + 18 = 9(a + 2)$   
3  $5y - 30 = 5(y - 6)$   
4  $6b - 4 = 2(3b - 2)$   
5  $4x + 16 = 4(x + 4)$   
6  $y^2 + 2y = y(y + 2)$   
7  $2b + 6b^2 = 2b(1 + 3b)$   
8  $8a^2 + 20a = 4a(2a + 5)$   
9  $2(x + 3)$   
10  $4(x - 5)$

- 11  $3(3 - 4x)$
- 12  $x(3x + 5)$
- 13  $5(a^2 + 2b)$
- 14  $12(2 + 3a^2)$
- 15  $10x(x - 10)$
- 16  $8(3x + 4y)$
- 17  $5a(3b - 4c)$
- 18  $6f(5f - 3g)$
- 19  $7a(6b + 5a)$
- 20  $5ab(a + 2b)$
- 21  $a(3b - 2c + 3d)$
- 22  $x^2y(2y - 3x)$
- 23  $5(x^2 - 3x + 3)$
- 24  $2(6x - 3y + 4z)$
- 25  $3b(3a + 2b)$
- 26  $2ac(2a - c)$
- 27  $4xy(3x + 2 - y)$
- 28  $3a^2b(1 - 3ab)$
- 29  $5abc(abc - 2)$
- 30  $a^2b(2 - 3b^2 + 7a^2)$
- 31  $a(4bc - 3c^2 + 2ab)$

### Exercise 20.5

- 1  $(a + b)(2x + 3)$
- 2  $(a - 2b)(5x - 3)$
- 3  $(p + q)(p + r)$
- 4  $(a + b)(x - y)$

- 5  $(a+b)(a-c)$   
6  $(a-b)(a-c)$   
7  $(b+3)(4a+3)$   
8  $(2a+3)(x-2y)$   
9  $(ax-b)(5x-2)$   
10  $(a^2+2b)(3a-2b)$   
11  $(5a+3b)(2x-y)$   
12  $(4c-3d)(2a-3b)$   
13  $(4a-3b)(2a+5c)$   
14  $(a+1)(a+b)$   
15  $(a+2b)(c+3d)$   
16  $(2a-3b)(5c-d)$   
17  $(5a+3d)(2b-c)$   
18  $(2x-3y)(3x-z)$   
19  $(5x^2-3y)(2-5y)$   
20  $(x-3)(2x-1)$

### Exercise 20.6

- 1  $x^2+5x+6$   
2  $a^2+7a+12$   
3  $a^2+3a+2$   
4  $x^2+3x-10$   
5  $x^2+4x-21$   
6  $x^2-11x+30$   
7  $x^2+3x-18$   
8  $x^2-9x+20$   
9  $x^2+4x+3$

- 10  $a^2 + 6a + 9$
- 11  $a^2 + 3a + 2$
- 12  $x^2 - x - 2$
- 13  $p^2 + 2p - 8$
- 14  $a^2 + 15a + 56$
- 15  $x^2 - 2x - 24$
- 16  $x^2 - 12x + 27$
- 17  $x^2 + 9x - 10$
- 18  $x^2 + 6x + 9$
- 19  $a^2 - 10a + 25$
- 20  $b^2 + 2b + 1$
- 21  $x^2 - 4x + 4$
- 22  $a^2 + 4a + 4$
- 23  $x^2 - 20x + 100$
- 24  $x^2 + 16x + 64$
- 25  $b^2 - 14b + 49$
- 26  $x^2 + 8x + 16$
- 27  $x^2 - 4$
- 28  $x^2 - 36$
- 29  $x^2 - 16$
- 30  $x^2 - 1$
- 31  $x^2 - 100$
- 32  $x^2 - 49$

### Exercise 20.7

- 1  $x^2 - x - 30$
- 2  $10x^2 - 22x + 4$

- 3  $6x^2 - 19x + 10$
- 4  $10x^2 - 3x - 18$
- 5  $2x^2 + 3xy + y^2$
- 6  $3x^2 - 17xy + 20y^2$
- 7  $2x^2 - 7xy + 6y^2$
- 8  $42x^2 + 20xy - 32y^2$
- 9  $4g^2 - 20gh + 21h^2$
- 10  $6j^2 - 37jm + 56m^2$
- 11  $10m^2 + 23mn - 42n^2$
- 12  $6r^2 - rn - 15n^2$
- 13  $4q^2 - 4pq - 63p^2$
- 14  $6r^2 - 37rs + 56s^2$
- 15  $4s^2 - 20st + 21t^2$
- 16  $x^3 + 6x^2 + 11x + 6$
- 17  $2y^3 + 11y^2 + 7y - 20$
- 18  $12a^3 + 11a^2 - 7a - 6$
- 19  $2m^3 - 3m^2n - 2mn^2 + 3n^3$
- 20  $6p^3 - 19p^2q + 19pq^2 - 6q^3$

### Exercise 20.8

- 1  $(x+5)(x-5)$
- 2  $(x+2)(x-2)$
- 3  $(2a+b)(2a-b)$
- 4  $(3+4y)(3-4y)$
- 5  $(5x+7y)(5x-7y)$
- 6  $(3x+8)(3x-8)$
- 7  $(1+7t)(1-7t)$

- 8  $(10x+1)(10x-1)$   
9  $(xy+4a)(xy-4a)$   
10  $(y+13)(y-13)$   
11  $(11x+12y)(11x-12y)$   
12  $2(2+x)(2-x)$   
13  $3(x+8)(x-8)$   
14  $5(3-2x)(3+2x)$   
15  $5(xy+2)(xy-2)$   
16  $3(x+2)(x-2)$   
17  $5(x+3)(x-3)$   
18  $7(x+7)(x-7)$   
19  $10(x+20)(x-20)$   
20  $8(x+5)(x-5)$

### Exercise 20.9

- 1  $(x+3)(x+2)$   
2  $(x+5)(x+1)$   
3  $(x+3)(x+1)$   
4  $(x+4)(x+2)$   
5  $(x+4)(x+1)$   
6  $(x+4)(x+5)$   
7  $(x+1)(x+1)$   
8  $(x-6)(x-1)$   
9  $(x-6)(x-3)$   
10  $(x-2)(x-5)$   
11  $(x-3)(x-1)$   
12  $(a-1)(a-1)$   
13  $(y-7)(y-2)$

**14**      $(x-4)(x-2)$

**15**      $(a+6)(a+2)$

**16**      $(a-3)(a-3)$

**17**      $(b-8)(b-4)$

**18**      $(x+3)(x+8)$

**19**      $(x-4)(x-5)$

**20**      $(x-7)(x-8)$

### Exercise 20.10

**1**      $(x+2)(x-4)$

**2**      $(x+5)(x-1)$

**3**      $(x+2)(x-3)$

**4**      $(x+6)(x-1)$

**5**      $(x+3)(x-1)$

**6**      $(x+3)(x-6)$

**7**      $(x+4)(x-7)$

**8**      $(x+1)(x-10)$

**9**      $(x+2)(x-11)$

**10**      $(x+8)(x-4)$

**11**      $(y+11)(y-2)$

**12**      $(x+4)(x-3)$

**13**      $(x+5)(x-4)$

**14**      $(a+10)(a-2)$

**15**      $(a+3)(a-9)$

**16**      $(a+2)(a-8)$

**17**      $(b+20)(b-1)$

**18**      $(x+13)(x-2)$



**19**      $(x+10)(x-3)$

**20**      $(x+2)(x-9)$

### Exercise 20.11

**1**      $(x+1)^2$

**2**      $(x-2)^2$

**3**      $(x-5)^2$

**4**      $(a+10)^2$

**5**      $(3-2y)^2$

**6**      $(2x+y)^2$

**7**      $(7a+2)^2$

**8**      $(6x-5y)^2$

**9**      $(4a-3b)^2$

**10**     $(2ab+c)^2$

### Exercise 20.12

**1**      $2(x+2)(x+1)$

**2**      $(3x+1)(x+2)$

**3**      $(2x+1)(x+4)$

**4**      $(2x+3)(x+2)$

**5**      $3(2x-1)(x-2)$

**6**      $3(x-2)^2$

**7**      $(3x-2)(x-3)$

**8**      $(x-1)(3x-10)$

**9**      $(3x-5)(x-2)$

**10**     $(2x-5)(2x-3)$

**11**     $(2x+1)(2x+3)$

**12**     $(7x+3)(x+1)$

- 13  $(5x-3)(x-2)$   
14  $(5x-2)(x-4)$   
15  $(3x-2)(2x-5)$   
16  $(4x-3)(2x-3)$   
17  $(3x+5)(x+4)$   
18  $(2x+3)(x+2)$   
19  $(3x+1)(x+4)$   
20  $(5x+3)(x+3)$   
21  $2(2x+1)(x+1)$   
22  $(3x+5)(x+2)$   
23  $(2x+1)(x+2)$   
24  $(4x+5)(x+3)$

### Exercise 20.13

- 1  $(3x-5)(x+2)$   
2  $(2x-1)(x+3)$   
3  $(3x+4)(x-2)$   
4  $(3x+1)(x-4)$   
5  $(2x-1)(x+5)$   
6  $(3x-5)(x+3)$   
7  $5(x-5)(x+2)$   
8  $(5x-2)(x+3)$   
9  $(2x+1)(2x-3)$   
10  $(7x-4)(x+2)$   
11  $(3x-7)(x+2)$   
12  $(3x+4)(x-5)$   
13  $(2x-7)(x+3)$   
14  $(2x+1)(x-8)$

**15**      $(2x-7)(3x+2)$

**16**      $(6x+5)(x-3)$

**17**      $(2x+5)(x-3)$

**18**      $(3x+7)(x-2)$

**19**      $(5x+3)(x-4)$

**20**      $(3x+4)(x-3)$

**21**      $x(x-2)(4x+5)$

**22**      $x(2x+3)(x-5)$

**23**      $x(4x+1)(x-2)$

**24**      $x(3x+2)(x-6)$

### Exercise 20.14

**1**      $(x+1)^2 - 4$       $-4$  when  $x = -1$

**2**      $(x-2)^2 - 6$       $-6$  when  $x = 2$

**3**      $(x+5)^2 + 75$       $75$  when  $x = -5$

**4**      $(x-10)^2 - 110$       $-110$  when  $x = 10$

**5**      $(2x-1)^2 + 4$       $4$  when  $x = \frac{1}{2}$

All answers were written by the authors.

## 21 Algebraic fractions

### Exercise 21.1

1  $\frac{5ab^2}{2}$

2  $3a^2b$

3  $\frac{3x^3y}{20}$

4  $\frac{3y^4}{2}$

5  $\frac{x-4}{2x}$

6  $\frac{3x}{x+3}$

7  $\frac{x+1}{x-1}$

8  $\frac{3x-4}{5(x-1)}$

9  $\frac{3}{x-2}$

10  $\frac{6}{x+2}$

11  $\frac{x-2}{x-1}$

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

13  $\frac{x+1}{x+3}$

14  $\frac{3(x+2)}{x+4}$

15  $\frac{3x+2}{2x-3}$

$$16 \quad \frac{2x-3}{x-1}$$

$$17 \quad \frac{3x}{2x-1}$$

$$18 \quad \frac{5(x+3)}{x-3}$$

$$19 \quad x+2$$

$$20 \quad \frac{x+2}{2x-3}$$

### Exercise 21.2

$$1 \quad \frac{11x}{10}$$

$$2 \quad \frac{x}{15}$$

$$3 \quad \frac{3x+1}{10}$$

$$4 \quad \frac{17x-12}{30}$$

$$5 \quad x$$

$$6 \quad \frac{3x-1}{x(x-1)}$$

$$7 \quad \frac{5x+3}{x(x+1)}$$

$$8 \quad \frac{x^2+6x+1}{(x+1)(x+3)}$$

$$9 \quad \frac{4x^2-x+3}{(x-1)(x+2)}$$

$$10 \quad \frac{-x^2+5x+2}{(x-1)(x+2)}$$

$$11 \quad \frac{7x^2-8x-10}{5x(x+1)}$$

$$12 \quad \frac{3x^2 - 17x - 15}{5x(x+1)}$$

$$13 \quad \frac{23x^2 + 4x + 51}{9(x-3)(x+2)}$$

$$14 \quad \frac{3(x+1)(2x+3)}{(2x+1)(x+2)}$$

$$15 \quad \frac{2(x^2 + 7x - 3)}{(x+3)(x-3)}$$

All answers were written by the authors.

## 22 Indices 2

### Exercise 22.1

- 1**     a)  $a^5$   
         b)  $a^9$   
         c)  $a^6$   
         d)  $a^9$
- 2**     a)  $a^2$   
         b)  $a^4$   
         c)  $a^6$   
         d)  $a^3$
- 3**     a)  $6a^5$   
         b)  $12a^9$   
         c)  $12a^6$   
         d)  $15a^9$
- 4**     a)  $3a^2$   
         b)  $2a^4$   
         c)  $2a^6$   
         d)  $3a^3$
- 5**     a)  $9a^6$   
         b)  $8a^3$   
         c)  $25a^8$   
         d)  $32a^{15}$
- 6**     a)  $x^4$   
         b)  $x^2$   
         c)  $x^2$   
         d)  $x^{12}$

- 7**     **a)**      $6a^5b^3$   
         **b)**      $6a^5b^7$   
         **c)**     Cannot simplify
- 8**     **a)**      $5ab^2$   
         **b)**      $2ac$   
         **c)**      $27b^4$
- 9**     **a)**      $\frac{4a^2c}{3b^2}$   
         **b)**      $\frac{8x^2y^2}{5z^2}$   
         **c)**      $\frac{6a^7b^3}{5c^3}$

## Exercise 22.2

- 1**     **a)**      $2^{\frac{5}{2}}$   
         **b)**      $2^{-\frac{7}{4}}$   
         **c)**      $2^{-6}$   
         **d)**      $2^{-3}$   
         **e)**      $2^{-\frac{2}{3}}$   
         **f)**      $2^{\frac{1}{2}}$
- 2**     **a)**      $3^3$   
         **b)**      $3^{-1}$   
         **c)**      $3^{\frac{3}{2}}$   
         **d)**      $3^6$   
         **e)**      $3^2$   
         **f)**      $3^{11n}$



- 3**
- a)  $2^5$
  - b)  $2^2$
  - c)  $2^3$
  - d)  $2^{-2}$
  - e)  $2^{3n}$
  - f)  $2^{3n-8}$

- 4**
- a)  $5^4$
  - b)  $5^2$
  - c)  $5^{-1}$
  - d)  $5^{-\frac{5}{2}}$
  - e)  $5^{4-n}$
  - f)  $5^{7n}$

- 5**
- a)  $2^3 \times 3$
  - b)  $2^6 \times 3^2$
  - c)  $2^{\frac{1}{3}} \times 3^{\frac{2}{3}}$
  - d)  $2^2 \times 3^{-2}$  or  $\frac{2^2}{3^2}$
  - e)  $3^3 \times 2^{-1}$  or  $\frac{3^3}{2}$
  - f)  $2^{4n} \times 3^{2n}$

- 6**
- a)  $x^5$
  - b)  $x^{2n}$
  - c)  $x^2$
  - d)  $x^{\frac{5}{2}}$
  - e)  $x^{\frac{29}{6}}$
  - f)  $x^{\frac{5}{4}}$

- 7**
- a)  $x = 4$
  - b)  $x = \frac{1}{3}$
  - c)  $x = 4$
  - d)  $x = -\frac{1}{2}$
  - e)  $x = -3$
  - f)  $x = -\frac{1}{2}$
- 8**
- a)  $10a^{-1}$
  - b)  $\frac{1}{2}a^3$
  - c)  $\frac{3}{2}a^{-\frac{1}{2}}$
  - d)  $\frac{8}{3}a^{-\frac{7}{2}}$
- 9**
- a)  $\frac{3b}{a}$
  - b)  $\frac{a}{3b^2}$
  - c)  $\frac{9a^2}{b^2}$
  - d)  $\frac{b^2}{5a^3}$
- 10**
- a)  $2y^4$
  - b)  $2y^{-7}$
  - c)  $\frac{1}{2}y^{\frac{3}{2}}$
  - d)  $\frac{5}{4}y^{-\frac{5}{2}}$

*All answers were written by the authors.*

## 23 Equations

### Exercise 23.1

1  $C = xy$

2  $A = mn$

3  $h = nt$

4  $F = 32 + 1.8C$

5  $A = \frac{1}{2}bh$

6  $I = \frac{V}{R}$

7  $C = np$

8  $w = nq$

9  $N = \frac{L}{t}$

10  $Q = \frac{1}{2}R + 1$

11  $3x + y$

12  $4s + 5$

13 a)  $n + 1$

b)  $n(n + 1)$

### Exercise 23.2

1  $C = 180$

2  $A = 42$

3  $h = 340$

4  $F = 104$

5  $A = 15$

6  $I = 5.44$

7  $C = 3500$

8  $w = 30\,000$

9  $N = 30$

10  $Q = 19$

### Exercise 23.3

1  $2x + 3 = 23$ ,  $x = 10$ ; their ages are 10 and 13

2  $3a + 15 = 180$ ,  $a = 55$ ; the angles are  $55^\circ$ ,  $55^\circ$  and  $70^\circ$

3  $3x = 45$ ,  $x = 15$ ; Chan spends \$15 and Ali spends \$30

4 a)  $330 + 3x = 540$ ,  $x = 70$

b) The angles are  $150^\circ$ ,  $150^\circ$ ,  $70^\circ$ ,  $70^\circ$  and  $100^\circ$

5 a)  $2x + 15 = 53$ ,  $x = 19$

b) 19 boys and 34 girls

6  $2x - 10 = 140$ ,  $x = 75$ ; 75 men and 65 women

7  $x = 2(2x - 30)$ ,  $x = 20$ ; angles are  $20^\circ$  and  $10^\circ$

8  $3(x + 4) = 27$ ,  $x = 5$

9  $2n - 5 = 3(n - 2)$ ,  $n = 1$

10  $4(c + 12) = 28c$ ,  $c = 2$ ; children pay \$2, adults \$14

### Exercise 23.4

1  $x = 4$

2  $x = 4$

3  $x = 3$

4  $a = 4$

5  $y = 3$

### Exercise 23.5

1  $x = 4$

2  $x = 4$

3  $x = -2$

4  $x = 0$

5  $x = 8$

6  $x = -4$

**7**      $x = 8\frac{1}{2}$

**8**      $x = 3$

**9**      $x = 3.4$

**10**     $x = 1\frac{3}{4}$

**11**     $x = 2$

**12**     $x = 4$

**13**     $x = -\frac{1}{4}$

**14**     $x = 10$

**15**     $x = 1$

**16**     $x = 3$

**17**     $x = 2$

**18**     $x = 8$

**19**     $x = 4$

**20**     $x = 5\frac{1}{2}$

### Exercise 23.6

**1**      $x = 4$

**2**      $x = 3$

**3**      $x = -3$

**4**      $x = 8$

**5**      $x = 1$

**6**      $x = 1$

**7**      $x = 2$

**8**      $x = 4$

**9**      $x = -13$

**10**     $x = 2$

**11**     $x = 1$

**12**      $x = 4\frac{1}{2}$

**13**      $x = 4$

**14**      $x = 1$

**15**      $x = 2$

**16**      $x = 7$

**17**      $x = 5$

**18**      $x = 4$

**19**      $x = 9$

**20**      $x = -7$

### Exercise 23.7

**1**      $x = 4$

**2**      $x = 6$

**3**      $x = 5$

**4**      $x = 2\frac{1}{2}$

**5**      $x = \frac{6}{7}$

**6**      $x = 12$

**7**      $x = 24\frac{1}{2}$

**8**      $x = 20$

**9**      $x = 50$

**10**      $x = 6\frac{1}{2}$

**11**      $x = 23$

**12**      $x = 7$

**13**      $x = 4$

**14**      $x = 1\frac{1}{4}$

**15**      $x = 1\frac{1}{2}$

**16**      $x = \frac{7}{10}$

**17**      $x = \frac{5}{9}$

**18**      $x = 12$

**19**      $x = 9$

**20**      $x = 24$

### Exercise 23.8

**1**      $x = 7$

**2**      $x = 4$

**3**      $x = 25\frac{1}{2}$

**4**      $x = 4$

**5**      $x = 3$

**6**      $x = 1$

**7**      $x = -1$

**8**      $x = 1$

**9**      $x = -\frac{1}{5}$

**10**      $x = \frac{1}{2}$

**11**      $x = 3$

**12**      $x = 0$

**13**      $x = 8\frac{8}{9}$

**14**      $x = 3\frac{1}{2}$

**15**      $x = -5\frac{1}{2}$

**Exercise 23.9**

- 1**      $x = 4, y = 1$
- 2**      $x = 2, y = 3$
- 3**      $x = 2, y = 2$
- 4**      $x = 4, y = 1$
- 5**      $x = 2, y = 3$
- 6**      $x = 5, y = 1$
- 7**      $x = 4, y = 1$
- 8**      $x = 2, y = 2$
- 9**      $x = 2, y = 1$
- 10**     $x = 3, y = 2$
- 11**     $x = 5, y = 7$
- 12**     $x = 4, y = 1$
- 13**     $x = 1, y = 5$
- 14**     $x = 2, y = 1$
- 15**     $x = 2, y = -1$
- 16**     $x = 2\frac{1}{2}, y = 1\frac{1}{2}$
- 17**     $x = \frac{1}{2}, y = 2\frac{1}{2}$
- 18**     $x = 2\frac{1}{2}, y = 1$
- 19**     $x = 3, y = -1$
- 20**     $x = -3, y = -2$
- 21**     $x = -1\frac{1}{2}, y = 1\frac{1}{2}$



### Exercise 23.10

- 1  $x = 2, y = 3$
- 2  $x = 1, y = 1$
- 3  $x = 4, y = 1$
- 4  $x = 2, y = 3$
- 5  $x = 1, y = 2$
- 6  $x = 5, y = 6$
- 7  $x = 5, y = 2$
- 8  $x = 4, y = 1$
- 9  $x = -1, y = 2$
- 10  $x = -2, y = -3$
- 11  $x = -2, y = 3$
- 12  $x = \frac{1}{2}, y = 2\frac{1}{2}$
- 13  $x = 2\frac{9}{26}, y = 3\frac{5}{26}$
- 14  $x = 5, y = -2$
- 15  $x = 2.6, y = 3.8$

### Exercise 23.11

- 1  $x = 2$  or  $x = 3$
- 2  $x = 1$  or  $x = 5$
- 3  $x = 1$  or  $x = 3$
- 4  $x = \pm 10$
- 5  $x = -2$  or  $x = -4$
- 6  $x = -1$  or  $x = -4$
- 7  $x = -4$  or  $x = -5$
- 8  $x = \pm 5$
- 9  $x = -1$  (repeated)
- 10  $x = 1$  or  $x = 6$
- 11  $x = 3$  or  $x = 6$

- 12  $x = 0$  or  $x = 8$   
13  $x = -3$  or  $x = -4$   
14  $x = 0$  or  $x = -3$   
15  $x = 0$  or  $x = -6$   
16  $x = 4$  or  $x = 6$   
17  $x = 2$  or  $x = 4$   
18  $x = \pm 13$   
19  $x = \pm 15$   
20  $x = -3$  or  $x = 1$   
21  $x = -5$  or  $x = 1$   
22  $x = 0$  or  $x = 10$   
23  $x = -3$  or  $x = 4$   
24  $x = -6$  or  $x = 1$   
25  $x = 0$  or  $x = 1$   
26  $x = -3$  or  $x = 5$   
27  $x = -3$  or  $x = 6$   
28  $x = -1$  or  $x = 10$   
29  $x = 2$  or  $x = 15$   
30  $x = -8$  or  $x = 4$

### Exercise 23.12

- 1  $x = -1.5$  or  $x = 4$   
2  $x = -\frac{2}{3}$  or  $x = 4$   
3  $x = -1.5$  or  $x = -1$   
4  $x = -1$  or  $x = 2.5$   
5  $x = -1$  or  $x = \frac{1}{3}$   
6  $x = -\frac{1}{2}$  or  $x = -5$   
7  $x = 1.5$  or  $x = 5$

8  $x = -\frac{4}{3}$  or  $x = \frac{1}{2}$

9  $x = -6$  or  $x = 5$

10  $x = 1$  or  $x = 3$

11  $x = -2$  or  $x = 3$

12  $x = -\frac{4}{3}$  or  $x = 6$

13  $x = \pm 2$

14  $x = \pm 3$

15  $x = \pm 5$

### Exercise 23.13

1  $x = 0.76$  or  $x = 5.24$

2  $x = -0.53$  or  $x = -9.47$

3  $x = 6.70$  or  $x = 0.30$

4  $x = -6.61$  or  $x = 0.61$

5  $x = 0.64$  or  $x = 9.36$

6  $x = 0.44$  or  $x = 4.56$

7  $x = 0.19$  or  $x = 1.31$

8  $x = -0.79$  or  $x = 2.12$

9  $x = -0.26$  or  $x = -5.74$

10  $x = -1.22$  or  $x = 0.55$

11  $x = -0.48$  or  $x = 1.68$

12  $x = -0.35$  or  $x = 2.85$

13  $x = -0.36$  or  $x = 0.56$

14  $x = -0.10$  or  $x = -0.65$

15 a)  $(x+6)^2 - 24$

b)  $-24$

c)  $x = -6 \pm 2\sqrt{6}$

16 a)  $2(x+2)^2 - 3$

$$\text{b)} \quad 5\left(x + \frac{1}{2}\right)^2 - 3\frac{1}{4}$$

$$\text{c)} \quad 2\left(x + \frac{9}{2}\right)^2 - 33\frac{1}{2}$$

### Exercise 23.14

$$1 \quad x = -0.84 \text{ or } x = -7.16$$

$$2 \quad x = -0.82 \text{ or } x = 1.82$$

$$3 \quad x = -1.85 \text{ or } x = 0.18$$

$$4 \quad x = 0.54 \text{ or } x = 1.86$$

$$5 \quad x = -2.32 \text{ or } x = 0.52$$

$$6 \quad x = -0.19 \text{ or } x = 5.19$$

$$7 \quad x = -0.74 \text{ or } x = -2.26$$

$$8 \quad x = -0.63 \text{ or } x = -6.37$$

$$9 \quad x = -0.85 \text{ or } x = 2.35$$

$$10 \quad x = -1.22 \text{ or } x = 0.55$$

$$11 \quad x = 0.76 \text{ or } x = 1.84$$

$$12 \quad x = -0.44 \text{ or } x = -1.36$$

$$13 \quad \text{Width} = 2.40 \text{ m and length} = 10.40 \text{ m}$$

$$14 \quad \text{a)} \quad 20x - 2x^2$$

$$\text{b)} \quad 7.24 \text{ m by } 5.53 \text{ m or } 2.76 \text{ m by } 14.47 \text{ m}$$

$$\text{c)} \quad 50 \text{ m}^2$$

$$15 \quad \text{a)} \quad 4x^2 + 74x + 330$$

$$\text{b)} \quad 0.90 \text{ m}$$

### Exercise 23.15

$$1 \quad \text{a)} \quad b = a + c$$

$$\text{b)} \quad x = \frac{3a - y}{w}$$

$$\text{c)} \quad t = \frac{v - u}{a}$$

$$\text{d)} \quad T = AH$$

- e)  $T = \frac{P-C}{3}$
- f)  $u = 2P - v$
- g)  $r = \frac{C}{2\pi}$
- h)  $q = \frac{A}{p} - r$  or  $q = \frac{A-pr}{p}$
- i)  $q = p - 2r$
- j)  $r = \frac{B-s}{5}$
- k)  $t = 2u - s$
- l)  $q = \frac{ms}{pr}$
- m)  $G = \frac{2F+L}{2}$  or  $G = F + \frac{L}{2}$
- n)  $n = \frac{Ft-m}{4}$
- o)  $S = 2aT$
- p)  $y = \frac{tx-A}{2t}$
- 2** a)  $l = \frac{P}{2} - w$
- b) 14 m
- 3** a)  $n = \frac{C-A}{32}$
- b) 56
- 4** a)  $w = \frac{T-40}{45}$
- b) 2.4 kg
- 5** a)  $r = \frac{S}{2\pi h}$
- b) 2.4 cm

- 6 a)  $h = \frac{3V}{\pi r^2}$   
 b) 27 cm
- 7 a)  $n = \frac{C-40}{5}$  or  $n = \frac{C}{5} - 8$   
 b) 39
- 8 a)  $h = \frac{S-2\pi r^2}{2\pi r}$  or  $h = \frac{S}{2\pi r} - r$   
 b) 7.3 cm

### Exercise 23.16

- 1  $t = \frac{s}{a+2b}$
- 2  $b = \frac{s}{a-c}$
- 3  $t = \frac{bP}{b-a}$
- 4  $u = \sqrt{v^2 - 2as}$
- 5  $r = \sqrt{\frac{A}{4\pi}}$
- 6  $y = \frac{7-3a}{3-b}$  or  $y = \frac{3a-7}{b-3}$
- 7  $a = \frac{cd}{b-c}$
- 8  $a = \frac{b+2}{2b+2}$  or  $a = \frac{b+2}{2(b+1)}$
- 9  $r = \pm \sqrt{\frac{s+1}{2}}$
- 10  $x = \frac{bs+s}{2a+b}$  or  $x = \frac{s(b+1)}{2a+b}$
- 11  $d = \frac{bc-ab}{a+c}$  or  $d = \frac{b(c-a)}{a+c}$
- 12  $t = \frac{ab}{1-bs}$

$$13 \quad c = \sqrt[3]{\frac{V - 5ab^2}{3}}$$

$$14 \quad P = \frac{100A}{100 + RT}$$

$$15 \quad v = \frac{su}{u - s}$$

$$16 \quad a = \frac{1}{s - b}$$

$$17 \quad c = \frac{1 - ab}{a}$$

$$18 \quad d = \frac{b + c - a}{a - b}$$

$$19 \quad b = \frac{100a}{m + 100}$$

$$20 \quad p = \frac{a}{1 - a}$$

$$21 \quad x = \frac{b - a}{2a - b}$$

$$22 \quad L = \frac{T^2 g}{4\pi^2}$$

$$23 \quad x = \pm \sqrt{\frac{y + 4}{3}}$$

$$24 \quad r = \sqrt{\frac{3V}{\pi h}}$$

$$25 \quad \text{a)} \quad d = 5.39$$

$$\text{b)} \quad 3.68 \text{ m}$$

$$\text{c)} \quad x = \sqrt{d^2 - y^2 - z^2}$$

$$\text{d)} \quad 0.71 \text{ m}$$

### Exercise 23.17

$$1 \quad x = 5$$

$$2 \quad x = 3$$

$$3 \quad x = 0$$

**4**      $x = 4$

**5**      $x = -3$

**6**      $x = 5$

**7**      $x = 1$

**8**      $x = -\frac{2}{3}$

**9**      $x = -1$  or  $x = \frac{3}{4}$

**10**     $x = \frac{3}{4}$  or  $x = 1$

**11**     $x = -\frac{3}{2}$  or  $x = \frac{5}{3}$

**12**     $x = \frac{1}{2}$  or  $x = 4$

**13**     $x = -11$  or  $x = 2$

**14**     $x = -\frac{1}{2}$  or  $x = 5$

**15**     $x = 1.70$  or  $x = 5.30$

**16**     $x = -1.30$  or  $x = 2.30$



All answers were written by the authors.

## 24 Inequalities

### Exercise 24.1

1 e.g.  $x = -3, -4$

2 a)  $x = -4, -3, -2, -1$

b)  $x = 2, 3, 4, 5$

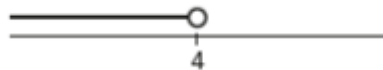
c)  $x = 2, 3, 4$

d)  $x = -4, -3, -2, -1$

3  $x \leq 7$



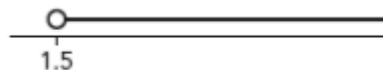
4  $x < 4$



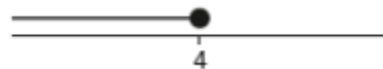
5  $x \leq 1$



6  $x > 1.5$



7  $x \leq 4$



8  $x \geq 5$

9  $x > 0.5$

10  $x > 2.5$

11  $x \geq 4$

12  $a > 1$

13  $x < 4$

14  $x < -2$

15  $x > 7$

16  $x \leq 1$

17  $x < 2$

18  $x \geq 2$

19  $x < 4$

20  $x > -3$

21  $x < -8.5$

22  $x > -6$

23  $x > -3$

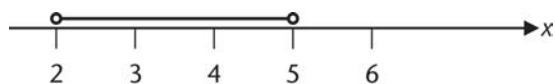
24  $x \geq -10$

25  $x < -18$

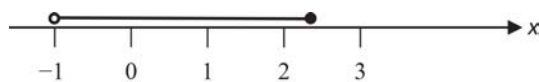
26  $x \leq 4$

27  $x < 17$

28  $2 < x < 5$



29  $-1 < x \leq 2.4$



30 a)  $x = 2, 3$

b)  $x = -2, -1, 0, 1, 2, 3$

31  $5 < a < 8$

32 a)  $11 < 3y - 4 \leq 23$ ;  $5 < y \leq 9$

b) 14 years

## Exercise 24.2

1 a)  $x > 2$

b)  $y < -2$

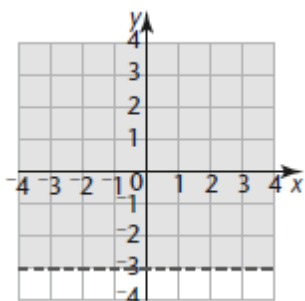
c)  $y < 2x$

d)  $y \geq x + 4$

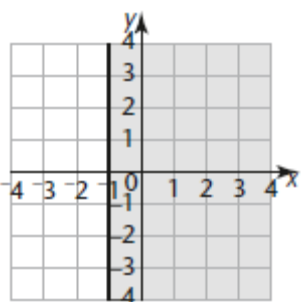
e)  $3x + 4y > 12$

f)  $y \leq 2x - 4$

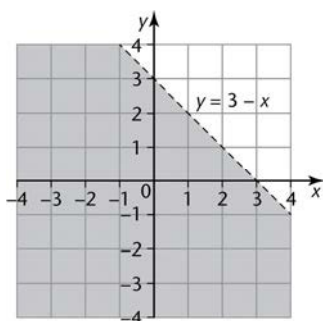
2



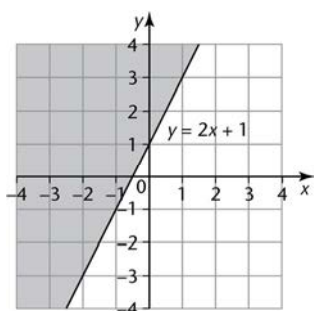
3



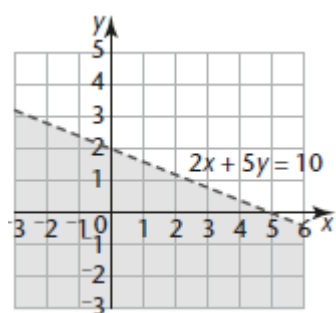
4



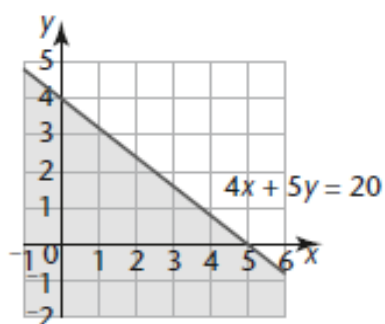
5



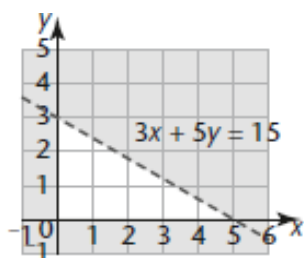
6



7



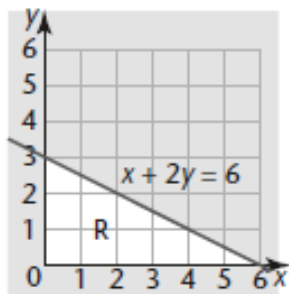
8



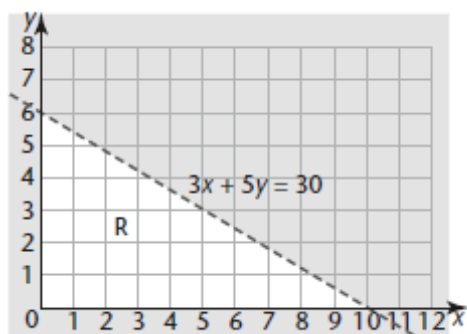
## Exercise 24.3

In this exercise, the required region is labelled R

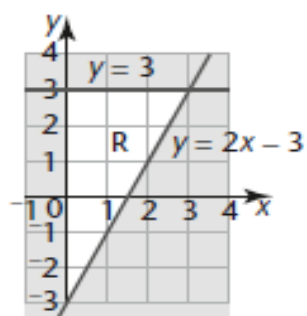
1



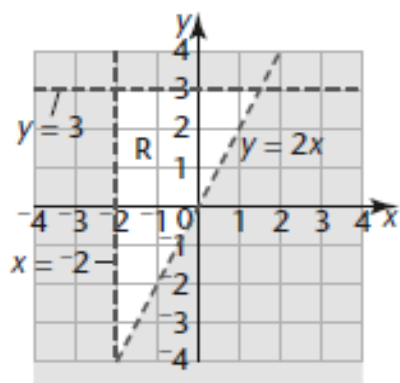
2



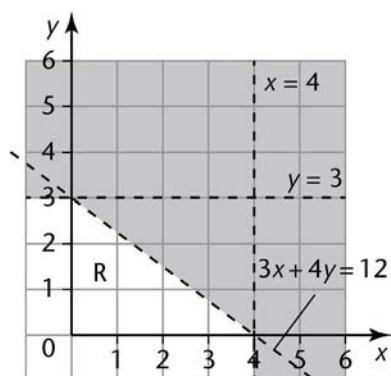
3



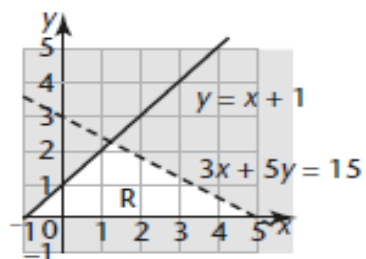
4



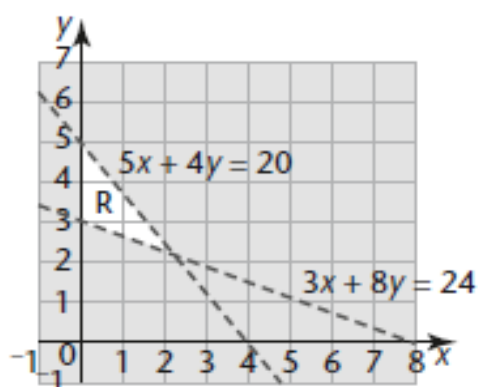
5



6



7



8       $x < 3$                    $4x + 3y \geq -3$                    $2y < x + 7$

9       $y < 5$                    $4y \leq x + 16$                    $x + y > 1$                    $y \geq 2x - 8$

10      $x \geq -3$                    $2y \geq x - 3$                    $3y + x < 8$                    $y \geq 0$

All answers were written by the authors.

## 25 Sequences

### Exercise 25.1

- 1
  - a) Add 4; 26
  - b) Add 8; 51
  - c) Add 5; 34
- 2
  - a) Multiply by 3; 729
  - b) Divide by 5; 5
  - c) Add 1 more each time; 22
- 3
  - a) 22, 27, 37
  - b) 22, 13, 7
  - c) 64, 256
- 4
  - a) 77 is in the sequence because the sequence is the multiples of 7 and  $77 = 11 \times 7$
  - b) 77 is not in the sequence because all the numbers in the sequence are even and 77 is odd.
- 5
  - a) 49
  - b) To get from one number to the next you add 3, 5, 7, 9, ...

### Exercise 25.2

- 1
  - a) Linear
  - b) 11, 13
- 2
  - a) Not linear
  - b) 30, 28
- 3
  - a) Linear
  - b) 66, 63
- 4
  - a) Linear
  - b) 17, 21
- 5
  - a) Not linear
  - b) 36, 49



- 6**     **a)**     Not linear  
         **b)**     45, 66
- 7**     **a)**     Linear  
         **b)**     30, 37

### Exercise 25.3

- 1**     2, 3, 4, 5  
**2**     2, 4, 6, 8  
**3**     1, 3, 5, 7  
**4**     6, 7, 8, 9  
**5**     3, 6, 9, 12  
**6**     4, 7, 10, 13  
**7**     2, 7, 12, 17  
**8**     10, 20, 30, 40  
**9**     0, 7, 14, 21  
**10**    1, 0, -1, -2  
**11**    1, 2, 3, 4  
**12**    4, 5, 6, 7  
**13**    4, 8, 12, 16  
**14**    0, 1, 2, 3  
**15**    3, 5, 7, 9  
**16**    2, 5, 8, 11  
**17**    11, 17, 23, 29  
**18**    -1, 1, 3, 5  
**19**    4, 3, 2, 1  
**20**    8, 6, 4, 2  
**21**    1, 4, 9, 16  
**22**    3, 6, 11, 18  
**23**    -4, -1, 4, 11  
**24**    3, 12, 27, 48  
**25**    1, 8, 27, 64

### Exercise 25.4

- 1  $n$
- 2  $2n + 2$
- 3  $4n$
- 4  $2n - 2$
- 5  $4n + 3$
- 6  $6n - 5$
- 7  $10n + 1$
- 8  $3n + 2$
- 9  $100n + 1$
- 10  $n - 1$
- 11  $3n - 1$
- 12  $2n + 5$
- 13  $5n - 1$
- 14  $5n + 10$
- 15  $4n - 5$
- 16  $2n + 3$
- 17  $n + 100$
- 18  $5 - n$
- 19  $10 - 3n$
- 20  $27 - 2n$

### Exercise 25.5

- 1
  - a)  $n^2 + 2$
  - b)  $n^2 - 5$
  - c)  $n^2 + n$
  - d)  $2n^2$
  - e)  $n^2 + 3n - 1$
  - f)  $n^2 - 2n + 4$

2 a)  $n^3 + 10$

b)  $n^3 - 9$

c)  $2n^3$

d)  $n^3 + n^2$

e)  $n^3 - n$

3 a)  $2^n - 1$

b)  $2^n + 12$

c)  $2^n + n$

d)  $2^n - 2n$

4 a)  $T_1 = A \times 1^3 + B \times 1^2 = A + B = 1$

$$T_2 = A \times 2^3 + B \times 2^2 = 8A + 4B = 12$$

b)  $A = 2, B = -1$

c)  $T_3 = 45, T_4 = 112$

5  $\frac{2n^2}{2n+1}$

6

Diagram ( $n$ )	1	2	3	4	$n$
Number of small squares	1	4	9	16	$n^2$
Numbers of dots	4	9	16	25	$(n+1)^2$
Number of lines	4	12	24	40	$2n^2 + 2n$

All answers were written by the authors.

## 26 Proportion

### Exercise 26.1

- 1**
- a)  $t \propto \frac{1}{s}$
  - b)  $p \propto w$
  - c)  $d \propto t$
  - d)  $b \propto \frac{1}{s}$
  - e)  $t \propto d$
  - f)  $c \propto m$
- 2**
- a)  $y \propto x$
  - b)  $y \propto x$
  - c)  $y \propto \frac{1}{x}$
  - d)  $y \propto x$
  - e)  $y \propto x$
  - f)  $y \propto \frac{1}{x}$
  - g)  $y \propto x$
  - h)  $y \propto x$
  - i)  $y \propto \frac{1}{x}$
  - j)  $y \propto x$

## Exercise 26.2

**1**     **a)**      $y = \frac{1}{3}x$

**b)**      $y = 7x$

**c)**      $y = \frac{80}{x}$

**d)**      $y = 5x$

**e)**      $y = \frac{2}{3}x$

**f)**      $y = \frac{15}{x}$

**g)**      $y = \frac{2}{3}x$

**h)**      $y = \frac{5}{4}x$

**i)**      $y = \frac{50}{x}$

**j)**      $y = \frac{2}{5}x$

**2**     **a)**      $I = \frac{V}{6}$

**b)**     10 amperes

**3**     **a)**      $w = \frac{330}{f}$

**b)**     0.5 m

**4**     **a)**     **i)**      $A = \frac{2}{5}B$

**ii)**      $A = \frac{1000}{B}$

**b)**     **i)**      $B = 62.5$

**ii)**      $B = 40$

**Exercise 26.3**

**1**     **a)**      $y = \frac{1}{12}x^2$

**b)**      $y = 12$

**c)**      $x = 24$

**2**     **a)**      $y = \frac{64}{x^2}$

**b)**      $y = 1$

**c)**      $x = \pm 1.6$

**3**     **a)**      $y = \frac{8}{3}\sqrt{x}$

**b)**      $y = 16$

**c)**      $x = 2.25$

**4**     **a)**      $y = \frac{40}{x^3}$

**b)**      $y = 0.32$

**c)**      $x = 0.5$

**5**     **a)**      $y = \frac{5}{2}x^3$

**b)**      $y = 160$

**c)**      $x = 6$

**6**      $y = 4$

**7**      $y = 0.625$

**8**      $y = 4.8$

**9**      $y = 4$

**10**      $y = 2$

**11**      $y = 0.36$

**12**     **a)**      $v = 4\sqrt{l}$

**b)**      $40 \text{ m/s}$

**13**    **a)**    35 days

**b)**     $n = \frac{105}{t}$

**14**    4 newtons

**15**    **a)**     $4p$

**b)**    96 m

**c)**    1500%

**16**    **a)**     $y \propto x^2$

**b)**     $y \propto \frac{1}{x^2}$

**c)**     $y \propto \frac{1}{x}$

**d)**     $y \propto \frac{1}{x^2}$

**e)**     $y \propto x^2$

**f)**     $y \propto \frac{1}{x}$

**g)**     $y \propto x$

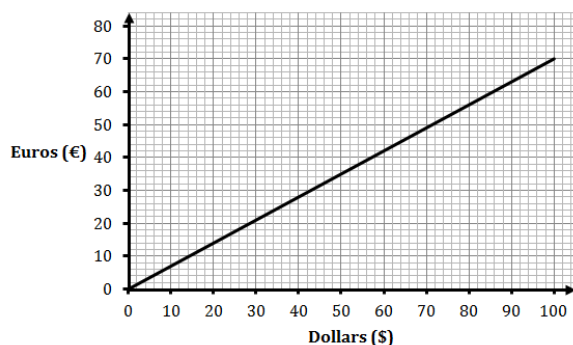
**h)**     $y \propto \frac{1}{x^2}$

All answers were written by the authors.

## 27 Graphs in practical situations

### Exercise 27.1

1 a)



b) i) €24 to €25

ii) \$85 to \$86

2 a) i) NZ\$60 to NZ\$65

ii) NZ\$260 to NZ\$270

b) i) £31 to £32

ii) £80

c) £186 to £192

3 a) i) 24 to 25 miles

ii) 40 to 41 miles

b) i) 16 to 17 km

ii) 89 to 90 km

c) 240 km

4 a) i) 31 to 33 °F

ii) 183 to 187 °F

b) i) 37 to 39 °C

ii) 76 to 78 °C



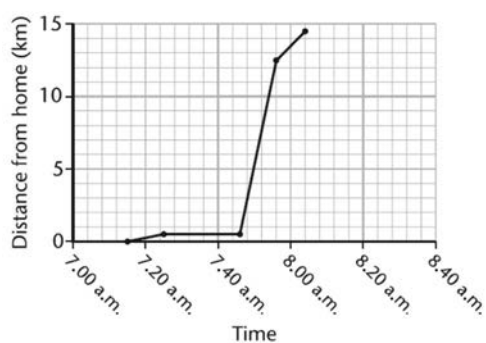
**Exercise 27.2**

- 1**
- a) 09 45
  - b) 6 minutes
  - c) 1.9 km
  - d) On the way to the supermarket.
  - e) 4 km/h

- 2**
- a) 10 10
  - b) 4.8 km
  - c) 10 minutes
  - d) 16 minutes

- 3**
- a) 1 hour 30 minutes
  - b) 45 minutes
  - c) 90 km
  - d) 12 48

- 4**
- a)



- b) 21 minutes
- c) 8.04 a.m.

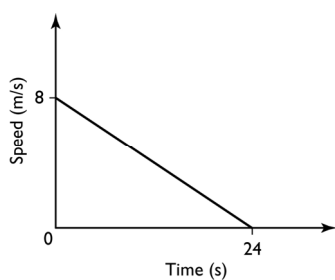
## Exercise 27.3

- 1 08 15 to 09 00: 13.3 km/h;  
 09 00 to 09 15: 0 km/h;  
 09 15 to 09 45: 16 km/h;  
 09 45 to 10 00: 0 km/h;  
 10 00 to 10 30: 10 km/h
- 2 0.25 m/s; 2.5 m/s
- 3 a) 4 m/s  
 b) 1 m/s

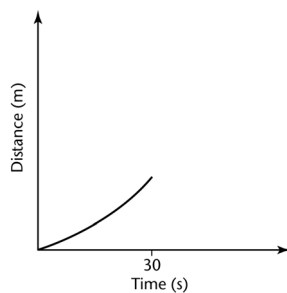
## Exercise 27.4

- 1  $0.75 \text{ m/s}^2$ ;  $0.4 \text{ m/s}^2$
- 2  $0.6 \text{ m/s}^2$ ;  $0.25 \text{ m/s}^2$
- 3  $1.9 \text{ to } 2 \text{ m/s}^2$ ;  $-2 \text{ m/s}^2$
- 4 a)  $t = 0 \text{ to } t = 30$ : acceleration is  $\frac{1}{3} \text{ m/s}^2$ ;  
 $t = 30 \text{ to } t = 45$ : acceleration is  $\frac{2}{3} \text{ m/s}^2$ ;  
 $t = 45 \text{ to } t = 65$ : acceleration is  $0 \text{ m/s}^2$ ;  
 $t = 65 \text{ to } t = 90$ : deceleration is  $0.8 \text{ m/s}^2$ .
- b) i) 6.7 m/s to 1 d.p.  
 ii) 12 m/s

- 5 a)



- b)  $\frac{1}{3} \text{ m/s}^2$
- c) 5 m/s
- 6 a) 18 m/s  
 b) 20 seconds

**Exercise 27.5****1**     **a)**     180 m**b)**     350 m**c)**     250 m**d)**     200 m**2**     **a)**      $0.25 \text{ m/s}^2$ **b)**     **i)**     600 m**ii)**     1800 m**3**     **a)**     690 m**b)**     30 seconds**4**      $u = 8$ **5**     **a)**     **i)**     10.5 m/s**ii)**     78.75 m**b)**

All answers were written by the authors.

## 28 Graphs of functions

### Exercise 28.1

1

$x$	-4	-3	-2	-1	0	1	2	-1.5
$x^2$	16	9	4	1	0	1	4	2.25
$+3x$	-12	-9	-6	-3	0	3	6	-4.5
$-7$	-7	-7	-7	-7	-7	-7	-7	-7
$y = x^2 + 3x - 7$	-3	-7	-9	-9	-7	-3	3	-9.25

2

$x$	-3	-2	-1	0	1	2	3
$x^2$	9	4	1	0	1	4	9
$2x^2$	18	8	2	0	2	8	18
$-8$	-8	-8	-8	-8	-8	-8	-8
$y = 2x^2 - 8$	10	0	-6	-8	-6	0	10

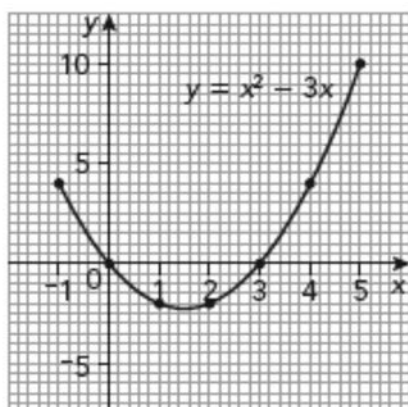
3

$x$	-6	-5	-4	-3	-2	-1	0	1	2	-2.5
$-x^2$	-36	-25	-16	-9	-4	-1	0	-1	-4	-6.25
$-5x$	30	25	20	15	10	5	0	-5	-10	12.5
$+6$	6	6	6	6	6	6	6	6	6	6
$y = -x^2 - 5x + 6$	0	6	10	12	12	10	6	0	-8	12.25

4 a)

$x$	-1	0	1	2	3	4	5	1.5
$x^2$	1	0	1	4	9	16	25	2.25
$-3x$	3	0	-3	-6	-9	-12	-15	-4.5
$y = x^2 - 3x$	4	0	-2	-2	0	4	10	-2.25

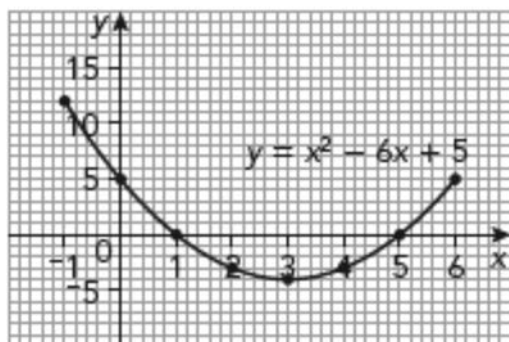
b)



5 a)

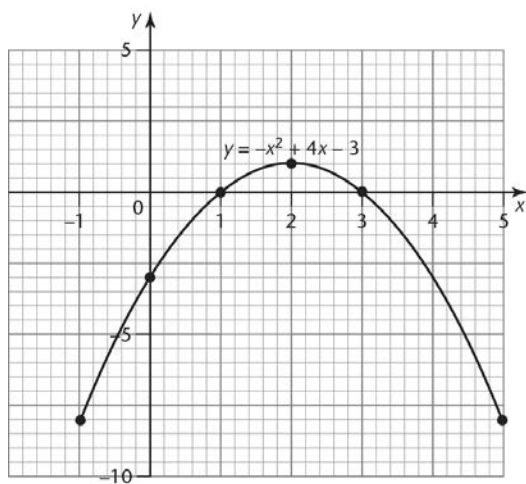
$x$	-1	0	1	2	3	4	5	6
$x^2$	1	0	1	4	9	16	25	36
$-6x$	6	0	-6	-12	-18	-24	-30	-36
$+5$	5	5	5	5	5	5	5	5
$y = x^2 - 6x + 5$	12	5	0	-3	-4	-3	0	5

b)



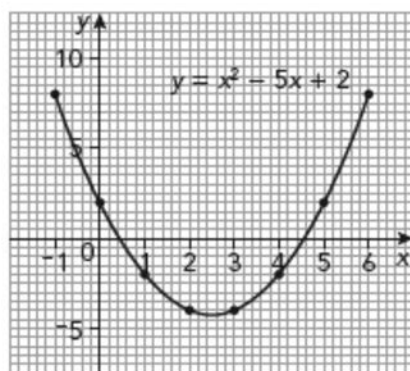
6

$x$	-1	0	1	2	3	4	5
$-x^2$	-1	0	-1	-4	-9	-16	-25
$+4x$	-4	0	4	8	12	16	20
$-3$	-3	-3	-3	-3	-3	-3	-3
$y = -x^2 + 4x - 3$	-8	-3	0	1	0	-3	-8



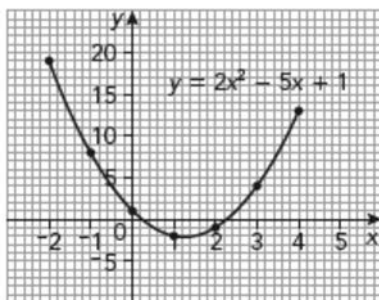
7 a)

$x$	-1	0	1	2	3	4	5	6	2.5
$x^2$	1	0	1	4	9	16	25	36	6.25
$-5x$	5	0	-5	-10	-15	-20	-25	-30	-12.5
$+2$	2	2	2	2	2	2	2	2	2
$y = x^2 - 5x + 2$	8	2	-2	-4	-4	-2	2	8	-4.25

b)  $x = 0.4$  (or  $0.5$ ) or  $x = 4.5$  (or  $4.6$ )

8 a)

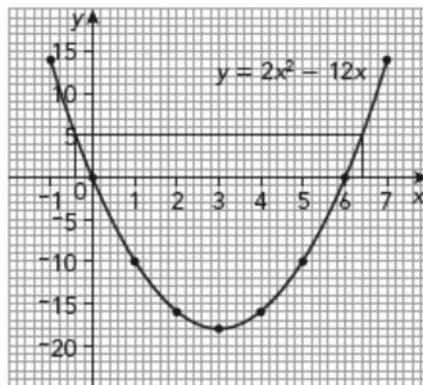
$x$	-2	-1	0	1	2	3	4	1.5
$x^2$	4	1	0	1	4	9	16	2.25
$2x^2$	8	2	0	2	8	18	32	4.5
$-5x$	10	5	0	-5	-10	-15	-20	-7.5
$+1$	1	1	1	1	1	1	1	1
$y = 2x^2 - 5x + 1$	19	8	1	-2	-1	4	13	-2

b)  $x = 0.2$  or  $x = 2.3$



9 a)

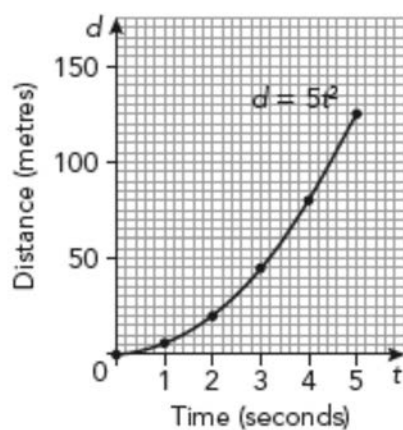
$x$	-1	0	1	2	3	4	5	6	7
$x^2$	1	0	1	4	9	16	25	36	49
$2x^2$	2	0	2	8	18	32	50	72	98
$-12x$	12	0	-12	-24	-36	-48	-60	-72	-84
$y = 2x^2 - 12x$	14	0	-10	-16	-18	-16	-10	0	14

b)  $x = -0.4$  or  $x = 6.4$

10 a)

$t$	0	1	2	3	4	5
$t^2$	0	1	4	9	16	25
$d = 5t^2$	0	5	20	45	80	125

b)

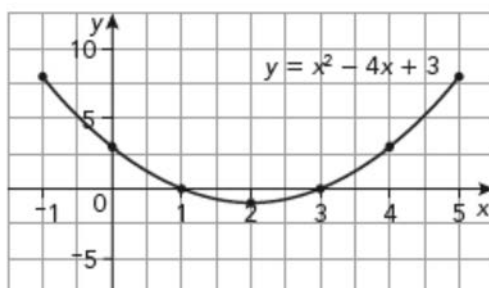


c) 3.6 seconds

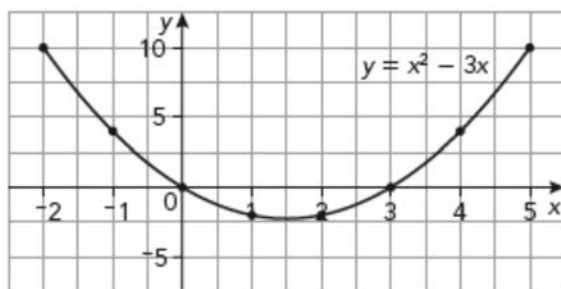
## Exercise 28.2

Answers are given correct to 1 decimal place.

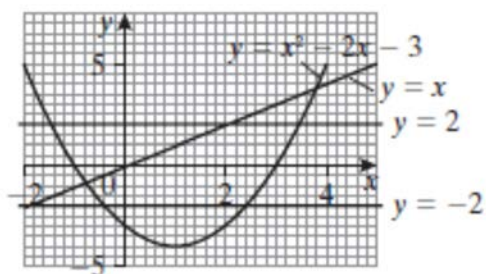
1 a)

b)  $x = 1$  or  $x = 3$

2 a)

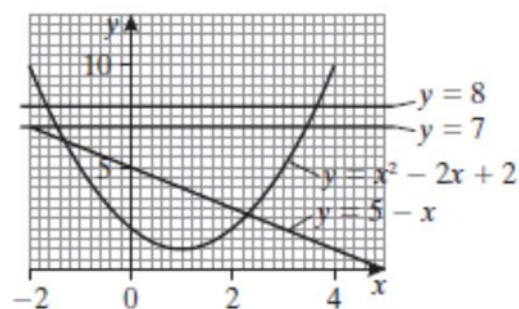
b)  $x = 0$  or  $x = 3$ 

3 a)



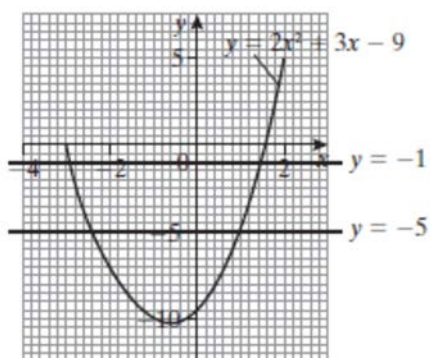
- b) i)  $x = -1$  or  $x = 3$   
 ii)  $x = -0.4$  or  $x = 2.4$   
 iii)  $x = -0.8$  or  $x = 3.8$   
 iv)  $x = -1.4$  or  $x = 3.4$

4 a)



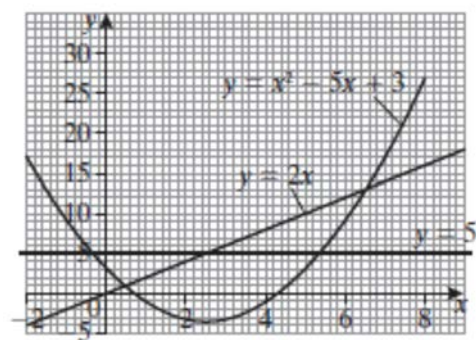
- b) i)  $x = -1.6$  or  $x = 3.6$   
 ii)  $x = -1.3$  or  $x = 2.3$   
 iii)  $x = -1.4$  or  $x = 3.4$

5 a)



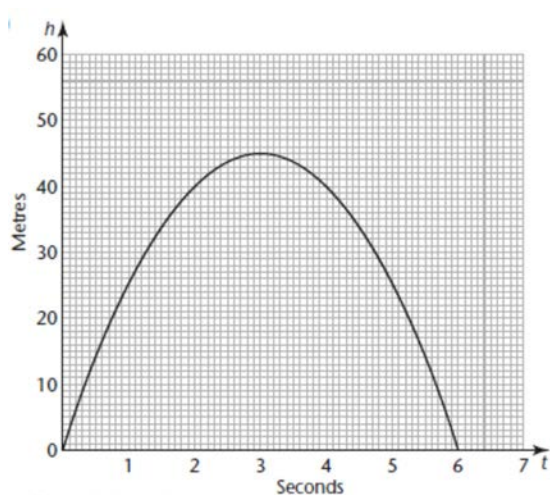
- b) i)  $x = -2.9$  or  $x = 1.4$   
 ii)  $x = -2.4$  or  $x = 0.9$

6 a)



- b) i)  $x = 0.7$  or  $x = 4.3$   
 ii)  $x = -0.4$  or  $x = 5.4$   
 iii)  $x = 0.5$  or  $x = 6.5$

7 a)



b) Just – it is at its maximum

c) 6 seconds

8  $y = -4$

9  $2x^2 - 9x + 4 = 0$

10  $3x^2 + 2x - 6 = 0$

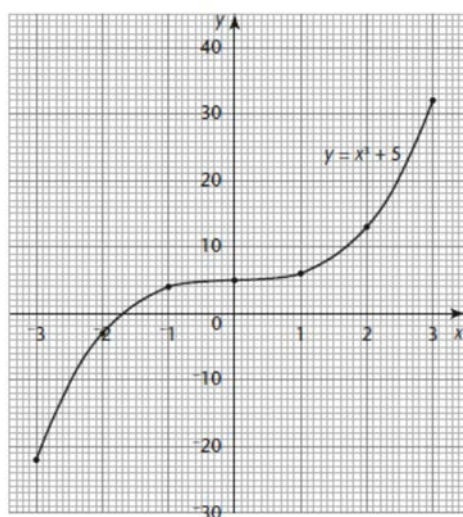
## Exercise 28.3

Answers are given correct to 1 decimal place.

1 a)

$x$	-3	-2	-1	0	1	2	3
$x^3$	-27	-8	-1	0	1	8	27
+5	5	5	5	5	5	5	5
$y = x^3 + 5$	-22	-3	4	5	6	13	32

b)

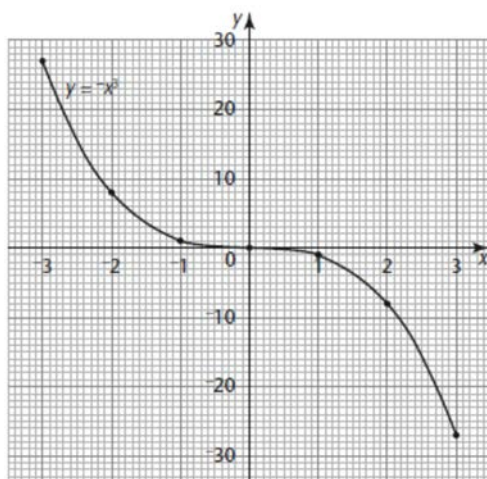


c)  $x = -1.7$

2 a)

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

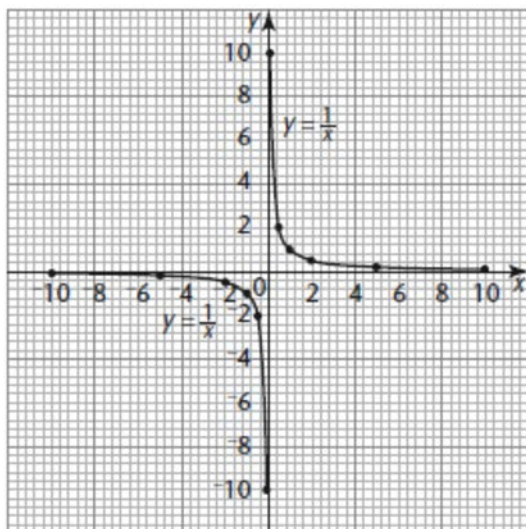
b)

c)  $x = -1.8$

3 a)

$x$	-10	-5	-2	-1	-0.5	-0.1	0.1	0.5	1	2	5	10
$y = \frac{1}{x}$	-0.1	-0.2	-0.5	-1	-2	-10	10	2	1	0.5	0.2	0.1

b)

c) *Due to small scale allow a wide tolerance.*

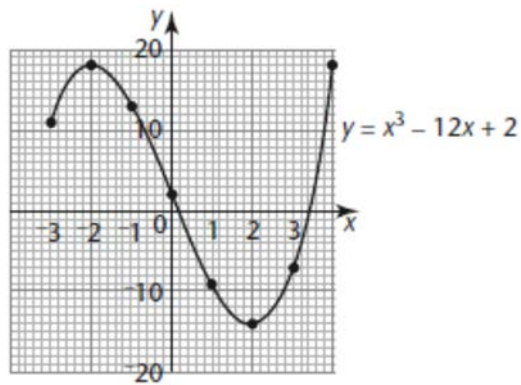
- i)  $x = 3.3$  (calculated answer:  $x = 3\frac{1}{3}$ )
- ii)  $x = -0.2$



4 a)

$x$	-3	-2	-1	0	1	2	3	4
$x^3$	-27	-8	-1	0	1	8	27	64
$-12x$	36	24	12	0	-12	-24	-36	-48
$+2$	2	2	2	2	2	2	2	2
$y = x^3 - 12x + 2$	11	18	13	2	-9	-14	-7	18

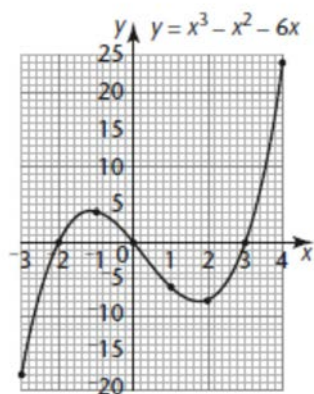
b)

c) The only two values in the range of the graph are  $x = 0.2$  and  $x = 3.4$

5 a)

$x$	-3	-2	-1	0	1	2	3	4
$x^3$	-27	-8	-1	0	1	8	27	64
$-x^2$	-9	-4	-1	0	-1	-4	-9	-16
$-6x$	18	12	6	0	-6	-12	-18	-24
$y = x^3 - x^2 - 6x$	-18	0	4	0	-6	-8	0	24

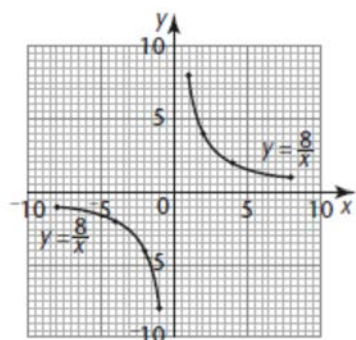
b)

c) The solution is  $x = -2$ ,  $x = 0$  or  $x = 3$

6 a)

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

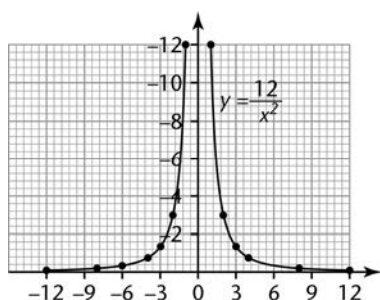
b)



7 a)

$x$	-12	-8	-6	-4	-3	-2	-1	1	2	3	4	6	8	12
$x^2$	144	64	36	16	9	4	1	1	4	9	16	36	64	144
$y = \frac{12}{x^2}$	0.08	0.19	0.33	0.75	1.33	3	12	12	3	1.33	0.75	0.33	0.19	0.08

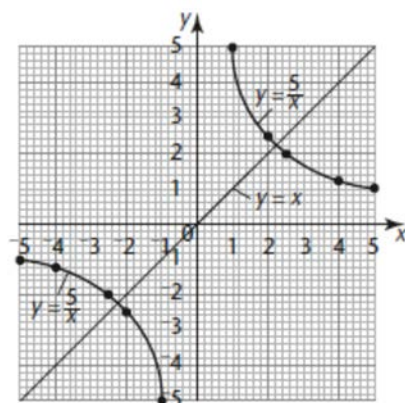
b)



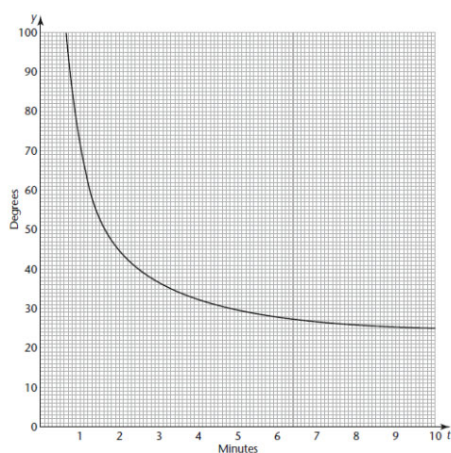
8 a)

$x$	-5	-4	-2.5	-2	-1	1	2	2.5	4	5
$y = \frac{5}{x}$	-1	-1.25	-2	-2.5	-5	5	2.5	2	1.25	1

b) and c)

d)  $x = -2.2$  or  $x = 2.2$ 

9 a)

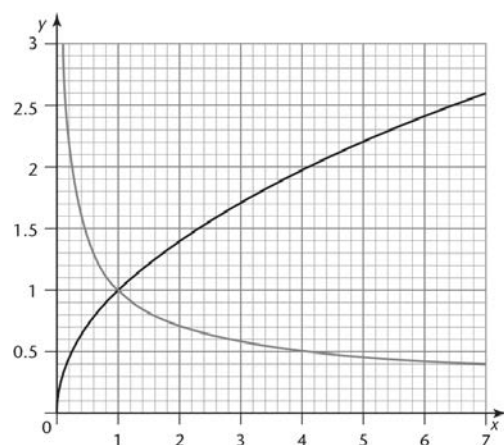


b) 2.5 minutes

c) About 20 °C

10  $y = -x^2 + 4x - 3$

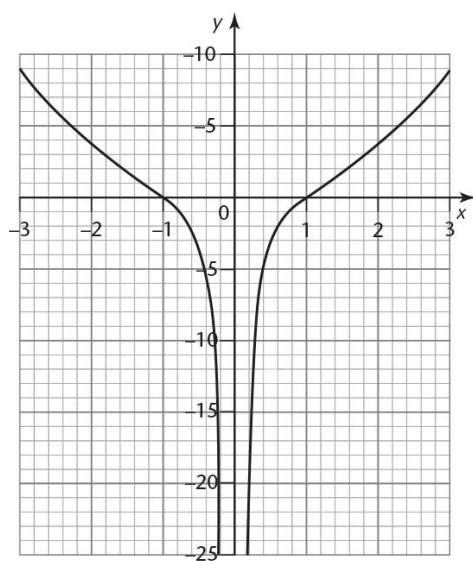
11 a) and b)



12 a)

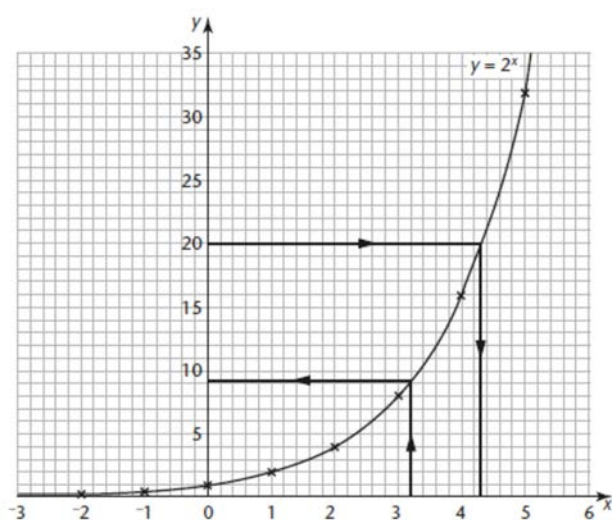
$x$	-3	-2	-1	-0.5	-0.2	0.2	0.5	1	2	3
$y$	8.9	3.75	0	-3.75	-25.0	-25.0	-3.75	0	3.75	8.9

b)



## Exercise 28.4

1

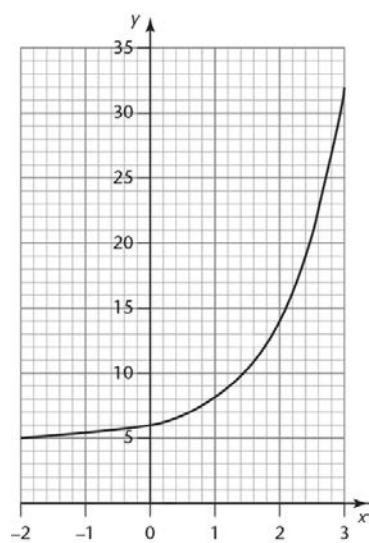


a)  $y = 9.2$

b)  $x = 4.3$

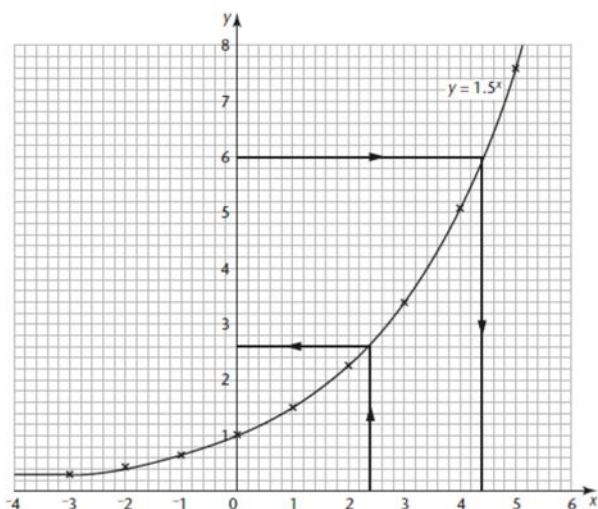
2

a)

b) The  $y$  values have increased by 5.

c) 2.5

3

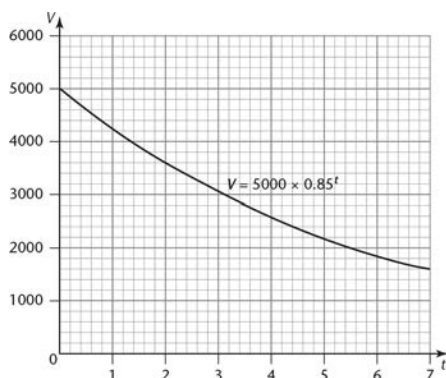


a)  $y = 2.6$

b)  $x = 4.4$

4 The graph of  $y = 3 \times 2^x$  is the same shape as  $y = 2^x$  but steeper. It is always above the graph of  $y = 2^x$  and crosses the y axis at  $(0, 3)$  instead of  $(0, 1)$ .

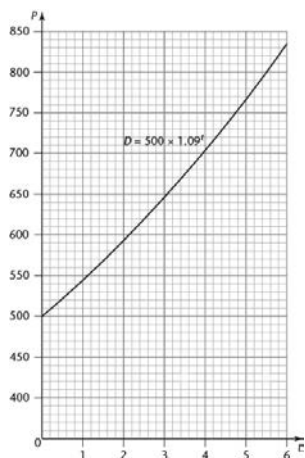
5 a) 15%



b)

c) 4.3 years

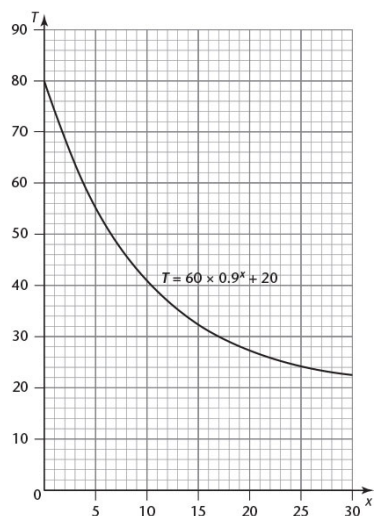
6 a) \$500



b)

c) 5.5 years

7 a) 80 °C



b)

c) 59–60 °C

d) just over 20 °C

## Exercise 28.5

All the answers in this exercise will approximate to the following:

1 Gradient of tangent at  $x = 4$  is 4; gradient of tangent at  $x = 1$  is  $-2$

2 Gradient of tangent at  $x = 4$  is 5; gradient of tangent at  $x = 1$  is  $-1$

3 Gradient of tangent at  $x = 2$  is 12; gradient of tangent at  $x = -1$  is 3

4 Gradient of tangent at  $x = 0$  is  $-12$ ; gradient of tangent at  $x = 2$  is 0; gradient of tangent at  $x = 3$  is 15

5 a)  $x = 1$  or  $x = -1$

b) Gradient of tangent at  $x = 2$  is  $-0.25$ ; gradient of tangent at  $x = -\frac{1}{2}$  is  $-4$

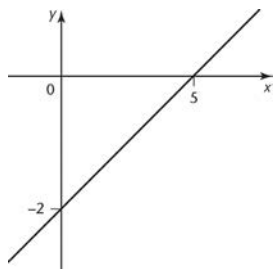


All answers were written by the authors.

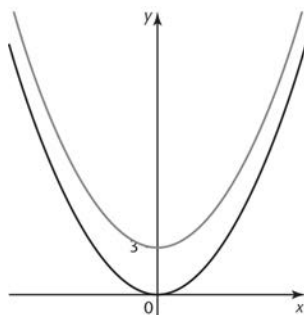
## 29 Sketching graphs

### Exercise 29.1

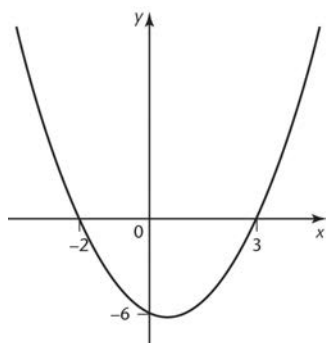
1



2 a) and b)



3 a)

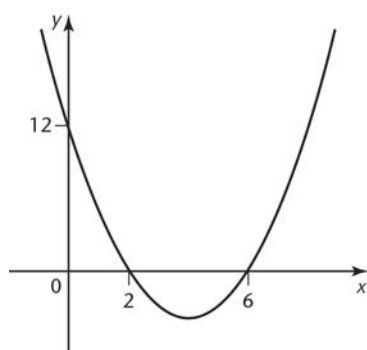


b)  $(0.5, -6.25)$

4 a)  $(x - 4)^2 - 4$

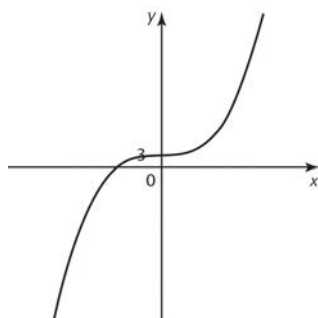
b)  $x = 2$  or  $6$

c)

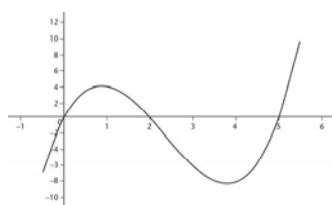
d)  $x = 4$ 

## Exercise 29.2

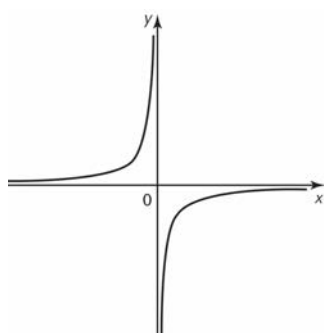
1

2 a)  $x(x-5)(x-2)$ 

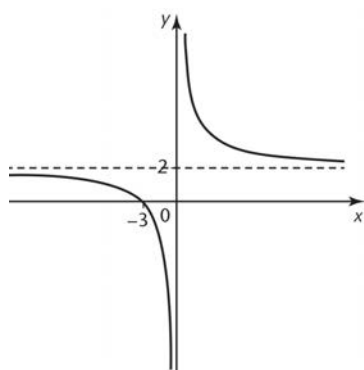
b)



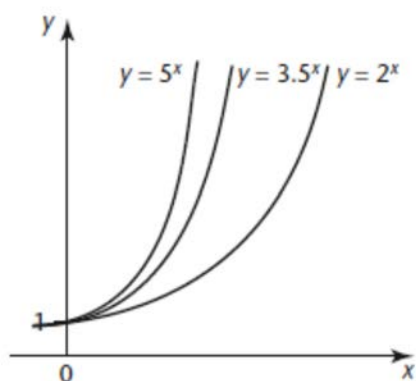
3 a)

b)  $y = x$  and  $y = -x$

4



5 a)

b) C  $y = 6^x$ , A  $y = 1.5^x$ , B  $y = 3^x$ 6 a) The graph of  $y = 2^x - 4$  is the graph of  $y = 2^x$  moved down by 4.b) At  $(0, -3)$  and  $(2, 0)$ .

All answers were written by the authors.

## 30 Functions

### Exercise 30.1

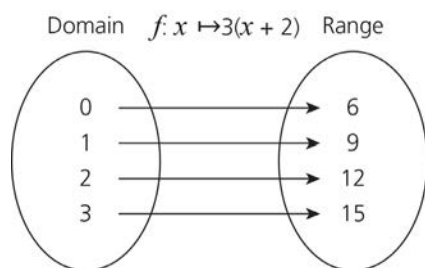
- 1 a)  $f(1) = 7$   
b)  $f(-2) = -5$   
c)  $f(0) = 3$

- 2 a)  $g(2) = 2$   
b)  $g(-3) = 12$   
c)  $g(0.5) = 5$

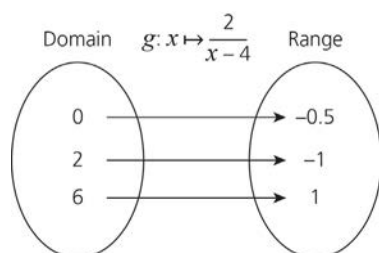
- 3 a)  $h(3) = 3$   
b)  $h(-4) = -\frac{1}{2}$   
c)  $h\left(\frac{1}{2}\right) = 13$

- 4 a)  $f(4) = 23$   
b)  $f(-3) = 16$   
c)  $f\left(\frac{1}{2}\right) = 7\frac{1}{4}$

5



- 6 a)



- b) 2 cannot be divided by zero.

7 a)  $g(-4) = -50$

b)  $x = -\frac{2}{3}$

c)  $5(2 - 3x)$

8 a)  $h(2) = 4$

b)  $x = -3$

c)  $\frac{6}{x}$

9 a)  $f(4) = 5$

b)  $x = 3.5$

c)  $x = 2.5$

10 a)  $h(4) = 11$

b)  $4x^2 - 5$

c)  $x = \pm 6$

11 a)  $f(4) = -4$

b)  $x = 0$  or  $x = 5$

c)  $x = -2$  or  $x = 7$

12 a)  $g(2) = 1.4$

b)  $x = 1.75$

c)  $x = \frac{4}{9}$

## Exercise 30.2

1 a)  $x = \frac{1}{2}$

b)  $f^{-1}(x) = \frac{x-3}{4}$

c)  $f^{-1}(5) = \frac{5-3}{4} = \frac{1}{2}$

2 a)  $g^{-1}(x) = \frac{6-x}{2}$

b)  $g^{-1}(4) = \frac{6-4}{2} = 1$ ;  $g(1) = 6 - 2 \times 1 = 4$

**3**     **a)**      $h^{-1}(x) = \frac{x}{3} + 6$

**b)**      $h^{-1}(9) = 9$

**c)**      $h^{-1}(x) = 6$

**4**     **a)**      $f^{-1}(x) = \frac{5x-1}{2}$

**b)**      $f^{-1}(3) = 7$

**c)**      $f^{-1}\left(\frac{4}{5}\right) = 1\frac{1}{2}$

**5**     **a)**      $g^{-1}(x) = 2(x+7)$

**b)**      $g^{-1}(-4) = 6$

**c)**      $g^{-1}(12) = 38$

**6**     **a)**      $h^{-1}(x) = \frac{12}{x} - 1$

**b)**      $h^{-1}(-4) = -4$

**c)**      $h^{-1}(2) = 5$

**7**     **a)**      $f^{-1}(9) = 4$

**b)**      $f^{-1}(0) = 2\frac{1}{2}$

**c)**      $f^{-1}(-18) = -\frac{1}{2}$

**8**     **a)**      $g^{-1}(1) = 2$

**b)**      $g^{-1}(-5) = 4$

**c)**      $g^{-1}(-293) = 100$

**9**     **a)**      $f^{-1}(x) = \frac{3x+1}{6}$

**b)**      $g^{-1}(x) = \frac{2-x}{5}$

**c)**      $h^{-1}(x) = \frac{6}{x}$

**d)**      $f^{-1}(x) = \frac{4(x+7)}{3}$

e)  $g^{-1}(x) = \frac{x-4}{8}$

f)  $h^{-1}(x) = \frac{1}{x-2}$

### Exercise 30.3

- 1**    a)    i)    144  
               ii)    9  
               iii)    52  
               iv)    7
- b)    i)     $(3x+6)^2$  or  $9(x+2)^2$   
               ii)     $3(x+2)^2 + 4$  or  $3x^2 + 12x + 16$
- 2**    a)    i)    5  
               ii)    3  
               iii)     $\frac{1}{3}$   
               iv)     $\frac{1}{9}$
- b)    i)     $\frac{2x+8}{x+1}$  or  $\frac{2(x+4)}{x+1}$   
               ii)     $\frac{2}{3x+3}$  or  $\frac{2}{3(x+1)}$
- 3**    a)    i)    27  
               ii)    900
- b)     $x = -3$  or  $-7$
- 4**    a)    i)    45  
               ii)    25
- b)    i)     $12x^2 - 3$  or  $3(4x^2 - 1)$   
               ii)     $x = \pm 3$
- 5**    a)    i)    2.5  
               ii)    1
- b)     $\frac{x+4}{x-2}$

- 6**      **a)**      **i)**      **20**
- ii)**       $\frac{4}{3}$
- b)**       $\frac{12}{2x^2 + 7}$
- 7**      **a)**      **i)**       $4x - 1$
- ii)**       $4x - 1$
- b)**      **i)**       $5$
- ii)**       $1$
- 8**      **a)**      **i)**       $18$
- ii)**       $0.3$
- b)**      **i)**       $\frac{3}{(x+1)^2 + 1}$
- ii)**       $0 \text{ or } -2$



All answers were written by the authors.

## 31 Coordinate geometry

### Exercise 31.1

- 1**     **a)**      $\frac{4}{7}$   
         **b)**      $-2.5$   
         **c)**      $0.2$
- 2**     **a)**      $0$   
         **b)**      $\frac{1}{4}$   
         **c)**      $-1$
- 3**     **a)**      $-4$   
         **b)**      $0.75$   
         **c)**      $-3.2$

### Exercise 31.2

- 1**     **a)**     **i)**      $(1, 6)$   
                 **ii)**      $4$   
         **b)**     **i)**      $(4, 4)$   
                 **ii)**      $6.32$   
         **c)**     **i)**      $(5, 4.5)$   
                 **ii)**      $6.71$   
         **d)**     **i)**      $(5.5, 4.5)$   
                 **ii)**      $7.07$   
         **e)**     **i)**      $(1, 2)$   
                 **ii)**      $6.32$   
         **f)**     **i)**      $(-5, -7)$   
                 **ii)**      $8.25$
- 2**      $(8, 7)$

- 3      a)      12.166  
         b)      6.083  
         c)      Length of line joining midpoints is half  $AC$

### Exercise 31.3

1

	Gradient	y-intercept
a)	0	3
b)	2	0
c)	3	-2
d)	5	-3
e)	5	2
f)	2	7
g)	-2	7
h)	-3	9

**2**

	<b>Gradient</b>	<b>y-intercept</b>
<b>a)</b>	0	-4
<b>b)</b>	-3	0
<b>c)</b>	-2	5
<b>d)</b>	5	1
<b>e)</b>	-2	3.5
<b>f)</b>	$-\frac{3}{2}$ or -1.5	4
<b>g)</b>	$-\frac{6}{5}$ or -1.2	2
<b>h)</b>	$-\frac{2}{5}$ or -0.4	3

**3**     **a)**      $y = 3x + 2$

**b)**      $y = 4 - x$

**c)**      $y = 5x$

**d)**      $y = 4x - 1$

**e)**      $y = 5 - 2x$

**f)**      $y = 3x$

**4**     **a)**      $y = 4x$

**b)**      $y = \frac{1}{2}x + 1$

**c)**      $y = -\frac{3}{2}x + 1$

**d)**      $y = -\frac{5}{2}x - 5$

- 5**     **a)**      $3x + 4y = 9$   
         **b)**      $y = x + 3$   
         **c)**      $y = 2x - 1$   
         **d)**      $3x + y = 2$   
         **e)**      $2x + 3y = 9$

### Exercise 31.4

- 1**     **a)**      $y = 2x + 2$   
         **b)**      $x + 2y = 4$   
         **c)**      $(0, 2)$
- 2**     **a)**      $y = 4x + 3$  and  $4x - y = 5$   
         **b)**      $2y - 3x = 5$  and  $6y + 4x = 1$
- 3**      $y = 3x + 2$
- 4**      $3x + 2y = 6$
- 5**      $x + 3y = 16$
- 6**      $3y = 2x + 9$
- 7**     **a)**      $\frac{1}{2}$   
         **b)**      $-\frac{1}{4}$   
         **c)**      $\frac{4}{5}$
- 8**      $3y = x + 4$

All answers were written by the authors.

## 32 Geometrical terms

### Exercise 32.1

- 1
- a) Acute
  - b) Right angle
  - c) Obtuse
  - d) Acute
  - e) Reflex
  - f) Reflex
- 2
- a) Obtuse
  - b) Acute
  - c) Reflex
  - d) Reflex
  - e) Obtuse
  - f) Reflex
  - g) Acute
  - h) Right angle
- 3
- a)  $AC$  and  $BD$
  - b)  $AB$

### Exercise 32.2

- 1
- a)  $090^\circ$
  - b)  $180^\circ$
  - c)  $270^\circ$
  - d)  $045^\circ$
  - e)  $135^\circ$
- 2
- a)  $024^\circ$
  - b)  $101^\circ$
  - c)  $003^\circ$

- 3     *A:*  $080^\circ$   
      *B:*  $120^\circ$   
      *C:*  $225^\circ$   
      *D:*  $310^\circ$

### Exercise 32.3

- 1     *Check students' diagrams; 5 diagonals*
- 2     Square, rectangle
- 3     Rectangle, parallelogram
- 4     All four angles  $90^\circ$ ; opposite sides parallel and the same length; diagonals same length
- 5     Square, rhombus
- 6     Parallelogram, rhombus
- 7     Opposite angles equal; all sides equal length; opposite sides parallel; diagonals bisect at  $90^\circ$
- 8     Square, rhombus, kite
- 9     Square, rectangle, isosceles trapezium
- 10    Square, rectangle, parallelogram, rhombus

### Exercise 32.4

- 1
  - a)     Cuboid
  - b)     Triangular prism
  - c)     Cube
  - d)     Square-based pyramid
- 2
  - a)     6 faces, 8 vertices
  - b)     5 faces, 6 vertices
  - c)     6 faces, 8 vertices
  - d)     5 faces, 5 vertices
- 3
  - a)     Sphere
  - b)     Cylinder
  - c)     Cone
  - d)     Triangular-based prism
- 4     Cuboid, triangular prism, cube and cylinder

### Exercise 32.5

1 a, b, c, d, h

2 a, c

### Exercise 32.6

1 Pairs **a)**, **b)**, **d)** and **f)** are congruent

2 Shapes *C*, *F* and *G*

3  $35^\circ$ ,  $75^\circ$  and  $70^\circ$

4 a) Yes, scale factor 3

b) No

### Exercise 32.7

1 a) Radius

b) Centre

c) Diameter

d) Chord

e) Tangent

2 11.4 cm

3 25.2 cm

All answers were written by the authors.

## 33 Geometrical constructions

### Exercise 33.1

1

	i) Estimated angle	ii) Measured angle
a)	$60^\circ - 70^\circ$	$65^\circ$
b)	$120^\circ - 130^\circ$	$125^\circ$
c)	$45^\circ - 55^\circ$	$50^\circ$
d)	$305^\circ - 315^\circ$	$310^\circ$

### Exercise 33.2

For measurements from students' diagrams, accept  $\pm 0.2$  cm and  $\pm 2^\circ$  throughout.

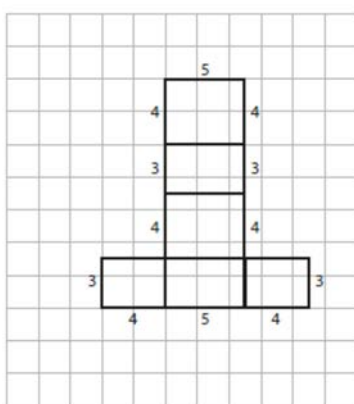
- 1 Check students' diagrams.
- 2
  - a)  $26^\circ, 36^\circ, 117^\circ$
  - b)  $65^\circ, 65^\circ, 50^\circ$
  - c)  $36^\circ, 63^\circ, 81^\circ$
- 3 Check students' diagrams.
- 4 Check students' diagrams.
- 5
  - a) Check students' diagrams.
  - b)  $BD = 10$  cm



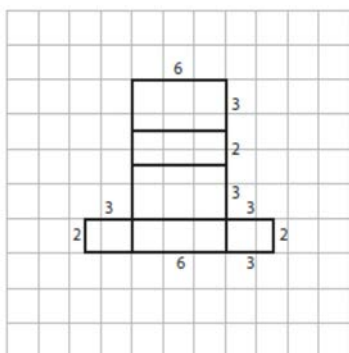
## Exercise 33.3

- 1     a)     Cube  
        b)     Square-based pyramid  
        c)     Triangular prism  
        d)     Triangular prism  
        e)     Triangle-based pyramid  
        f)     Cube
- 2     The nets are not drawn to size, but lengths are marked. Other nets are possible.

a)



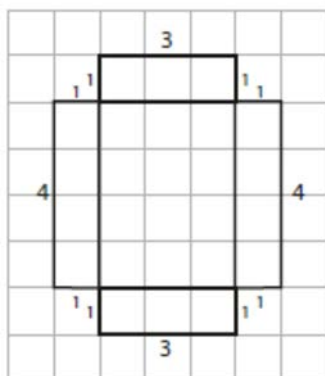
b)



- 3     a)     12  
        b)     8  
        c)     6
- 4     a)     i)     Points  $K$  and  $I$   
               ii)     Point  $F$   
        b)     4 cm by 2 cm by 1 cm  
        c)      $28 \text{ cm}^2$

d)  $8 \text{ cm}^3$

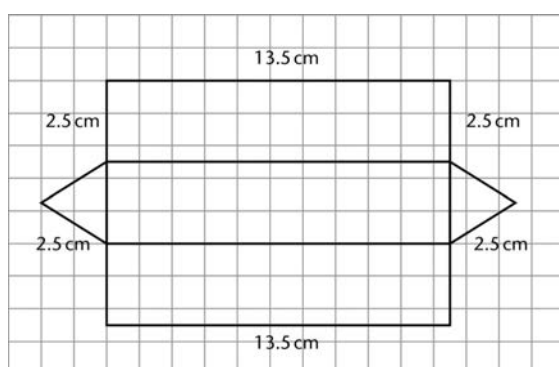
5 a)



b)  $650 \text{ cm}^2$

c)  $1500 \text{ cm}^3$

6



*All answers were written by the authors.*

## 34 Scale drawings

### Exercise 34.1

- 1**
- a) 12.4 m
  - b) 20.8 m
  - c) 27.2 m
  - d) 10.4 m
- 2**
- a) 42 km
  - b) 99 km
  - c) 57 km
  - d) 28 km
- 3** Check students' lines. The lines should be the lengths given below.
- a) 5 cm
  - b) 5 cm
  - c) 12 cm
  - d) 7.5 cm
- 4**
- a) 12.4 m
  - b)
    - Living room: 11.2 m by 6 m
    - Dining room: 6.8 m by 4.8 m
    - Bedroom 1: 5.6 m by 6 m
    - Bedroom 2: 3.4 m by 4.8 m
    - Bathroom: 2.4 m by 3.6 m
    - Kitchen: 4.6 m by 3.6 m
  - c) 13 cm by 7.5 cm

- 5      a)      i)      92 km  
                  ii)      274 km  
                  iii)      112 km  
                  iv)      66 km  
                  v)      128 km  
                  vi)      276 km  
             b)      4.5 cm

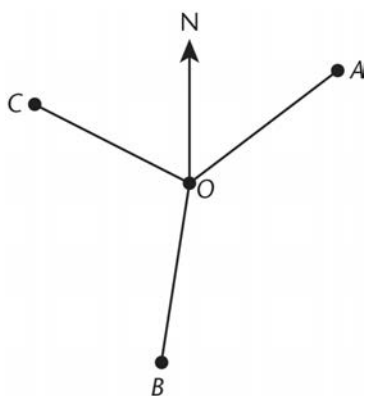
## Exercise 34.2

Accept  $\pm 2^\circ$  for all answers involving measurement.

Diagrams are not full size and are intended only as a guide.

- 1      A:  $078^\circ$ ; B:  $112^\circ$ ; C:  $207^\circ$ ; D:  $290^\circ$

2



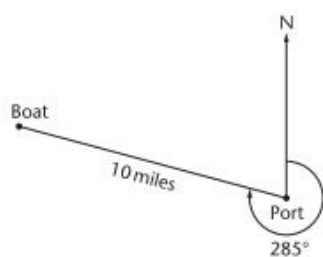
- 3       $304^\circ$

- 4       $110^\circ$

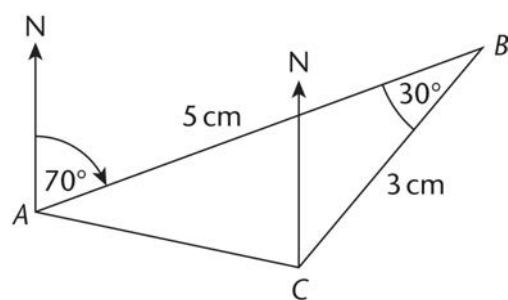
- 5      a)       $259^\circ$

- b)       $336^\circ$

6



7 a)



b)  $282^\circ$

8 a)  $136^\circ$

b)  $230^\circ$

c)  $050^\circ$

All answers were written by the authors.

## 35 Similarity

### Exercise 35.1

- 1 8 cm
- 2 8 cm
- 3 Middle mat: 15 cm by 24 cm  
Largest mat: 25 cm by 40 cm
- 4  $PQ = 4.2$  cm;  $PR = 5.88$  cm
- 5  $PQ = 3.5$  m;  $QR = 6.02$  m
- 6 3 cm
- 7 42 m
- 8
  - a) Angle  $BAC =$  Angle  $CDE$  (alternate angles)  
Angle  $ACB =$  Angle  $DCE$  (vertically opposite angles)  
Angle  $ABC =$  Angle  $CED$  (alternate angles)  
Corresponding angles are equal so triangle  $ABC$  is similar to triangle  $CDE$ .
  - b)  $AC = 13.5$  cm;  $BC = 27$  cm
- 9 Although the lengths of corresponding sides are in constant proportion, the angle between two sets of corresponding sides in the two quadrilaterals is different. Therefore, the two shapes cannot be similar.
- 10
  - a) In triangles  $ADC$  and  $BDA$ ,  
Angle  $ADC =$  Angle  $BDA = 90^\circ$   
Angle  $ABD +$  Angle  $ACB = 90^\circ$   
Angle  $DAC +$  Angle  $ACB = 90^\circ$   
So Angle  $ABD =$  Angle  $DAC$  and similarly Angle  $BAD =$  Angle  $ACB$   
So corresponding angles are equal and therefore triangles  $ADC$  and  $BDA$  are similar.
  - b)  $BD = 1.8$  cm

## Exercise 35.2

- 1**     **a)**     4  
         **b)**     9  
         **c)**     25  
         **d)**     16  
         **e)**     36  
         **f)**     100
- 2**     **a)**     1000  
         **b)**     64  
         **c)**     125  
         **d)**     8  
         **e)**     27  
         **f)**     512
- 3**     **a)**     4  
         **b)**     6  
         **c)**     8  
         **d)**     10
- 4**     **a)**      $72.5 \text{ cm}^2$   
         **b)**      $18.1 \text{ m}^2$
- 5**     25.9 cl
- 6**      $360 \text{ cm}^2$
- 7**     1 : 50
- 8**     27 : 64 : 125
- 9**     2.48 m
- 10**    **a)**     15  
         **b)**     225  
         **c)**      $4.52 \text{ m}^2$
- 11**    15.1 cm
- 12**     $0.0226 \text{ m}^2$  or  $226 \text{ cm}^2$
- 13**     $77.44 \text{ cm}^2$
- 14**     $693 \text{ cm}^2$

All answers were written by the authors.

## 36 Symmetry

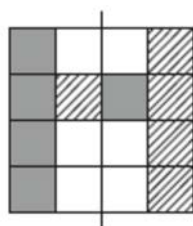
### Exercise 36.1

1 a) 4

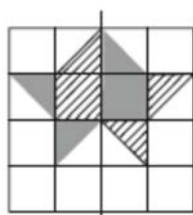
b) 0

c) 3

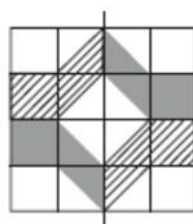
2 a)



b)

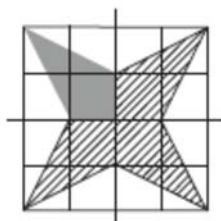


c)

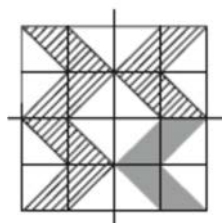




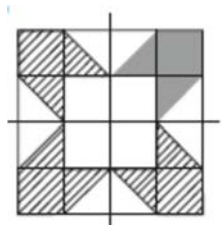
3 a)



b)

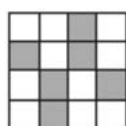


c)

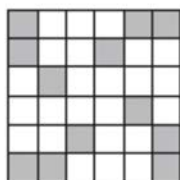


## Exercise 36.2

1



2



3 Check students' diagrams.

Pattern with rotational symmetry order 2 and no lines of symmetry.

4



### Exercise 36.3

- 1
  - a) Two lines of symmetry, rotational symmetry of order 2
  - b) Three lines of symmetry, rotational symmetry of order 3
  - c) Five lines of symmetry, rotational symmetry of order 5
- 2
  - a) 9
  - b) An infinite number
- 3 2 planes of symmetry, 1 axis of symmetry
- 4 Check students' diagrams.  
Sketch of octagon with 2 lines of symmetry and rotational symmetry of order 2
- 5
  - a) Square
  - b) Kite or isosceles trapezium
- 6 Sphere
- 7 Rotational symmetry gives  
exterior angle =  $360 \div 6 = 60^\circ$   
interior angle =  $180 - 60 = 120^\circ$

All answers were written by the authors.

## 37 Angles

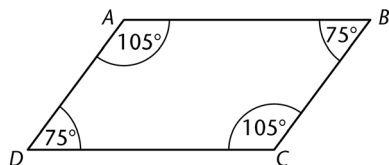
### Exercise 37.1

- 1
- a)  $a = 19^\circ$  (The sum of the angles on a straight line is  $180^\circ$ )
  - b)  $b = 143^\circ$  (The sum of the angles at a point is  $360^\circ$ )
  - c)  $c = 48^\circ$  (The sum of the angles on a straight line is  $180^\circ$ )  
 $d = 132^\circ$  (Vertically opposite angles are equal or the sum of the angles on a straight line is  $180^\circ$ )
  - d)  $e = 45^\circ$  (The sum of the angles on a straight line is  $180^\circ$ )
  - e)  $f = 65^\circ$  ( $f + 71^\circ = 136^\circ$ . Vertically opposite angles are equal)
  - f)  $g = 117^\circ$  (The sum of the angles on a straight line is  $180^\circ$ )  
 $h = 63^\circ$  (Vertically opposite angles are equal or the sum of the angles on a straight line is  $180^\circ$ )
  - g)  $k = 80^\circ$  (The sum of the angles at a point is  $360^\circ$ )
- 2  $113^\circ + 123^\circ + 134^\circ = 370^\circ$ . Karim has measured incorrectly as the angles at a point total  $360^\circ$ .

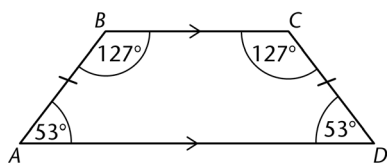
### Exercise 37.2

- 1
- $x = 74^\circ$  (Alternate angles are equal)
  - $y = 137^\circ$  (Corresponding angles are equal)
  - $z = 67^\circ$  (Allied angles add up to  $180^\circ$ )
- 2
- $a = 110^\circ, b = 70^\circ, c = 70^\circ$
  - $d = 105^\circ, e = 75^\circ, f = 63^\circ, g = 63^\circ$
  - $p = 82^\circ, q = 67^\circ, r = 31^\circ$

3



4



- 5  $a = 40^\circ$  (The sum of the angles on a straight line is  $180^\circ$ )

$b = 72^\circ$  (Alternate angles are equal)

$c = 68^\circ$  (The sum of the angles in a triangle is  $180^\circ$  or corresponding angles are equal)

$d = 81^\circ$  (Alternate angles are equal)

$e = 57^\circ$  (The sum of the angles in a triangle is  $180^\circ$ )

$f = 57^\circ$  (The sum of the angles on a straight line is  $180^\circ$  or corresponding angles are equal)

- 6** Angle  $ABE = 51^\circ$ , Angle  $CDE = 94^\circ$  (The sum of the angles in a triangle is  $180^\circ$ )  
Corresponding angles  $BEA$  and  $CDE$  (or  $ABE$  and  $BCD$ ) are equal therefore lines  $BE$  and  $CD$  are parallel.

### Exercise 37.3

- 1**  $a = 70^\circ$  (The sum of the angles in a triangle is  $180^\circ$ )
- 2**  $b = 21^\circ$  (The sum of the angles in a triangle is  $180^\circ$ )
- 3**  $c = 71^\circ$  (Equal angles in an isosceles triangle)  
 $d = 38^\circ$  (The sum of the angles in a triangle is  $180^\circ$ )
- 4**  $e = f = 72^\circ$  (Equal angles in an isosceles triangle and the sum of the angles in a triangle is  $180^\circ$ )
- 5**  $g = 60^\circ$  (Angles in an equilateral triangle are all  $60^\circ$ )  
 $h = 120^\circ$  (The sum of the angles on a straight line is  $180^\circ$ )
- 6**  $b = 113^\circ$  (The sum of the angles in a triangle is  $180^\circ$ )
- 7**  $c = 60^\circ$  (The sum of the angles in a triangle is  $180^\circ$ )
- 8**  $a = 50^\circ$  (The sum of the angles in a triangle is  $180^\circ$ )  
 $b = 130^\circ$  (The sum of the angles on a straight line is  $180^\circ$ )
- 9**  $c = 20^\circ$  (The sum of the angles on a straight line is  $180^\circ$ )  
 $d = 130^\circ$  (The sum of the angles in a triangle is  $180^\circ$ )
- 10**  $e = 137^\circ$  (The sum of the angles on a straight line is  $180^\circ$ )  
 $f = 25^\circ$  (The sum of the angles in a triangle is  $180^\circ$ )  
 $g = 68^\circ$  (The sum of the angles on a straight line is  $180^\circ$ )
- 11**  $h = 128^\circ$  (The sum of the angles on a straight line is  $180^\circ$ )  
 $i = 64^\circ$  (The sum of the angles in a triangle is  $180^\circ$ )
- 12**  $a = 74^\circ$  (Equal angles in an isosceles triangle and the sum of the angles in a triangle is  $180^\circ$ )
- 13**  $b = 41^\circ$  (Equal angles in an isosceles triangle and the sum of the angles in a triangle is  $180^\circ$ )
- 14**  $a = 54^\circ$  (The sum of the angles in a triangle is  $180^\circ$ )
- 15**  $b = 45^\circ$  (The sum of the angles in a triangle is  $180^\circ$ )

- 16**  $c = 36^\circ$  (The sum of the angles in a triangle is  $180^\circ$ )
- 17**  $a = 126^\circ$  (The sum of the angles in a quadrilateral is  $360^\circ$ )
- 18**  $i = 115^\circ$  (The sum of the angles in a quadrilateral is  $360^\circ$ )
- 19**  $j = 123^\circ$  (The sum of the angles in a quadrilateral is  $360^\circ$ )  
 $k = 57^\circ$  (The sum of the angles on a straight line is  $180^\circ$ )
- 20**  $l = 100^\circ$  (The sum of the angles on a straight line is  $180^\circ$ )  
 $m = 84^\circ$  (The sum of the angles in a quadrilateral is  $360^\circ$ )

### Exercise 37.4

- 1**    **a)**     $58^\circ$   
      **b)**     $110^\circ, 121^\circ, 97^\circ, 90^\circ, 122^\circ$
- 2**    **a)**     $78^\circ$   
      **b)**     $126^\circ, 132^\circ, 115^\circ, 145^\circ, 100^\circ, 102^\circ$
- 3**    **a)**     $61^\circ$   
      **b)**     $113^\circ, 137^\circ, 89^\circ, 143^\circ, 119^\circ, 119^\circ$
- 4**    Exterior angle =  $40^\circ$ ; interior angle =  $140^\circ$
- 5**    **a)**     $150^\circ$   
      **b)**     $162^\circ$
- 6**    15 sides
- 7**     $107^\circ$
- 8**    Exterior angle =  $24^\circ$ ; interior angle =  $156^\circ$
- 9**    12 sides
- 10**    $130^\circ$

All answers were written by the authors.

## 38 Circle theorems

### Exercise 38.1

1 Kite

Reason:  $AT = BT$  (equal tangents)

and  $AO = BO$  (equal radii).

2 Triangles  $OXQ$ ,  $OYR$  and  $OYS$

Reason:  $PQ = RS$  (equal chords are equidistant from centre)

So  $PX = XQ = RY = YS$

$OP = OQ = OR = OS$  (equal radii).

3  $\hat{MCA} = 62^\circ$

Reason:  $\hat{AMC} = 90^\circ$  (perpendicular from centre to chord)

So  $\hat{MCA} = 62^\circ$  (angle sum of triangle =  $180^\circ$ )

### Exercise 38.2

1  $a = 140^\circ$  (Angle at centre =  $2 \times$  angle at circumference)

2  $b = 45^\circ$  (Angle at circumference =  $\frac{1}{2}$  angle at centre)

$c = 45^\circ$  (Equal angles in an isosceles triangle and the sum of the angles in a triangle is  $180^\circ$ )

3  $d = 100^\circ$  (Equal angles in an isosceles triangle and the sum of the angles in a triangle is  $180^\circ$ )

$e = 50^\circ$  (Angle at circumference =  $\frac{1}{2}$  angle at centre)

4  $f = 60^\circ$  (The sum of the angles on a straight line is  $180^\circ$ )

$g = 120^\circ$  (Angle at centre =  $2 \times$  angle at circumference)

5  $h = 25^\circ$  (Angle at circumference =  $\frac{1}{2}$  angle at centre =  $45^\circ$ ; equal angles in an isosceles triangle)

6  $i = 22^\circ$  (Angle at centre =  $2 \times$  angle at circumference =  $136^\circ$ ; equal angles in an isosceles triangle)

- 7  $j = 45^\circ$  (Angle at circumference =  $\frac{1}{2}$  angle at centre)  
 $k = 135^\circ$  (The sum of the angles on a straight line is  $180^\circ$ )
- 8  $l = 42^\circ$  (Angle at circumference =  $\frac{1}{2}$  angle at centre)
- 9  $m = 30^\circ$  (Angle in a semicircle is  $90^\circ$  and the sum of the angles in a triangle is  $180^\circ$ )
- 10  $n = 120^\circ$  (Angle at circumference =  $\frac{1}{2}$  angle at centre)

### Exercise 38.3

- 1  $a = 50^\circ$  (Angles in the same segment are equal)  
 $b = 100^\circ$  (Angle at centre =  $2 \times$  angle at circumference)
- 2  $c = 110^\circ$  (Angles around a point sum to  $360^\circ$  and  
angle at circumference =  $\frac{1}{2}$  angle at centre)  
 $d = 110^\circ$  (Angles in the same segment are equal)
- 3  $e = 45^\circ$  (Angle at circumference =  $\frac{1}{2}$  angle at centre)  
 $f = 45^\circ$  (Angles in the same segment are equal)
- 4  $g = 45^\circ$  (Angle at circumference =  $\frac{1}{2}$  angle at centre)  
 $h = 45^\circ$  (Angles in the same segment are equal)  
 $i = 45^\circ$  (Equal angles in an isosceles triangle)
- 5  $j = 80^\circ$  (Angle at circumference =  $\frac{1}{2}$  angle at centre)  
 $k = 100^\circ$  (Angles in opposite segments are supplementary)
- 6  $l = 140^\circ$  (Angle at centre =  $2 \times$  angle at circumference)  
 $m = 110^\circ$  (Angles in opposite segments are supplementary)
- 7 Obtuse angle at centre =  $120^\circ$  (Angles in isosceles triangle)  
Reflex angle at centre =  $240^\circ$  (Angles about a point)  
 $n = 120^\circ$  (Angle at circumference =  $\frac{1}{2}$  angle at centre)

- 8**  $o = 20^\circ$  (Angles in the same segment are equal)  
 $p = 40^\circ$  (Angles in the same segment are equal)  
 $q = 60^\circ$  (External angle of triangle)
- 9**  $r = 104^\circ$  (Angles in opposite segments are supplementary)  
 $s = 85^\circ$  (Angles in opposite segments are supplementary)
- 10**  $t = 50^\circ$  (Angles in the same segment are equal)  
 $u = 56^\circ$  (Sum of the angles in a triangle is  $180^\circ$  and angles in the same segment are equal)  
 $v = 34^\circ$  (Angles in opposite segments are supplementary)
- 11**  $w = 45^\circ$  (Angles in opposite segments are supplementary)  
 $x = 60^\circ$  (Angles in opposite segments are supplementary)
- 12**  $y = 40^\circ$  (Angles in the same segment are equal)  
 $z = 80^\circ$  (Angle at centre =  $2 \times$  angle at circumference)  
 $a = 50^\circ$  (Equal angles in an isosceles triangle and the sum of the angles in a triangle is  $180^\circ$ )
- 13**  $b = 95^\circ$  (Angles on a straight line and angles in opposite segments are supplementary)  
 $c = 126^\circ$  (Angles in opposite segments are supplementary and angles on a straight line)
- 14**  $d = 30^\circ$  (Angle in a semi-circle, angle sum of triangle and angles in same segment)
- 15**  $e = 90^\circ$  (Angle in a semicircle is  $90^\circ$ )  
 $f = 40^\circ$  (Angles in the same segment are equal)  
 $g = 32^\circ$  (Angle sum of triangle is  $180^\circ$ )

### Exercise 38.4

Other reasons may be equally valid.

- 1**  $a = 40^\circ$  (Equal angles in an isosceles triangle and the sum of the angles in a triangle is  $180^\circ$ )  
 $b = 40^\circ$  (Angles in the same segment are equal or angle in a semi-circle is  $90^\circ$ )  
 $c = 50^\circ$  (Angle in a semi-circle is  $90^\circ$ )
- 2**  $d = 60^\circ$  (Angles in the same segment are equal)  
 $e = 20^\circ$  (Angles on straight line, angles in a kite, angles in a triangle)  
 $f = 20^\circ$  (Angles in the same segment are equal)
- 3**  $g = 69^\circ$  (Angle at circumference =  $\frac{1}{2}$  angle at centre)  
 $h = 34.5^\circ$  (Angles on straight line, angles in an isosceles triangle)



- 4  $i = 90^\circ$  (Angle in a semi-circle is  $90^\circ$ )  
 $j = 80^\circ$  (Angles in an isosceles triangle, angles on straight line)  
 $k = 50^\circ$  (Angles in an isosceles triangle)
- 5  $l = 50^\circ$  (Angles in the same segment are equal)  
 $m = 40^\circ$  (Angle at centre =  $2 \times$  angle at circumference, angles in an isosceles triangle)
- 6  $n = 40^\circ$  (Base angles in an isosceles triangle are equal)
- 7  $o = 55^\circ$  (Angles in the same segment are equal)  
 $p = 27.5^\circ$  (Angles in opposite segments are supplementary, angles in an isosceles triangle)
- 8  $q = 90^\circ$  (Angle in a semi-circle is  $90^\circ$ )  
 $r = 30^\circ$  (Angle in a semi-circle is  $90^\circ$ , angles sum of triangle)  
 $s = 30^\circ$  (Angles in the same segment are equal)  
 $t = 40^\circ$  (Angles on straight line, angles in a triangle)
- 9  $u = 18^\circ$  (Angle in a semi-circle is  $90^\circ$ , angle sum of triangle, angles in the same segment are equal)

### Exercise 38.5

Other reasons may be equally valid.

- 1  $a = 50^\circ$  (Angle between tangent and radius is  $90^\circ$ )
- 2  $b = 50^\circ$  (Angle between tangent and radius is  $90^\circ$ , angle sum of quadrilateral)
- 3  $c = 70^\circ$  (Angle between tangent and radius is  $90^\circ$ )  
 $d = 20^\circ$  (Angles in the same segment are equal)
- 4  $e = 15^\circ$  (Angle between tangent and radius is  $90^\circ$  so  $6e = 90^\circ$ )  
 $f = 30^\circ$  (Angles in an isosceles triangle)
- 5  $g = 45^\circ$  (Angle between tangent and radius is  $90^\circ$ )
- 6  $h = 50^\circ$  (Angle between tangent and radius is  $90^\circ$ , angle sum of triangle)  
 $i = 30^\circ$  (Angle between tangent and radius is  $90^\circ$ , angle sum of triangle)
- 7  $j = 40^\circ$  (Angle between tangent and radius is  $90^\circ$ )  
 $k = 50^\circ$  (Angle in a semi-circle is  $90^\circ$ , angles sum of triangle)  
 $l = 40^\circ$  (Angles in the same segment are equal)
- 8  $m = n = 55^\circ$  (Angles in an isosceles triangle and kite, angle between tangent and radius)

## Exercise 38.6

- 1  $a = 71^\circ$  (The sum of the angles in a triangle is  $180^\circ$ )  
 $b = 71^\circ$  (Alternate segment theorem)
- 2  $c = 41^\circ$  (Alternate segment theorem)  
 $d = 35^\circ$  (Alternate segment theorem)  
 $e = 104^\circ$  (The sum of the angles in a triangle is  $180^\circ$ )  
 $f = 76^\circ$  (The sum of the opposite angles in a cyclic quadrilateral is  $180^\circ$ )
- 3  $g = 90^\circ$  (Angle in a semi-circle is  $90^\circ$ )  
 $h = 58^\circ$  (The sum of the angles in a triangle is  $180^\circ$ )  
 $i = 32^\circ$  (Alternate segment theorem)  
 $j = 58^\circ$  (Alternate segment theorem)
- 4  $k = 61^\circ$  (Alternate segment theorem)  
 $l = 122^\circ$  (The angle at the centre is twice the angle at the circumference)  
 $m = 29^\circ$  (The angles at the base of an isosceles triangle are equal)
- 5  $n = 63^\circ$  (Tangents to a circle from an external point are equal in length, angles at the base of an isosceles triangle are equal, alternate segment theorem)  
 $o = 71^\circ$  (Tangents to a circle from an external point are equal in length, angles at the base of an isosceles triangle are equal, alternate segment theorem)  
 $p = 46^\circ$  (The sum of the angles in a triangle is  $180^\circ$ )

*All answers were written by the authors.*

## 39 Units of measure

### Exercise 39.1

- 1
  - a) millimetres or centimetres
  - b) metres or centimetres
  - c) metres
  - d) millimetres or centimetres
- 2
  - a) 45.2 mm
  - b) 20 mm
  - c) 45 mm
  - d) 93.5 mm
  - e) 2101 mm
  - f) 3000 mm
  - g) 2239 mm
  - h) 9100 mm
- 3
  - a) 5200 cm
  - b) 500 cm
  - c) 232 cm
  - d) 1816 cm
  - e) 66 cm
  - f) 7 cm
  - g) 31 cm
  - h) 4.6 cm
- 4
  - a) 2.1463 m
  - b) 5.142 m
  - c) 5.7 m
  - d) 1.146 m
- 5
  - a) 31 cm, 1600 mm, 2.42 m, 284 cm, 9 m
  - b) 105 mm, 3.2 m, 423 cm, 6100 mm, 804 cm
- 6 6.7 km

- 7**     **a)**     12 g  
         **b)**     7000 g  
         **c)**     1130 g  
         **d)**     2140 g
- 8**     **a)**     6.6 kg  
         **b)**     8 kg  
         **c)**     6.3 kg  
         **d)**     5.126 kg
- 9**     **a)**     874 g, 1.7 kg, 4000 g, 9.4 kg, 52 000 g  
         **b)**     0.174 kg, 2104 g, 2.79 kg, 3.4 kg, 4123 g
- 10**    750 g
- 11**    **a)**     520 ml  
         **b)**     7000 ml  
         **c)**     1520 ml  
         **d)**     160 ml
- 12**    **a)**     95.03 litres  
         **b)**     2 litres  
         **c)**     2.341 litres
- 13**    650 ml

### Exercise 39.2

- 1**     **a)**     30 000 cm<sup>2</sup>  
         **b)**     230 mm<sup>2</sup>  
         **c)**     95 200 cm<sup>2</sup>  
         **d)**     1.4 mm<sup>2</sup>
- 2**     **a)**     900 cm<sup>2</sup>  
         **b)**     81.4 cm<sup>2</sup>  
         **c)**     720 m<sup>2</sup>  
         **d)**     9.4 m<sup>2</sup>

- 3**     **a)**      $3\,200\,000\text{ cm}^3$   
         **b)**      $0.000\,042\text{ m}^3$   
         **c)**      $0.005\text{ m}^3$   
         **d)**      $6\,420\,000\text{ cm}^3$
- 4**     **a)**      $2610\text{ cm}^3$   
         **b)**     9.5 litres  
         **c)**     2400 ml  
         **d)**     0.91 litres
- 5**     Calculation should be  $5 \times 2 \times 0.5 (= 5\text{ m}^3)$  not  $5 \times 2 \times 50$
- 6**     195 mm (or 19.5 cm)
- 7**     1000
- 8**     100
- 9**     147 if the sugar cubes are not crushed; 179 if the sugar cubes are crushed.
- 10**    50 m

All answers were written by the authors.

## 40 Mensuration

### Exercise 40.1

- 1     a)     10 cm  
       b)     38 cm
- 2     a)     Missing lengths: 8 cm and 9 cm; Perimeter 72 cm  
       b)     Missing lengths: 10 cm, 6 cm and 7 cm; Perimeter 74 cm  
       c)     Missing lengths: 120 m and 90 m; Perimeter 660 m  
       d)     Missing lengths: 3.4 cm, 2 cm, 8.2 cm, 2 cm, 3.4 cm and 3.1 cm;  
             Perimeter 44.2 cm
- 3     a)     11.4 cm  
       b)     12.8 cm  
       c)     11.2 cm
- 4     5 cm
- 5     30 cm
- 6     1 cm by 29 cm; 2 cm by 28 cm; 3 cm by 27 cm; 4 cm by 26 cm;  
       5 cm by 25 cm; 6 cm by 24 cm; 7 cm by 23 cm; 8 cm by 22 cm;  
       9 cm by 21 cm; 10 cm by 20 cm; 11 cm by 19 cm; 12 cm by 18 cm;  
       13 cm by 17 cm; 14 cm by 16 cm; 15 cm by 15 cm

### Exercise 40.2

- 1     16.92 cm<sup>2</sup>
- 2     6.76 m<sup>2</sup>
- 3     15.023 cm<sup>2</sup>
- 4     36 m<sup>2</sup>
- 5     a)     2.34 km<sup>2</sup>  
       b)     6.2 km
- 6     49 cm<sup>2</sup>
- 7     15 cm
- 8     a)     444 m<sup>2</sup>  
       b)     22.2 kg  
       c)     9

**Exercise 40.3**

- 1**
- a)  $12 \text{ cm}^2$
  - b)  $20 \text{ m}^2$
  - c)  $35 \text{ cm}^2$
  - d)  $31.5 \text{ m}^2$
  - e)  $30.38 \text{ cm}^2$
  - f)  $12.6 \text{ m}^2$
  - g)  $7.5 \text{ m}^2$
  - h)  $16.38 \text{ cm}^2$
  - i)  $24 \text{ m}^2$
- 2**
- a)  $40 \text{ m}^2$
  - b)  $45 \text{ cm}^2$
  - c)  $49.5 \text{ m}^2$
  - d)  $17.5 \text{ m}^2$
  - e)  $13.76 \text{ cm}^2$
  - f)  $9.86 \text{ m}^2$
  - g)  $8.16 \text{ m}^2$
  - h)  $11.25 \text{ cm}^2$
  - i)  $19.09 \text{ m}^2$
- 3**
- a)  $24 \text{ cm}^2$
  - b)  $4.8 \text{ cm}$

**Exercise 40.4**

- 1**
- a)  $40 \text{ cm}^2$
  - b)  $42 \text{ cm}^2$
  - c)  $30 \text{ cm}^2$
  - d)  $34.2 \text{ cm}^2$
  - e)  $37.6 \text{ cm}^2$  to 1 d.p.
  - f)  $23.8 \text{ cm}^2$

- 2**
- a)  $46 \text{ cm}^2$
  - b)  $14 \text{ cm}^2$
  - c)  $42 \text{ cm}^2$
  - d)  $43.7 \text{ cm}^2$  to 1 d.p.
  - e)  $67.8 \text{ cm}^2$  to 1 d.p.
  - f)  $57.1 \text{ cm}^2$  to 1 d.p.
- 3**
- a)  $a = 8$
  - b)  $b = 4$
  - c)  $c = 8$
- 4**
- a)  $x = 6$
  - b)  $y = 4.6$
  - c)  $z = 4.5$

### Exercise 40.5

- 1**
- a)  $30 \text{ cm}^2$
  - b)  $16 \text{ cm}^2$
  - c)  $15 \text{ cm}^2$
  - d)  $31.5 \text{ cm}^2$  to 1 d.p.
  - e)  $16.2 \text{ cm}^2$  to 1 d.p.
  - f)  $19.5 \text{ cm}^2$  to 1 d.p.
- 2**
- a)  $20 \text{ cm}^2$
  - b)  $12.5 \text{ cm}^2$
  - c)  $21 \text{ cm}^2$
  - d)  $5.2 \text{ cm}^2$  to 1 d.p.
  - e)  $15.3 \text{ cm}^2$
  - f)  $12.6 \text{ cm}^2$  to 1 d.p.
- 3**
- a)  $a = 4$
  - b)  $b = 3$
  - c)  $c = 1.5$
- 4**
- a)  $x = 2.6$
  - b)  $y = 3.6$
  - c)  $z = 2.6$



**5**      9 cm

**6**      8 cm

### Exercise 40.6

- 1**      **a)**       $69 \text{ cm}^2$   
         **b)**       $60 \text{ cm}^2$   
         **c)**       $38 \text{ cm}^2$   
         **d)**       $96 \text{ cm}^2$   
         **e)**       $76 \text{ cm}^2$   
         **f)**       $70 \text{ cm}^2$   
         **g)**       $33 \text{ cm}^2$   
         **h)**       $66 \text{ cm}^2$   
         **i)**       $78 \text{ cm}^2$   
         **j)**       $125 \text{ cm}^2$

- 2**      **a)**       $28 \text{ cm}^2$   
         **b)**       $28.5 \text{ cm}^2$   
         **c)**       $32 \text{ cm}^2$   
         **d)**       $20 \text{ cm}^2$   
         **e)**       $35 \text{ cm}^2$   
         **f)**       $21.2 \text{ cm}^2$

### Exercise 40.7

- 1**      **a)**      37.7 cm  
         **b)**      28.3 cm  
         **c)**      62.8 m  
         **d)**      51.2 cm  
         **e)**      47.8 m  
         **f)**      78.5 m  
         **g)**      0.9 cm  
         **h)**      53.4 m  
         **i)**      15.9 m  
         **j)**      20.4 cm

- 2**     **a)**     31.4 cm  
         **b)**     44.0 cm  
         **c)**     100.5 m  
         **d)**     113.7 m  
         **e)**     33.3 m  
         **f)**     175.9 cm  
         **g)**     20.1 cm  
         **h)**     377.0 m  
         **i)**     11.9 m  
         **j)**     458.7 cm
- 3**     **a)**      $6\pi$  cm  
         **b)**      $10\pi$  cm  
         **c)**      $7\pi$  cm  
         **d)**      $8\pi$  cm
- 4**     57.5 m
- 5**     40 074 km
- 6**     94.2 cm
- 7**     **a)**     23.9 cm  
         **b)**     5.7 cm  
         **c)**     15.9 cm
- 8**     95.5 m
- 9**     44.0 m

### Exercise 40.8

- 1**     **a)**      $50.3 \text{ cm}^2$  to 1 d.p.  
         **b)**      $804 \text{ m}^2$  to the nearest  $\text{m}^2$   
         **c)**      $401 \text{ m}^2$  to the nearest  $\text{m}^2$   
         **d)**      $581 \text{ m}^2$  to the nearest  $\text{m}^2$   
         **e)**      $249 \text{ cm}^2$  to the nearest  $\text{cm}^2$

- 2     a)      $25\pi$  m  
       b)      $16\pi$  cm  
       c)      $144\pi$  cm  
       d)      $49\pi$  m
- 3     a)      $28.3 \text{ cm}^2$  to 1 d.p.  
       b)      $201 \text{ m}^2$  to the nearest  $\text{m}^2$   
       c)      $88.2 \text{ cm}^2$  to 1 d.p.  
       d)      $547 \text{ cm}^2$  to the nearest  $\text{cm}^2$   
       e)      $16.6 \text{ m}^2$  to 1 d.p.
- 4      $7.07 \text{ m}^2$  to 2 d.p.
- 5      $254 \text{ cm}^2$  to the nearest  $\text{cm}^2$
- 6      $0.503 \text{ m}^2$  to 3 d.p.
- 7      $1099 \text{ m}^2$  to the nearest  $\text{m}^2$
- 8      $124 \text{ cm}^2$  to the nearest  $\text{cm}^2$
- 9     Square:  $3.5 \times 3.5 = 12.25 \text{ cm}^2$ ; circle:  $\pi \times 2^2 = 12.57 \text{ cm}^2$  to 2 d.p.  
       So the circle has the larger area.
- 10    15
- 11     $145 \text{ cm}^2$  to the nearest  $\text{cm}^2$   
       Check:  $\pi \times 6.8^2 \approx 3 \times 7^2 = 147 \text{ cm}^2$  (or  $3 \times 50 = 150 \text{ cm}^2$ )

### Exercise 40.9

- 1     a)     3.56 cm  
       b)     13.6 cm  
       c)     27.0 cm  
       d)     12.4 cm  
       e)     8.41 cm  
       f)     5.91 cm

- 2**     a)      $9.08 \text{ cm}^2$   
         b)      $25.1 \text{ cm}^2$   
         c)      $139 \text{ cm}^2$   
         d)      $59.5 \text{ cm}^2$   
         e)      $18.1 \text{ cm}^2$   
         f)      $13.9 \text{ cm}^2$
- 3**     a)      $25.7 \text{ cm}$   
         b)      $26.3 \text{ cm}$   
         c)      $51.3 \text{ cm}$
- 4**     a)      $43^\circ$   
         b)      $185^\circ$   
         c)      $58^\circ$   
         d)      $57^\circ$   
         e)      $203^\circ$   
         f)      $159^\circ$   
         g)      $62^\circ$
- 5**     a)      $4.91 \text{ cm}$  to 3 s.f.  
         b)      $4.84 \text{ cm}$  to 3 s.f.  
         c)      $5.57 \text{ cm}$  to 3 s.f.
- 6**     a)      $6.59 \text{ cm}$  to 3 s.f.  
         b)      $1.51 \text{ cm}$  to 3 s.f.  
         c)      $1.81 \text{ m}$  to 3 s.f.
- 7**     Blue area =  $626 \text{ mm}^2$  to the nearest  $\text{mm}^2$   
         Black strip length =  $167 \text{ mm}$  to the nearest mm
- 8**      $57.295\ 7795\dots^\circ$

### Exercise 40.10

- 1**      $30 \text{ cm}^3$   
**2**      $8 \text{ cm}^3$   
**3**      $3 \text{ m}^3$   
**4**      $4 \text{ cm}$   
**5**      $837 \text{ cm}^3$  to the nearest  $\text{cm}^3$

- 6**      $217 \text{ cm}^3$  to the nearest  $\text{cm}^3$
- 7**      $402 \text{ cm}^3$  to the nearest  $\text{cm}^3$
- 8**     a)      $525 \text{ cm}^3$   
         b)      $405 \text{ cm}^3$   
         c)      $67.5 \text{ cm}^3$
- 9**     a)      $384 \text{ cm}^3$   
         b)      $168 \text{ cm}^3$   
         c)      $173 \text{ cm}^3$  to the nearest  $\text{cm}^3$
- 10**     $46.8 \text{ cm}^3$
- 11**     $171 \text{ m}^3$  to the nearest  $\text{m}^3$
- 12**     $110 \text{ cm}^3$  to the nearest  $\text{cm}^3$
- 13**     $16 \text{ cm}$
- 14**     $9.07 \text{ cm}$  to 3 s.f.
- 15**     $6.44 \text{ m}$  to 3 s.f.
- 16**     $4.05 \text{ litres}$

### Exercise 40.11

- 1**     a)      $94 \text{ cm}^2$   
         b)      $144.8 \text{ cm}^2$
- 2**      $2400 \text{ cm}^2$
- 3**      $1710 \text{ cm}^2$
- 4**      $13\,600 \text{ cm}^2$
- 5**      $240 \text{ cm}^2$
- 6**     a)      $496 \text{ cm}^2$   
         b)      $217 \text{ cm}^2$   
         c)      $302 \text{ cm}^2$   
         d)      $430 \text{ cm}^2$   
         e)      $352 \text{ cm}^2$
- 7**     a)      $108 \text{ cm}^2$   
         b)      $216 \text{ cm}^2$

**Exercise 40.12**

- 1**     **a)**      $18 \text{ cm}^3$   
         **b)**      $54 \text{ cm}^3$   
         **c)**      $70 \text{ m}^3$   
         **d)**      $50 \text{ cm}^3$   
         **e)**      $179 \text{ cm}^3$  to 3 s.f.  
         **f)**      $30 \text{ cm}^3$
- 2**     **a)**      $103 \text{ cm}^3$  to 3 s.f.  
         **b)**      $314 \text{ cm}^3$  to 3 s.f.  
         **c)**      $51.5 \text{ cm}^3$  to 3 s.f.  
         **d)**      $154 \text{ cm}^3$  to 3 s.f.  
         **e)**      $1010 \text{ cm}^3$  to 3 s.f.  
         **f)**      $181 \text{ cm}^3$  to 3 s.f.
- 3**     **a)**      $524 \text{ cm}^3$  to 3 s.f.  
         **b)**      $998 \text{ cm}^3$  to 3 s.f.  
         **c)**      $33.5 \text{ mm}^3$  to 3 s.f.  
         **d)**      $113 \text{ cm}^3$  to 3 s.f.  
         **e)**      $435 \text{ cm}^3$  to 3 s.f.  
         **f)**      $1990 \text{ mm}^3$  to 3 s.f.
- 4**      $12 \text{ cm}$
- 5**     **a)**      $3.64 \text{ cm}$  to 3 s.f.  
         **b)**      $3.06 \text{ cm}$  to 3 s.f.  
         **c)**      $6.18 \text{ cm}$  to 3 s.f.
- 6**     **a)**      $556 \text{ cm}^3$  to 3 s.f.  
         **b)**      $2310 \text{ cm}^3$  to 3 s.f.  
         **c)**      $4190 \text{ cm}^3$  to 3 s.f.
- 7**     **a)**      $6.59 \text{ cm}$  to 3 s.f.  
         **b)**      $12.4 \text{ cm}$  to 3 s.f.
- 8**      $88$
- 9**      $12 \text{ cm}$
- 10**     $3.17 \text{ cm}$

## Exercise 40.13

- 1       $145 \text{ cm}^2$
- 2      a)       $204 \text{ cm}^2$  to 3 s.f.  
         b)       $58.0 \text{ cm}^2$  to 3 s.f.  
         c)       $135 \text{ cm}^2$  to 3 s.f.
- 3      a)       $46.1 \text{ cm}^2$  to 3 s.f.  
         b)       $66.8 \text{ cm}^2$  to 3 s.f.
- 4      a)       $314 \text{ cm}^2$  to 3 s.f.  
         b)       $483 \text{ cm}^2$  to 3 s.f.  
         c)       $50.3 \text{ mm}^2$  to 3 s.f.  
         d)       $113 \text{ cm}^2$  to 3 s.f.  
         e)       $278 \text{ cm}^2$  to 3 s.f.  
         f)       $765 \text{ mm}^2$  to 3 s.f.
- 5       $1.95 \text{ cm}$  to 3 s.f.
- 6       $173 \text{ cm}^2$  to 3 s.f.
- 7       $375 \text{ cm}^2$  to 3 s.f.
- 8       $255 \text{ cm}^2$  to 3 s.f.
- 9       $7.64 \text{ cm}$  to 3 s.f.
- 10      $170 \text{ cm}^2$
- 11      $3.54 \text{ cm}$  to 3 s.f.
- 12      $75.2 \text{ cm}^2$  to 3 s.f.
- 13      $130 \text{ cm}^2$  to 3 s.f.
- 14      $6.4 \times 10^{10} \text{ km}^2$
- 15      $484 \text{ cm}^2$  to 3 s.f.
- 16      $124 \text{ cm}^3$  to 3 s.f.
- 17     a)       $158 \text{ cm}^2$  to 3 s.f.  
         b)       $6.57 \text{ cm}$  to 3 s.f.  
         c)       $121 \text{ cm}^3$  to 3 s.f.

- 18 a)  $68.3 \text{ cm}^2$   
 b)  $4.33 \text{ cm}$  to 3 s.f.  
 c)  $36.1 \text{ cm}^3$  to 3 s.f.
- 19 a)  $3.34 \text{ cm}$  to 3 s.f.  
 b)  $72.0 \text{ cm}^2$  to 3 s.f.
- 20  $204 \text{ cm}^2$

### Exercise 40.14

- 1  $346 \text{ m}^3$  to 3 s.f.
- 2 a)  $5.74 \text{ cm}$  to 3 s.f.  
 b)  $11.8 \text{ cm}$  to 3 s.f.
- 3 a)  $3 \text{ cm}$   
 b)  $1230 \text{ cm}^3$  to 3 s.f.  
 c)  $722 \text{ cm}^2$  to 3 s.f.
- 4 Radius of whole cone  $= 2r$

$$\text{Volume of whole cone} = \frac{1}{3}\pi(2r)^2 \times 2h = \frac{8}{3}\pi r^2 h$$

$$\text{Volume of small cone} = \frac{1}{3}\pi r^2 h$$

$$\text{Volume of frustum} = \text{Volume of whole cone} - \text{volume of small cone}$$

$$\begin{aligned} &= \frac{8}{3}\pi r^2 h - \frac{1}{3}\pi r^2 h \\ &= \frac{7}{3}\pi r^2 h \quad \text{as required.} \end{aligned}$$

- 5  $169 \text{ cm}^3$  to 3 s.f.
- 6  $24.0 \text{ cm}^2$
- 7  $29.6 \text{ cm}$
- 8 a) The 'top cone' is similar to the 'whole cone' if their radii and heights are in the same ratio.  
 Ratio of radii is  $8 \div 10 = 0.8$   
 Ratio of heights is  $40 \div 50 = 0.8$   
 Hence the 'top cone' is similar to the 'whole cone' and so the base is a frustum.
- b)  $2.56 \text{ litres}$
- 9  $219\,000 \text{ m}^3$  to 3 s.f.



*All answers were written by the authors.*

## 41 Pythagoras' theorem and trigonometry

### Exercise 41.1

- 1 125 cm<sup>2</sup>
- 2 351 cm<sup>2</sup>
- 3 168 cm<sup>2</sup>
- 4 200 cm<sup>2</sup>

### Exercise 41.2

- 1 11.18 cm
- 2 11.31 cm
- 3 13 cm
- 4 5.66 cm
- 5 28.91 cm
- 6 4 cm
- 7 8.94 cm
- 8 5.83 m
- 9 24 cm
- 10 6.34 cm
- 11 9.35 m
- 12 6.57 cm

### Exercise 41.3

- 1 250.4 m to 1 d.p.
- 2 28.6 m to 1 d.p.
- 3 4.9 m to 1 d.p.
- 4 88.3 cm to 1 d.p.

## Exercise 41.4

*All answers are correct to 3 s.f.*

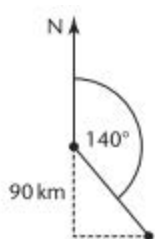
- 1**      $a = 3.5 \text{ cm}$   
          $b = 6.76 \text{ cm}$   
          $c = 8.18 \text{ cm}$   
          $d = 8.57 \text{ cm}$   
          $e = 2.01 \text{ cm}$   
          $f = 1.33 \text{ cm}$   
          $g = 3.41 \text{ m}$   
          $h = 2.00 \text{ m}$
- 2**      $2.05 \text{ m}$
- 3**     **a)**      $6.88 \text{ cm}$   
         **b)**      $68.8 \text{ cm}^2$
- 4**     **a)**      $85.5 \text{ km}$   
         **b)**      $235 \text{ km}$
- 5**     Minimum:  $5.18 \text{ m}$ ; maximum:  $19.7 \text{ m}$

## Exercise 41.5

*All answers are correct to 3 s.f.*

- 1**      $a = 9.24 \text{ cm}$   
          $b = 13.4 \text{ cm}$   
          $c = 10.5 \text{ cm}$   
          $d = 11.4 \text{ m}$   
          $e = 23.0 \text{ cm}$   
          $f = 10.7 \text{ cm}$   
          $g = 7.71 \text{ m}$   
          $h = 26.7 \text{ m}$
- 2**      $9.53 \text{ km}$
- 3**     **a)**      $1.89 \text{ m}$   
         **b)**      $4.73 \text{ m}^2$

4 a)



b) 75.5 km

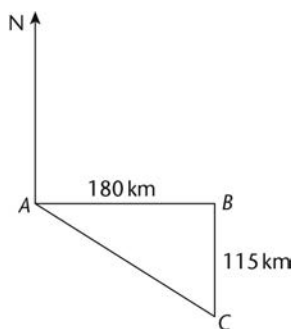
5 3.48 m

### Exercise 41.6

All answers are correct to 3 s.f.

1  $a = 47.2^\circ$  $b = 9.46^\circ$  $c = 45.6^\circ$  $d = 69.2^\circ$  $e = 52.8^\circ$  $f = 42.7^\circ$  $g = 39.6^\circ$  $h = 56.7^\circ$ 2  $69.8^\circ$ 3  $36.9^\circ$ 4  $32.3^\circ$ 

5 a)

b)  $123^\circ$ 

6 a) 169 m

b)  $24.0^\circ$

7  $AC = 231$  km; bearing of  $C$  from  $A$  is  $194^\circ$

8  $13.6$  m

### Exercise 41.7

*All answers are correct to 3 s.f.*

1  $27.9^\circ$

2  $17.7$  m

3  $23.1^\circ$

4  $25.5$  m

5  $36.4$  m

### Exercise 41.8

1 a)  $0.8660$

b)  $-0.5$

2  $17.5^\circ$  or  $162.5^\circ$  to 1 d.p.

3  $45.6^\circ$  to 1 d.p.

4 a)  $\frac{5}{12}$

b)  $-\frac{5}{13}$

5 a)  $5$

b)  $0.8$

c)  $-0.6$

6 a)  $0.8$

b)  $-0.6$

### Exercise 41.9

*All answers are correct to 3. s.f. unless otherwise stated.*

1  $c = 5.39$  cm

$A = 46^\circ$

$a = 5.22$  cm

2  $p = 11.6$  cm

$R = 26^\circ$

$r = 5.50$  cm

- 3**      $B = 66.0^\circ$   
           $C = 72.0^\circ$   
           $c = 7.39 \text{ cm}$
- 4**      $M = 71.4^\circ$   
           $N = 28.6^\circ$   
           $n = 6.46 \text{ cm}$
- 5**      $P = 32.2^\circ$   
           $R = 78.4^\circ$   
           $r = 7.53 \text{ cm}$
- 6**      $Y = 35.5^\circ$   
           $Z = 48.5^\circ$   
           $z = 9.04 \text{ cm}$
- 7**      $y = 7.10 \text{ cm}$   
           $Z = 45^\circ$   
           $z = 7.81 \text{ cm}$
- 8**      $s = 1.13 \text{ m}$   
           $T = 59^\circ$   
           $t = 2.70 \text{ m}$
- 9**      $28.2 \text{ cm}$
- 10**     $B = 94.3^\circ$
- 11**    a)      $AT = 85.7 \text{ m}; BT = 60.5 \text{ m}$   
          b)      $38.9 \text{ m}$
- 12**    a)      $AB = 25.7 \text{ m}; BC = 42.7 \text{ m}$   
          b)      $23.9 \text{ m}$
- 13**     $AC = 43.9 \text{ km}; BC = 25.3 \text{ km}$

### Exercise 41.10

- 1**      $A = 64.09^\circ, B = 73.91^\circ, b = 8.76 \text{ cm}$  or  $A = 115.91^\circ, B = 22.09^\circ, b = 3.43 \text{ cm}$
- 2**     a)     These values give  $\sin C = 1.09\dots$ , which is impossible.  
          b)      $7.66 \text{ cm}$  to 3 s.f.
- 3**      $C = 127^\circ, B = 28.5^\circ, b = 5.76 \text{ cm}$  or  $C = 53.5^\circ, B = 102^\circ, b = 11.8 \text{ cm}$

## Exercise 41.11

*All answers correct to 3 s.f.*

- 1 14.2 cm
- 2 3.91 cm
- 3  $48.5^\circ$
- 4  $50.7^\circ$
- 5 18.7 cm
- 6  $52.0^\circ$
- 7  $39.5^\circ$
- 8  $49.3^\circ$
- 9  $A = 45.9^\circ$  (opposite the shortest side)
- 10 4.79 km
- 11 9.59 km
- 12  $x = 11.3$  m;  $y = 19.5^\circ$
- 13 4.85 cm; 6.40 cm
- 14
  - a)
    - i) 11.7 m
    - ii) 10.2 m
    - iii) 10.8 m
  - b)
    - i)  $58.6^\circ$
    - ii)  $67.5^\circ$

## Exercise 41.12

*All answers correct to 3 s.f.*

- 1
  - a)  $8.94 \text{ cm}^2$
  - b)  $19.7 \text{ cm}^2$
  - c)  $20.5 \text{ cm}^2$
  - d)  $34.0 \text{ cm}^2$
  - e)  $12.1 \text{ m}^2$
- 2  $15 \text{ cm}^2$
- 3  $73.2^\circ$
- 4 44.6 cm

- 5       $35.7 \text{ cm}^2$
- 6       $17.3 \text{ cm}^2$
- 7      Area of field =  $6000 \text{ m}^2$   
( $1981.0... \text{ m}^2 + 4018.6... \text{ m}^2$ )

### Exercise 41.13

*All answers correct to 3 s.f.*

- 1      a)       $41.6^\circ$   
         b)       $15 \text{ cm}$   
         c)       $17 \text{ cm}$   
         d)       $28.1^\circ$
- 2      a)       $11.3 \text{ cm}$   
         b)       $27.9^\circ$   
         c)       $12.8 \text{ cm}$   
         d)       $51.3^\circ$
- 3      a)       $AC = 102.5 \text{ m to 1 d.p.}; BC = 64.0 \text{ m to 1 d.p.}$   
         b)       $120.9 \text{ m to 1 d.p.}$   
         c)       $328.0^\circ \text{ to 1 d.p.}$
- 4      a)       $45^\circ$   
         b)       $73.4^\circ$   
         c)       $11.3 \text{ cm}$   
         d)       $5.66 \text{ cm}$   
         e)       $12.8 \text{ cm}$   
         f)       $66.2^\circ$
- 5      a)       $33.8 \text{ cm}$   
         b)       $94.3 \text{ cm}$   
         c)       $21^\circ$
- 6      a)      i)       $17 \text{ cm}$   
                 ii)       $13.1 \text{ cm}$   
                 iii)       $69.7^\circ$   
         b)      i)       $10.8 \text{ cm}$   
                 ii)       $68.2^\circ$

- 7 a) 21.2 cm  
b) 16.8 cm  
c) 16.8 cm

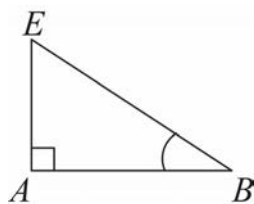
- 8 Yes.  $CE = 11.96$  m and  $AC = 87.3$  m;

$$AC = \sqrt{80^2 + 35^2} = 87.3 \text{ m}$$

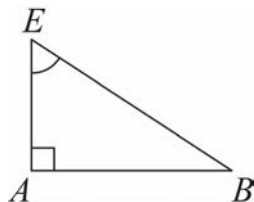
- 9 a) 11.0 cm  
b)  $35.5^\circ$
- 10 a) 10.9 m  
b)  $68.9^\circ$   
c) 11.7 m

### Exercise 41.14

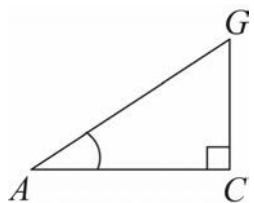
- 1 a)



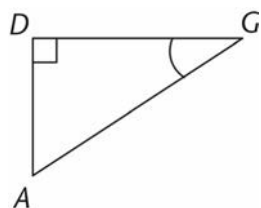
- b)



- c)



- d)

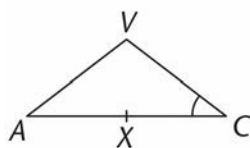




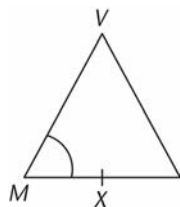
- 2     a)      $32^\circ$   
       b)      $58^\circ$   
       c)      $26.6^\circ$   
       d)      $32.5^\circ$

- 3     a)      $36.7^\circ$   
       b)      $33.5^\circ$

- 4     a)



- b)



- 5     a)      $65.4^\circ$   
       b)      $74.6^\circ$
- 6     a)      $23.4^\circ$   
       b)      $49.3^\circ$

- 7      $62.1^\circ$

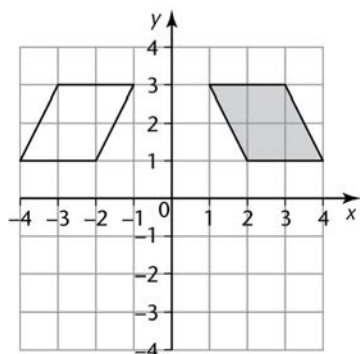
- 8     a)     22.9cm  
       b)     i)      $12.6^\circ$   
             ii)      $60.8^\circ$

All answers were written by the authors.

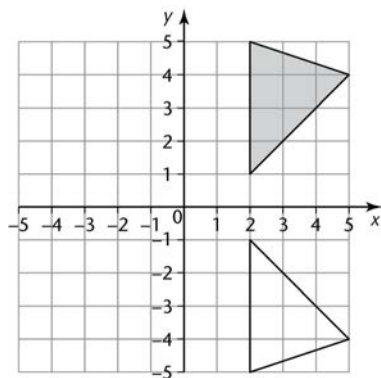
## 42 Transformations

### Exercise 42.1

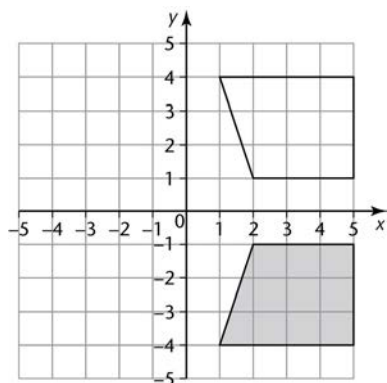
1



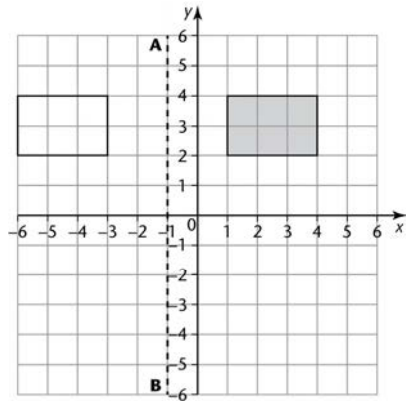
2



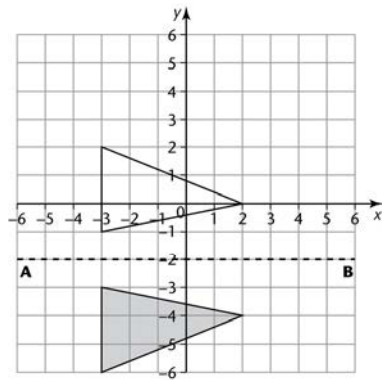
3



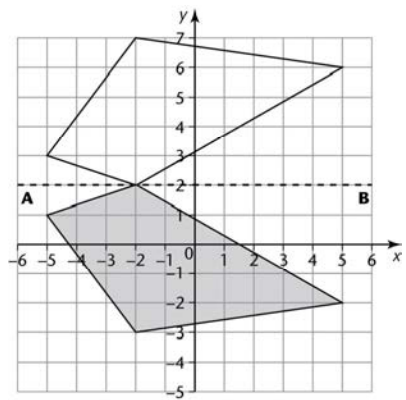
4



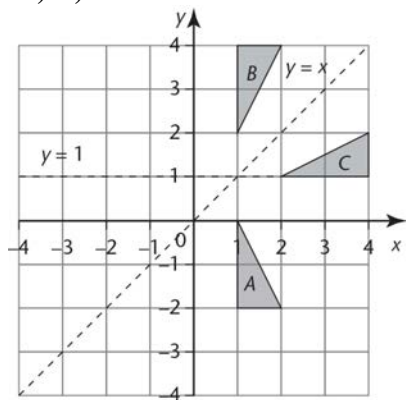
5



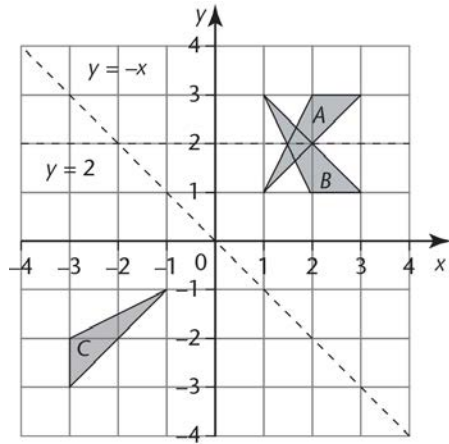
6



7 a)–c)

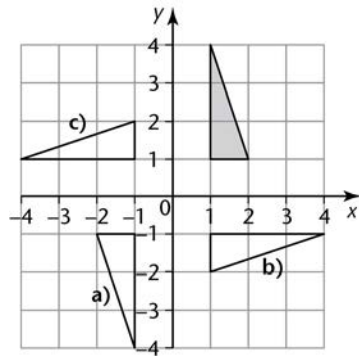


8 a)–c)

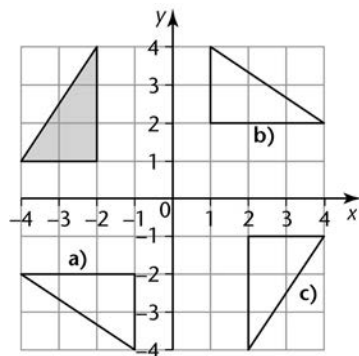


## Exercise 42.2

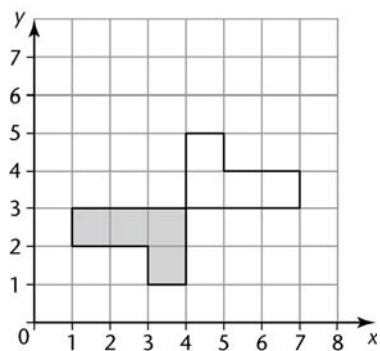
1



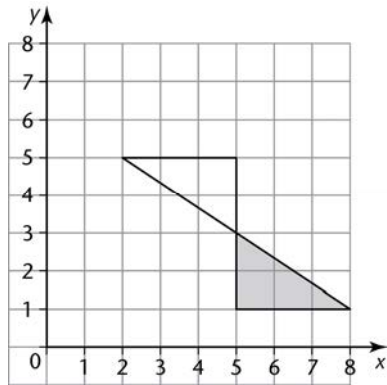
2



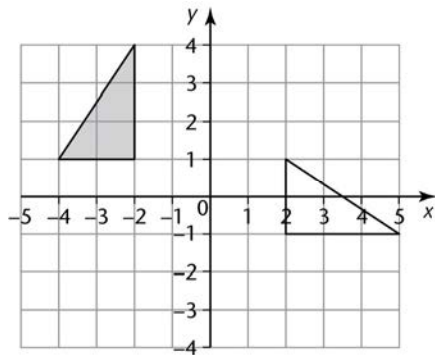
3



4

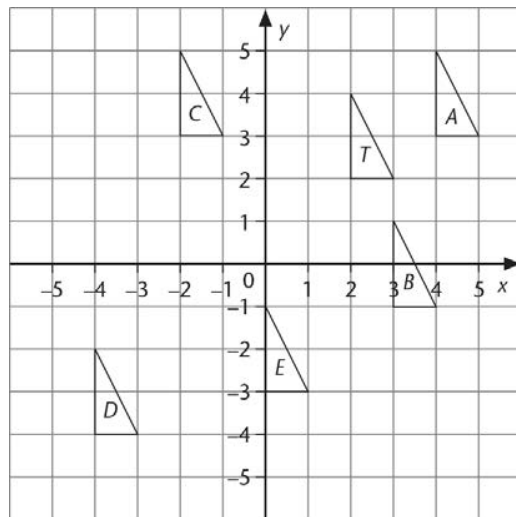


5

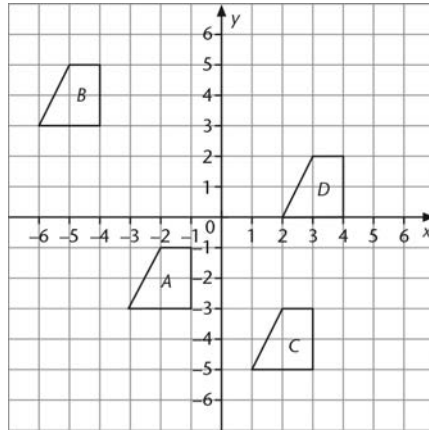


## Exercise 42.3

1 a)–e)

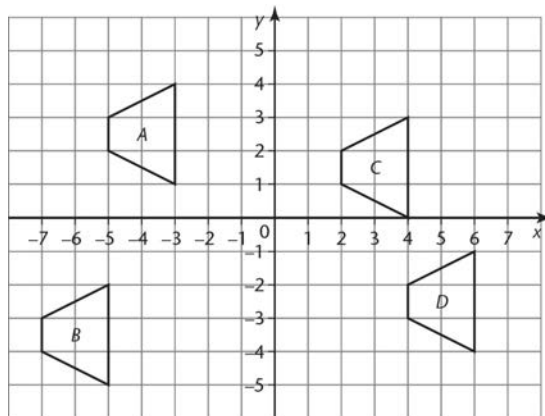


2 a)–c)



d) Shape D is mapped back on to shape A after translation by  $\begin{pmatrix} -5 \\ -3 \end{pmatrix}$

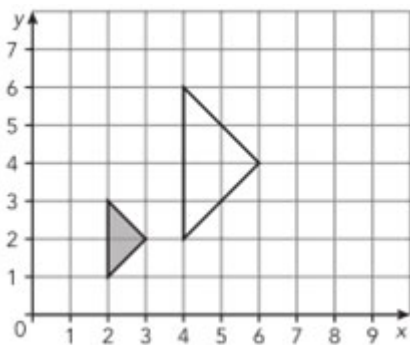
3 a)–c)



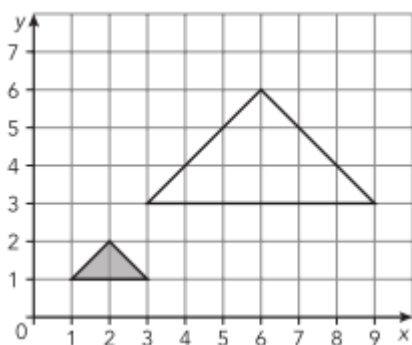
d) Translate D by  $\begin{pmatrix} -9 \\ 5 \end{pmatrix}$

## Exercise 42.4

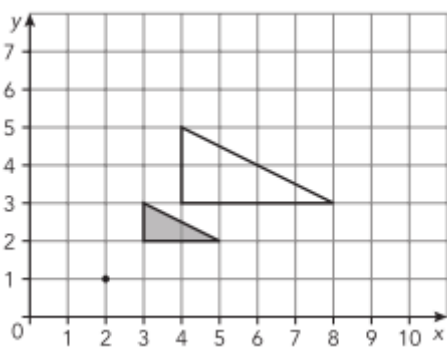
1



2

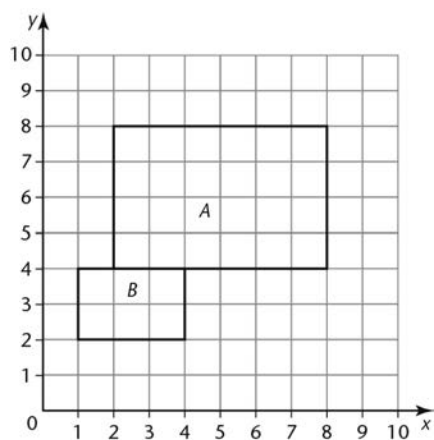


3

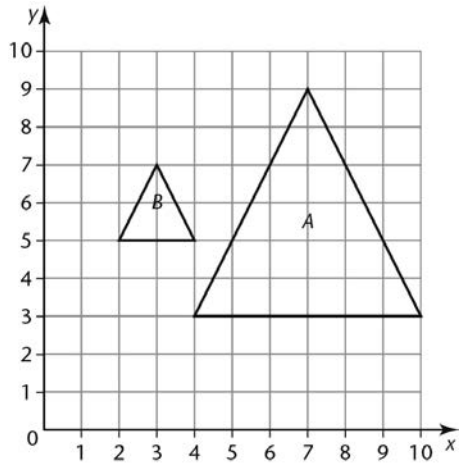


## Exercise 42.5

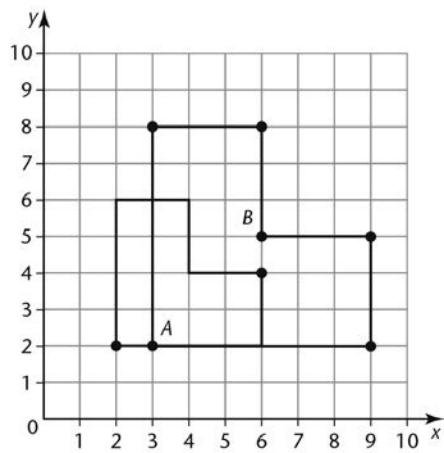
1



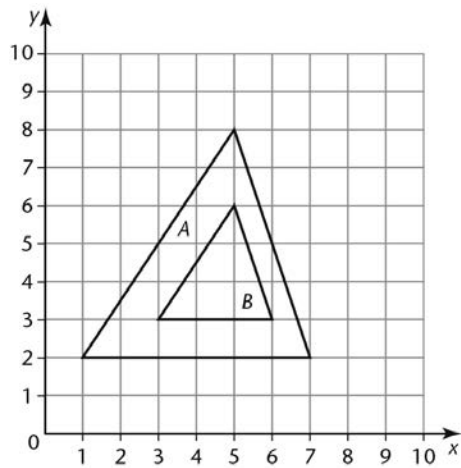
2



3



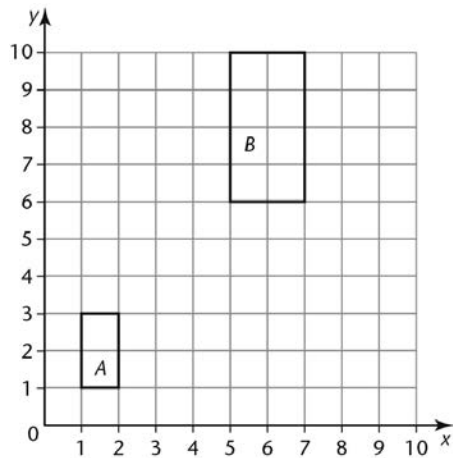
4



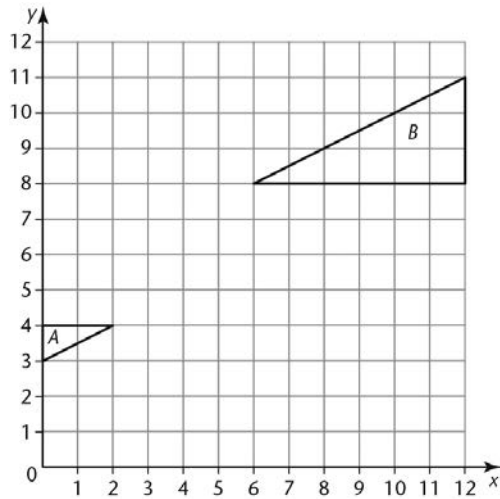


## Exercise 42.6

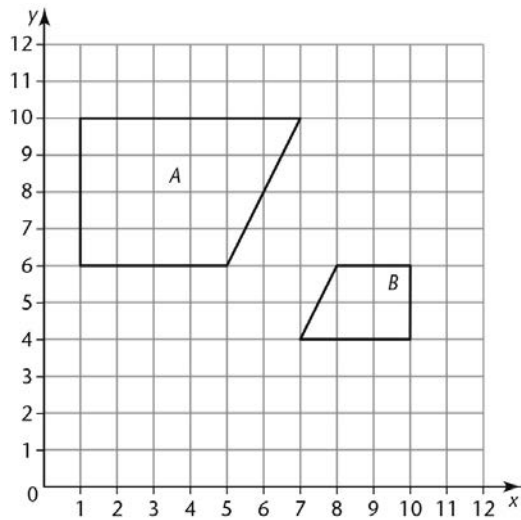
1



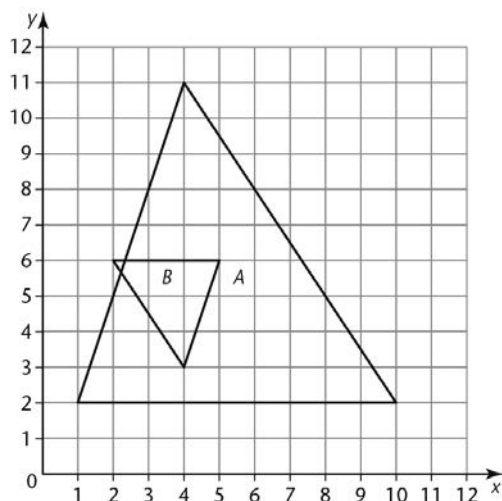
2



3



4



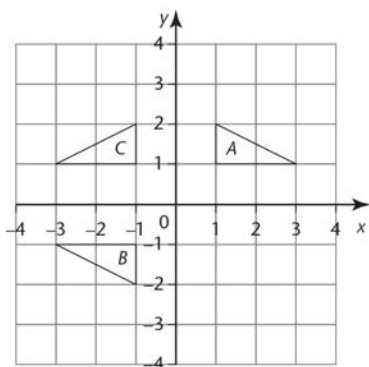
## Exercise 42.7

- 1 Reflection in the line  $y = x$
- 2 Reflection in the line  $x = 3$
- 3 Translation by the vector  $\begin{pmatrix} 2 \\ -1 \end{pmatrix}$
- 4
  - a) Translation by the vector  $\begin{pmatrix} 2 \\ -1 \end{pmatrix}$
  - b) Translation by the vector  $\begin{pmatrix} -1 \\ -2 \end{pmatrix}$
  - c) Translation by the vector  $\begin{pmatrix} -2 \\ 1 \end{pmatrix}$
  - d) Translation by the vector  $\begin{pmatrix} -4 \\ 2 \end{pmatrix}$
- 5
  - a) Reflection in the line  $y = 2$
  - b) Reflection in the line  $x = 3$
  - c) Reflection in the line  $y = x$
- 6
  - a) Translation by the vector  $\begin{pmatrix} 3 \\ -5 \end{pmatrix}$
  - b) Enlargement, scale factor 2, centre (0, 4)
  - c) Translation by the vector  $\begin{pmatrix} -8 \\ -3 \end{pmatrix}$

- d) Enlargement, scale factor  $2\frac{1}{2}$ , centre (0, 0)
- e) Translation by the vector  $\begin{pmatrix} -6 \\ 4 \end{pmatrix}$
- f) Enlargement, scale factor  $\frac{1}{3}$ , centre (5, 3)
- 7 Enlargement, scale factor  $-3$ , centre (1, 8)
- 8 Enlargement, scale factor  $-2$ , centre (0, 3)
- 9 Enlargement, scale factor  $-\frac{1}{2}$ , centre (2, 3)

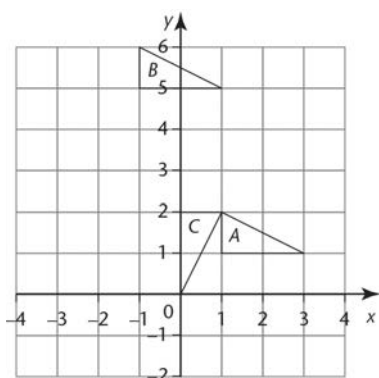
### Exercise 42.8

- 1 a) and b)



- c) Reflection in the y-axis

- 2 a), b)



- c) Rotation  $90^\circ$  about (1, 2)
- 3 Reflection in the line  $y = x$
- 4 Rotation  $180^\circ$  about (3, -2)

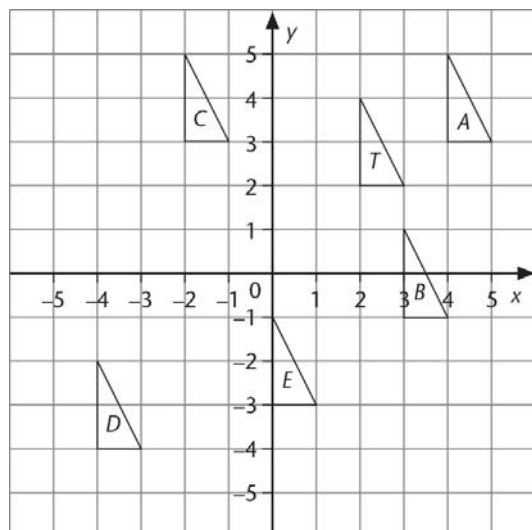
- 5 Translation through the vector  $\begin{pmatrix} 0 \\ -8 \end{pmatrix}$
- 6 Reflection in the line  $y = x + 1$
- 7 Enlargement, scale factor  $-2$ , centre  $(0, 2)$

All answers were written by the authors.

## 43 Vectors

### Exercise 43.1

1



- 2
- a) Translation of  $\begin{pmatrix} 5 \\ 2 \end{pmatrix}$
  - b) Translation of  $\begin{pmatrix} 4 \\ -6 \end{pmatrix}$
  - c) Translation of  $\begin{pmatrix} 1 \\ 8 \end{pmatrix}$
  - d) Translation of  $\begin{pmatrix} -4 \\ 6 \end{pmatrix}$

### Exercise 43.2

1  $\overrightarrow{AB} = \begin{pmatrix} 4 \\ 1 \end{pmatrix}$

$\overrightarrow{CD} = \begin{pmatrix} 2 \\ 0 \end{pmatrix}$

$\overrightarrow{CB} = \begin{pmatrix} 1 \\ 4 \end{pmatrix}$

$\overrightarrow{AD} = \begin{pmatrix} 5 \\ -3 \end{pmatrix}$

$\overrightarrow{CA} = \begin{pmatrix} -3 \\ 3 \end{pmatrix}$

2  $\overrightarrow{EF} = \begin{pmatrix} 4 \\ 3 \end{pmatrix}$

$\overrightarrow{GH} = \begin{pmatrix} -2 \\ -2 \end{pmatrix}$

$$\overrightarrow{EH} = \begin{pmatrix} 6 \\ 1 \end{pmatrix}$$

$$\overrightarrow{GF} = \begin{pmatrix} -4 \\ 0 \end{pmatrix}$$

$$\overrightarrow{FH} = \begin{pmatrix} 2 \\ -2 \end{pmatrix}$$

- 3**
- a)  $\begin{pmatrix} 0 \\ 2 \end{pmatrix}$
  - b)  $\begin{pmatrix} -4 \\ 0 \end{pmatrix}$
  - c)  $\begin{pmatrix} -2 \\ 3 \end{pmatrix}$
  - d)  $\begin{pmatrix} 1 \\ 7 \end{pmatrix}$
  - e)  $\begin{pmatrix} 8 \\ -6 \end{pmatrix}$
  - f)  $\begin{pmatrix} -6 \\ 4 \end{pmatrix}$

**4**

	Original point	Vector	New point
a)	(1, 2)	$\begin{pmatrix} 3 \\ 2 \end{pmatrix}$	(4, 4)
b)	(2, 3)	$\begin{pmatrix} 4 \\ 1 \end{pmatrix}$	(6, 4)
c)	(1, 0)	$\begin{pmatrix} -3 \\ 2 \end{pmatrix}$	(-2, 2)
d)	(4, 2)	$\begin{pmatrix} 0 \\ -3 \end{pmatrix}$	(4, -1)
e)	(-3, 2)	$\begin{pmatrix} -5 \\ -2 \end{pmatrix}$	(-8, 0)
f)	(6, 1)	$\begin{pmatrix} -6 \\ -1 \end{pmatrix}$	(0, 0)

**5**      $\overrightarrow{AB} = 2\mathbf{a}$

$\overrightarrow{CD} = -\mathbf{a}$

$\overrightarrow{EF} = \frac{1}{2}\mathbf{a}$

$\overrightarrow{GH} = \frac{3}{2}\mathbf{a}$

$\overrightarrow{PQ} = -\frac{1}{2}\mathbf{a}$

$\overrightarrow{RS} = \frac{9}{4}\mathbf{a}$

**6**      $\overrightarrow{AB} = \mathbf{a}$

$\overrightarrow{CD} = -\mathbf{b}$

$\overrightarrow{EF} = 2\mathbf{b}$

$\overrightarrow{GH} = -\frac{1}{2}\mathbf{a}$

$\overrightarrow{PQ} = -\frac{1}{2}\mathbf{b}$

$\overrightarrow{RS} = 3\mathbf{a}$

**7**      $\overrightarrow{AB} = 2\mathbf{a}$

$\overrightarrow{CD} = -2\mathbf{a}$

$\overrightarrow{EB} = \mathbf{a}$

$\overrightarrow{GD} = -\mathbf{a}$

$\overrightarrow{HF} = 2\mathbf{a}$

$\overrightarrow{FC} = \mathbf{b}$

**8**      $\overrightarrow{BC} = \mathbf{b}$

$\overrightarrow{CD} = -\mathbf{a}$

$\overrightarrow{EB} = \frac{1}{2}\mathbf{a}$

$\overrightarrow{GD} = -\frac{1}{2}\mathbf{a}$

$\overrightarrow{HF} = \mathbf{a}$

$\overrightarrow{FC} = \frac{1}{2}\mathbf{b}$

## Exercise 43.3

- 1      a)  $\begin{pmatrix} 4 \\ 6 \end{pmatrix}$   
      b)  $\begin{pmatrix} 9 \\ 3 \end{pmatrix}$   
      c)  $\begin{pmatrix} 2 \\ 3 \end{pmatrix}$   
      d)  $\begin{pmatrix} 1 \\ 0 \end{pmatrix}$   
      e)  $\begin{pmatrix} 5 \\ 12 \end{pmatrix}$
- 2      a)  $\begin{pmatrix} -6 \\ 0 \end{pmatrix}$   
      b)  $\begin{pmatrix} -1 \\ -2 \end{pmatrix}$   
      c)  $\begin{pmatrix} 0.5 \\ -1.5 \end{pmatrix}$   
      d)  $\begin{pmatrix} 6 \\ 1 \end{pmatrix}$   
      e)  $\begin{pmatrix} 0 \\ 1 \end{pmatrix}$
- 3      a)  $\begin{pmatrix} 3 \\ 12 \end{pmatrix}$   
      b)  $\begin{pmatrix} 8 \\ 12 \end{pmatrix}$   
      c)  $\begin{pmatrix} 4 \\ 5 \end{pmatrix}$   
      d)  $\begin{pmatrix} 7 \\ 4 \end{pmatrix}$   
      e)  $\begin{pmatrix} 7 \\ 18 \end{pmatrix}$
- 4      a)  $\begin{pmatrix} -2 \\ 0 \end{pmatrix}$   
      b)  $\begin{pmatrix} -6 \\ 3 \end{pmatrix}$   
      c)  $\begin{pmatrix} -1 \\ 2 \end{pmatrix}$   
      d)  $\begin{pmatrix} -3 \\ -10 \end{pmatrix}$   
      e)  $\begin{pmatrix} -0.5 \\ 5.5 \end{pmatrix}$



## Exercise 43.4

1  $\overrightarrow{OP} = \begin{pmatrix} 3 \\ 4 \end{pmatrix}$

$$\overrightarrow{OQ} = \begin{pmatrix} -2 \\ 1 \end{pmatrix}$$

$$\overrightarrow{OR} = \begin{pmatrix} -4 \\ -5 \end{pmatrix}$$

2 a)  $\overrightarrow{OA} = \begin{pmatrix} -2 \\ 1 \end{pmatrix}$

$$\overrightarrow{OB} = \begin{pmatrix} 4 \\ 3 \end{pmatrix}$$

$$\overrightarrow{OC} = \begin{pmatrix} 7 \\ 4 \end{pmatrix}$$

b) i)  $\overrightarrow{AB} = \begin{pmatrix} 6 \\ 2 \end{pmatrix}$

ii)  $\overrightarrow{BC} = \begin{pmatrix} 3 \\ 1 \end{pmatrix}$

c)  $\overrightarrow{AB} = 2 \times \overrightarrow{BC}$ . So  $ABC$  is a straight line and  $AB = 2 \times BC$  in length.

3 a)  $\overrightarrow{OA} = \begin{pmatrix} 2 \\ 1 \end{pmatrix}$

$$\overrightarrow{OB} = \begin{pmatrix} 4 \\ 4 \end{pmatrix}$$

$$\overrightarrow{OC} = \begin{pmatrix} 7 \\ 4 \end{pmatrix}$$

b) i)  $\overrightarrow{AB} = \begin{pmatrix} 2 \\ 3 \end{pmatrix}$

ii)  $\overrightarrow{CD} = \begin{pmatrix} -4 \\ -6 \end{pmatrix}$

c)  $\overrightarrow{CD} = -2 \times \overrightarrow{AB}$ . So the line  $AB$  is parallel to  $CD$  and  $CD = 2 \times AB$  in length.

## Exercise 43.5

1 a)  $\begin{pmatrix} 12 \\ 6 \end{pmatrix}$

b)  $\begin{pmatrix} -6 \\ -3 \end{pmatrix}$

c)  $\begin{pmatrix} 24 \\ 12 \end{pmatrix}$

d)  $\begin{pmatrix} 3 \\ 1.5 \end{pmatrix}$

e)  $\begin{pmatrix} -2 \\ -1 \end{pmatrix}$

f) 6.71 correct to 3 s.f.

- 2**
- a)  $\begin{pmatrix} 3 \\ 9 \end{pmatrix}$
  - b)  $\begin{pmatrix} 4 \\ 7 \end{pmatrix}$
  - c)  $\begin{pmatrix} 2 \\ 1 \end{pmatrix}$
  - d)  $\begin{pmatrix} 5 \\ 10 \end{pmatrix}$
  - e)  $\begin{pmatrix} -3 \\ 1 \end{pmatrix}$
  - f) 3.16 correct to 3 s.f.
  - g) 5
- 3**
- a)  $\begin{pmatrix} -3 \\ -9 \end{pmatrix}$
  - b)  $\begin{pmatrix} 2 \\ -20 \end{pmatrix}$
  - c)  $\begin{pmatrix} 4 \\ -4 \end{pmatrix}$
  - d)  $\begin{pmatrix} -7 \\ 12 \end{pmatrix}$
  - e)  $\begin{pmatrix} 4.5 \\ -1 \end{pmatrix}$
  - f) 5
  - g) 3.16 correct to 3 s.f.
- 4**
- a)  $\begin{pmatrix} 20 \\ 32 \end{pmatrix}$
  - b)  $\begin{pmatrix} -10 \\ -16 \end{pmatrix}$
  - c)  $\begin{pmatrix} 2.5 \\ 4 \end{pmatrix}$
  - d)  $\begin{pmatrix} 45 \\ 72 \end{pmatrix}$
  - e)  $\begin{pmatrix} 2 \\ 3.2 \end{pmatrix}$
  - f) 9.43 correct to 3 s.f.
- 5**
- a)  $\begin{pmatrix} 8 \\ 2 \end{pmatrix}$
  - b)  $\begin{pmatrix} 9 \\ 4 \end{pmatrix}$
  - c)  $\begin{pmatrix} 1 \\ 2 \end{pmatrix}$

d)  $\begin{pmatrix} 13 \\ 5 \end{pmatrix}$

e)  $\begin{pmatrix} 7 \\ 7 \end{pmatrix}$

f) 2.24 correct to 3 s.f.

6 a)  $\begin{pmatrix} -6 \\ -9 \end{pmatrix}$

b)  $\begin{pmatrix} 0 \\ 1 \end{pmatrix}$

c)  $\begin{pmatrix} -7 \\ -4 \end{pmatrix}$

d)  $\begin{pmatrix} 14 \\ 30 \end{pmatrix}$

e)  $\begin{pmatrix} 3 \\ 8.5 \end{pmatrix}$

f) 7

### Exercise 43.6

1  $\overrightarrow{BC} = 2\mathbf{b} - \mathbf{a}$

2  $\overrightarrow{PR} = 2\mathbf{a} - 3\mathbf{b}$

3 a)  $\overrightarrow{AB} = -\mathbf{a} - \mathbf{b}$

b)  $\overrightarrow{BC} = 3\mathbf{b} - 4\mathbf{a}$

c)  $\overrightarrow{AC} = 2\mathbf{b} - 5\mathbf{a}$

4  $\overrightarrow{BC} = \mathbf{b}$

$\overrightarrow{CD} = -\mathbf{a}$

$\overrightarrow{BD} = \mathbf{b} - \mathbf{a}$

$\overrightarrow{AC} = \mathbf{a} + \mathbf{b}$

5  $\overrightarrow{AB} = \mathbf{b} - \mathbf{a}$

$\overrightarrow{CB} = \frac{1}{3}(\mathbf{b} - \mathbf{a})$

$\overrightarrow{OC} = \frac{1}{3}\mathbf{a} + \frac{2}{3}\mathbf{b}$

6  $\overrightarrow{EB} = \frac{1}{2}\mathbf{a} - \mathbf{b}$

7  $\overrightarrow{EB} = \mathbf{b} - \frac{2}{3}\mathbf{a}$

8 a)  $\overrightarrow{FA} = \mathbf{b}$

- b)  $\overrightarrow{BD} = -\mathbf{b} - \mathbf{a}$
- c)  $\overrightarrow{AB} = \mathbf{b} - \mathbf{a}$
- d)  $\overrightarrow{AC} = \mathbf{b} - 2\mathbf{a}$
- 9 a)  $\overrightarrow{AB} = \mathbf{b} - \mathbf{a}$
- b)  $\overrightarrow{AP} = \frac{1}{3}(\mathbf{b} - \mathbf{a})$
- c)  $\overrightarrow{OP} = \mathbf{a} + \frac{1}{3}(\mathbf{b} - \mathbf{a}) = \frac{2}{3}\mathbf{a} + \frac{1}{3}\mathbf{b}$
- 10 a)  $\overrightarrow{AE} = 3\mathbf{a}$   
 $\overrightarrow{AF} = 3\mathbf{b}$   
 $\overrightarrow{BC} = \mathbf{b} - \mathbf{a}$   
 $\overrightarrow{EF} = 3\mathbf{b} - 3\mathbf{a}$
- b)  $\overrightarrow{EF} = 3 \times \overrightarrow{BC}$  so  $EF$  and  $BC$  are parallel and  $EF = 3 \times BC$  in length.
- 11 a)  $\overrightarrow{AB} = \mathbf{b} - \mathbf{a}$ ;  $\overrightarrow{OC} = 4\mathbf{a}$  and  $\overrightarrow{OD} = 4\mathbf{b}$  so  $\overrightarrow{CD} = 4\mathbf{b} - 4\mathbf{a} = 4(\mathbf{b} - \mathbf{a})$ .  
 As  $\overrightarrow{CD}$  is a multiple of  $\overrightarrow{AB}$ ,  $AB$  and  $CD$  are parallel.
- b) 1 : 4
- 12 a) i)  $\overrightarrow{OE} = 2\mathbf{a} + \mathbf{c}$   
 ii)  $\overrightarrow{AC} = \mathbf{c} - \mathbf{a}$   
 iii)  $\overrightarrow{OF} = \frac{2}{3}\mathbf{a} + \frac{1}{3}\mathbf{c}$
- b)  $O$ ,  $F$  and  $E$  are on a straight line.  
 $OE = 3 \times OF$
- 13 a) i)  $\mathbf{c} - \mathbf{a}$   
 ii)  $\frac{1}{2}(\mathbf{c} - \mathbf{a})$  or  $\frac{1}{2}\mathbf{c} - \frac{1}{2}\mathbf{a}$   
 iii)  $\frac{1}{2}\mathbf{a} + \frac{1}{2}\mathbf{c}$   
 iv)  $\mathbf{a} + \mathbf{c}$
- b)  $O$ ,  $D$  and  $B$  are in a straight line, and  $D$  is the midpoint of  $OB$ .

*All answers were written by the authors.*

## 44 Probability

### Exercise 44.1

**1**      **a)**       $\frac{1}{6}$

**b)**       $\frac{1}{2}$

**c)**       $\frac{2}{3}$

**2**      **a)**       $\frac{2}{5}$

**b)**       $\frac{3}{5}$

**3**      **a)**       $\frac{7}{20}$

**b)**       $\frac{3}{20}$

**c)**       $\frac{1}{2}$

**4**      **a)**       $\frac{1}{3}$

**b)**       $\frac{2}{9}$

**5**      **a)**       $\frac{3}{20}$

**b)**       $\frac{3}{8}$

**c)**       $\frac{23}{40}$

**6**      **a)**       $\frac{2}{7}$

**b)**       $\frac{8}{35}$

## Exercise 44.2

- 1  $\frac{5}{8}$
- 2 0.999
- 3 0.3
- 4  $\frac{3}{5}$  or 0.6
- 5  $\frac{1}{3}$
- 6 0.7
- 7  $\frac{1}{5}$
- 8 0.11

## Exercise 44.3

- 1 125
- 2 50
- 3 18
- 4 50
- 5 20

## Exercise 44.4

- 1 a) 0.154  
b) 0.255
- 2 a) i)  $\frac{103}{500}$   
ii)  $\frac{96}{500}$   
b) Yes, all frequencies are close to the expected value of  $500 \div 5 = 100$
- 3 a) 0.41  
b) 0.59
- 4 a) 0.27  
b) 0.19

5 a)  $\frac{7}{20}$

b) 420

6 a)  $\frac{1}{5}$

b) 60

### Exercise 44.5

1 a)

**Spinner 2**

<b>Spinner 1</b>		<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>
	<b>1</b>	2	3	4	5	6	7
	<b>2</b>	3	4	5	6	7	8
	<b>3</b>	4	5	6	7	8	9
	<b>4</b>	5	6	7	8	9	10

b)  $\frac{1}{12}$

c)  $\frac{5}{12}$

d)  $\frac{1}{2}$

2 a)

**Spinner**

<b>Coin</b>		<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>
	<b>H</b>	H1	H2	H3	H4	H5	H6
	<b>T</b>	T1	T2	T3	T4	T5	T6

b) i)  $\frac{1}{12}$

ii)  $\frac{1}{4}$

3 a)

		First spin			
		1	2	3	4
Second spin	1	1	2	3	4
	2	2	4	6	8
	3	3	6	9	12
	4	4	8	12	16

b) i)  $\frac{3}{16}$

ii)  $\frac{1}{4}$

iii)  $\frac{1}{4}$

4 a)

		First spin				
		2	4	6	8	10
Second spin	2	4	6	8	10	12
	4	6	8	10	12	14
	6	8	10	12	14	16
	8	10	12	14	16	18
	10	12	14	16	18	20

b)  $\frac{3}{5}$

c)  $\frac{7}{25}$

5 a)  $\frac{15}{35}$

b)  $\frac{3}{35}$



c)  $\frac{6}{35}$

6 a)  $\frac{6}{13}$

b)  $\frac{2}{13}$

c)  $\frac{7}{13}$

### Exercise 44.6

1  $\frac{9}{100}$  or 0.09

2 0.24

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

b)  $\frac{1}{9}$

4  $\frac{1}{49}$

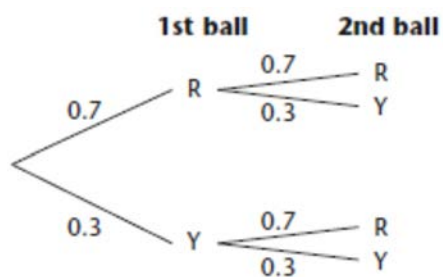
5 a) 0.12

b) 0.42

6  $\frac{1}{125}$

### Exercise 44.7

1



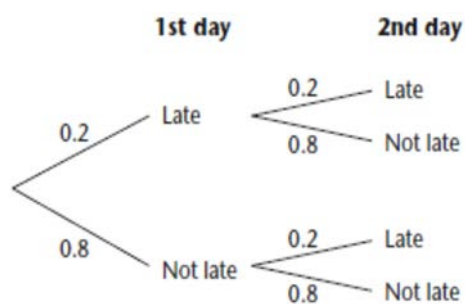
a) 0.49

b) 0.21

c) 0.21

d) 0.42

2 a)

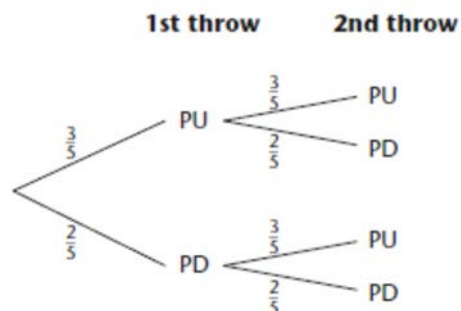


b) i) 0.04

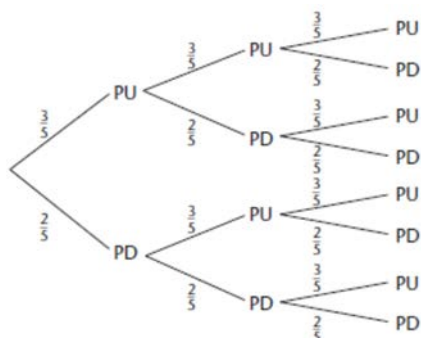
ii) 0.32

3 a)  $\frac{3}{5}$ 

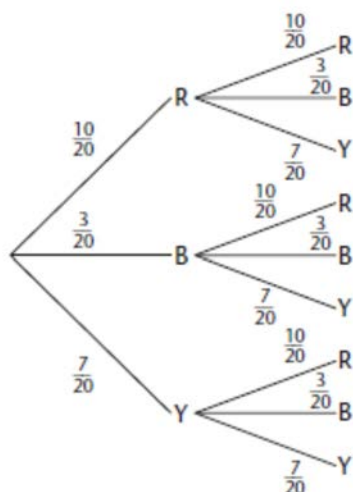
b)

c) i)  $\frac{9}{25}$ ii)  $\frac{12}{25}$ 

4

a)  $\frac{27}{125}$ b)  $\frac{36}{125}$

5 a)



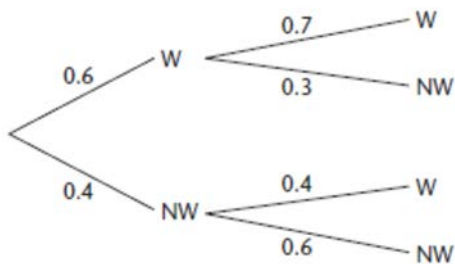
- b) i)  $\frac{9}{400}$   
 ii)  $\frac{79}{200}$   
 iii)  $\frac{121}{200}$

- 6 a) 0.343  
 b) 0.09  
 c) 0.441

### Exercise 44.8

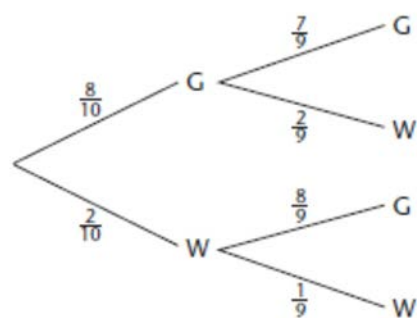
1  $\frac{5}{8}$

2 a)



- b) 0.34  
 c) 0.76

**3**     **a)**



**b)**      $\frac{2}{90} = \frac{1}{45}$

**c)**      $\frac{32}{90} = \frac{16}{45}$

**4**     0.76

**5**      $\frac{25}{28}$

All answers were written by the authors.

## 45 Categorical, numerical and grouped data

### Exercise 45.1

1 a)

Number of letters	Frequency
0	16
1	19
2	21
3	10
4	5
5	3
6	3
7	2
8	1

b) 10

2 Possible answers include the following:

- a) Those not in the phone book have no chance of being included.
- b) Those working on Saturday would not be included.

3 Possible answers include the following:

Make the categories exclusive (in Paul's first draft, for example, 1 hour could go in two categories).

Have more categories, for example, split the groups into classes of 30 minutes rather than 1 hour.

**4** Possible faults include the following:

- a) The person's favourite sport might be one that isn't listed.
- b) This question is too vague. It needs categories, such as hours spent exercising.
- c) This is a leading question.

Check students' new questions.

**5** Check students' questions.

**6** a)

	Japanese	Not Japanese	Total
<b>Red</b>	35	65	100
<b>Not red</b>	72	438	510
<b>Total</b>	107	503	610

b) 610

c) 107

d) 72

e) 100

**7** a)

	Existing drug	New drug	Total
<b>Symptoms eased</b>	700	550	1250
<b>No change in symptoms</b>	350	250	600
<b>Total</b>	1050	800	1850

b) 1850

c) 550

8 a)

	Gold	Silver	Bronze	Total
USA	31	18	10	59
Germany	18	16	9	43
China	22	9	11	42
Total	71	43	30	144

b) USA

c) China

## Exercise 45.2

1 a) 6

b) 5.5

2 a) 4 people

b) Mode = 194 mm; median = 198 mm

3 a) Mode = \$10 000; median = \$13 000

b) Check students' explanations.

4 Harvey: mode = 0; median = 19

Nick: mode = 9; median = 9

You would choose Harvey if you wanted the possibility of high scores but Nick if you wanted a more consistent player.

## Exercise 45.3

1 a) Mean = 6; range = 9

b) Mean = 6.5; range = 11

c) Mean = 20.625; range = 19

d) Mean = 466; range = 756

2

	Data set A	Data set B	Data set C
Range	6	6	12
Mean	3.36	3.36	6.73

The data in set C are twice those in set A, as are the range and the mean.

The data in set B are 2 sets of the data in set A.

The range and mean of sets A and B are the same.

3 a) 3

b) i) Mean = 3; range = 6

ii) Mean = 30; range = 60

iii) Mean = 130; range = 60

4 Mean = \$19 500; range = \$60 000

5 a) 15.875

b) 11

6 a) i) \$32

ii) \$175.80

b) i) \$92

ii) \$188

7 a) 83 cm

b) 25 cm

8 a) 63

b) 7.3

## Exercise 45.4

*All comments given as answers are only suggestions and any comment that makes sense should be accepted.*

1 a) Carl: mean = 19; range = 10

Adam: mean = 19.75; range = 17

b) Adam has a slightly better (higher) average, but his scores are more spread out.



- 2     a)     Resort A: mean = 165 hours; median = 170.5 hours; range = 81 hours  
Resort B: mean = 161.5 hours; median = 168.5 hours; range = 58 hours
- b)     Resort A has a higher average number of hours of sunshine, but resort B is more consistent.
- 3     a)     Mean = 31.6; median = 32; mode = 30
- b)     The mode because it shows which size sold the most often.
- 4     a)     Mean = 8.88; median = 9.0; range = 1.2
- b)     The better average would be the median as it is not affected by extreme scores.  
(Alternatively, the mean is better because it uses every value.)
- 5     a)     8.825
- b)     Slightly better; she would have scored 8.8 if the mean of all the judge's marks had been calculated.
- 6     The median salary at the two factories was the same but the mean salary at Prothero was higher. However, the range at Prothero was much higher, suggesting that a few of the salaries there were much higher than the rest. Apart from a few high salaries, the rest were probably about the same as those at Jaline.

### Exercise 45.5

- 1     1.96
- 2     a)     5
- b)     4.57 (i.e. 5 minutes late)
- 3     a)     30
- b)     40
- c)     1.33
- d)     1
- 4     \$1.07
- 5     Mean = 7.52; median = 7; mode = 7

### Exercise 45.6

- 1     a)      $8 < t \leq 10$
- b)      $4 < t \leq 6$
- c)     8 seconds
- d)     5.18 seconds to 3 s.f.
- 2     a)      $70 < h \leq 80$
- b)      $70 < h \leq 80$

- c) 40 cm
- d) 72.8 cm
- 3 a)  $1.4 < l \leq 1.6$
- b)  $1.4 < l \leq 1.6$
- c) 0.8 m
- d) 1.5 m
- 4 35.4 cm
- 5 47.25 g
- 6 51.5 seconds
- 7 4.66 m
- 8 3.48 cm

### Exercise 45.7

- 1 a)  $40 < m \leq 60$
- b)  $40 < m \leq 60$
- c) 80
- d) 55.3
- 2 a) 13–15
- b) 10–12
- c) 12
- d) 11.4
- 3 a)  $16\,000 < a \leq 20\,000$
- b)  $12\,000 < a \leq 16\,000$
- c) 20 000
- d) 14 533
- 4 17.2

All answers were written by the authors.

## 46 Statistical diagrams

### Exercise 46.1

1 a) Monday 30; Tuesday 35; Wednesday 25; Thursday 40; Friday 55

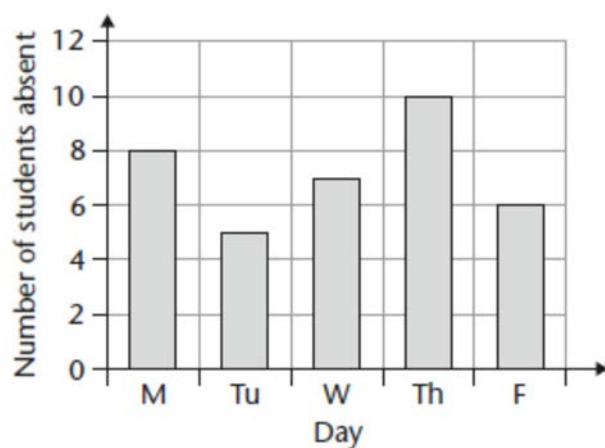
b) Friday; people want books to read over the weekend.

2 a) 7










b) 3


c) 30

3



4

Week 1			
Week 2			
Week 3			
Week 4			

 represents 8 bikes.

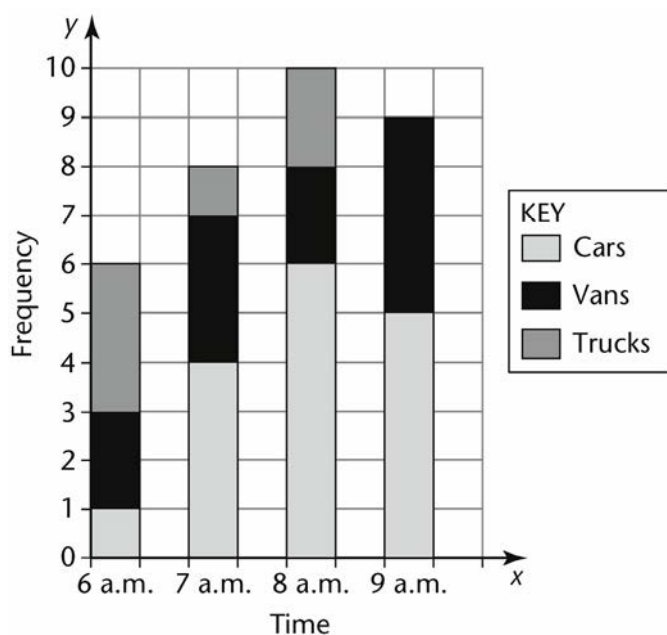
5 a) 35

b) 160–170 cm

c) 4

d) 140–150 cm

- 6 For example,

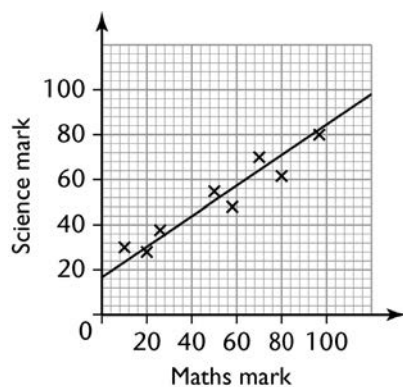


### Exercise 46.2

- 1 Students should draw a pie chart with angles of  $36^\circ$ ,  $120^\circ$ ,  $84^\circ$ ,  $72^\circ$  and  $48^\circ$ .
- 2
  - a) A
  - b)
    - i) 20
    - ii) 9
- 3
  - a)  $\frac{140}{360} = \frac{7}{18}$
  - b) 72

### Exercise 46.3

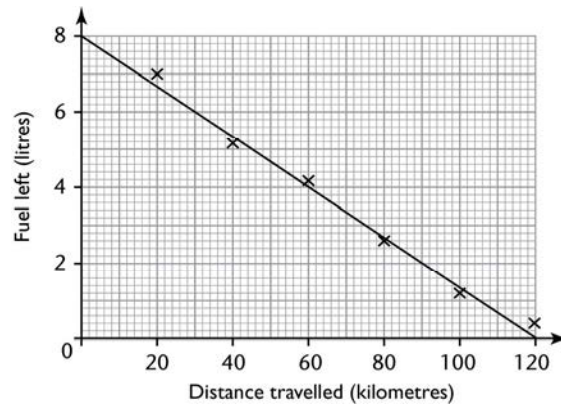
- 1 a), c)



- b) Reasonably strong positive correlation
- d)
  - i) 44

ii) 85

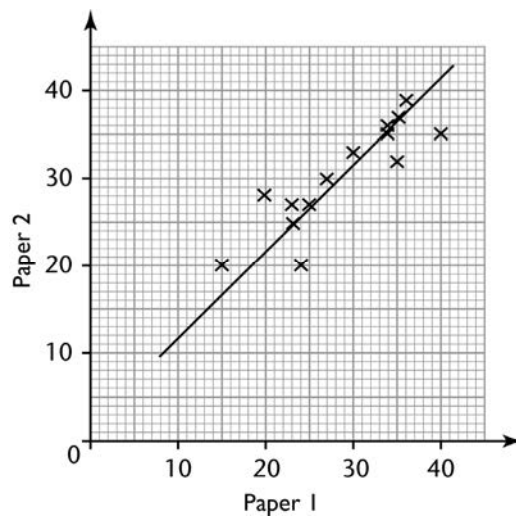
2 a), c)



b) Strong negative correlation

d) About 3.4 litres

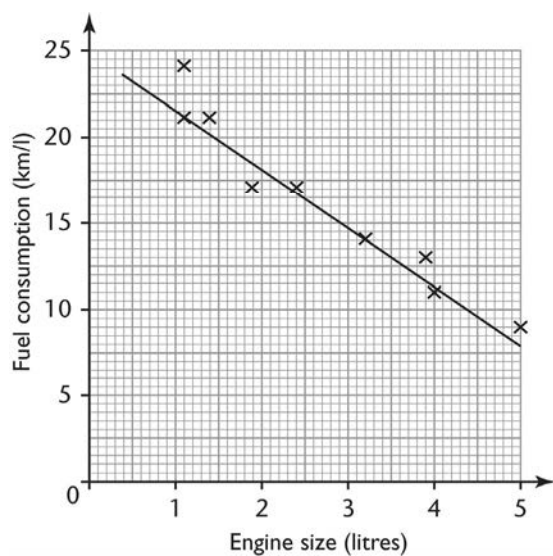
3 a), c)



b) Strong positive correlation

d) About 33

4 a), c)



b) Strong negative correlation

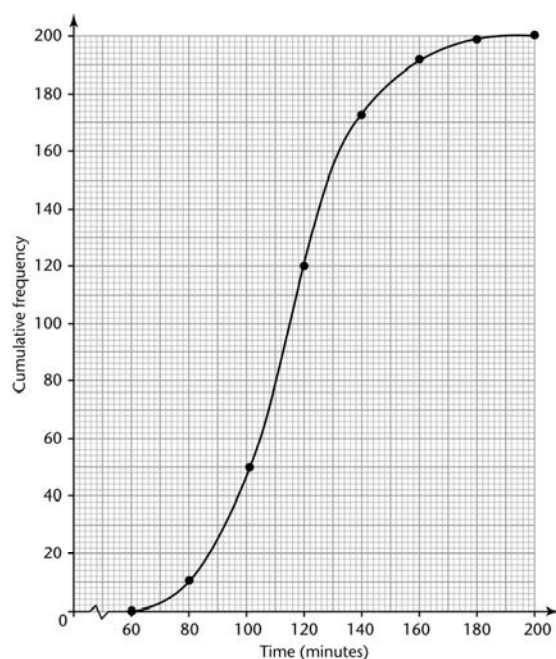
d) About 15 km/litre

## Exercise 46.4

1 a)

Time in minutes ( $t$ )	$t \leq 60$	$t \leq 80$	$t \leq 100$	$t \leq 120$	$t \leq 140$	$t \leq 160$	$t \leq 180$	$t \leq 200$
Cumulative frequency	0	10	47	119	174	192	199	200

b)

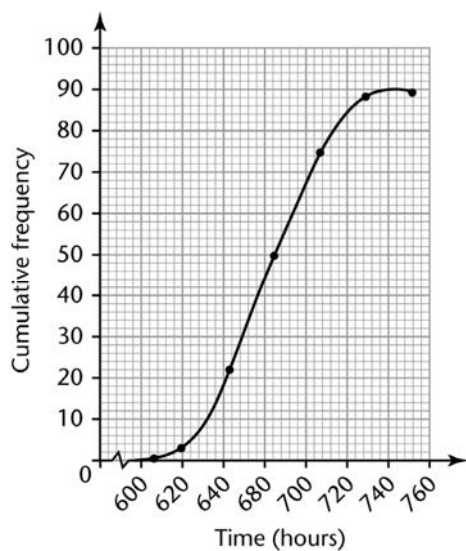
c) i) 24 ( $\pm 1$ )

ii) 15 ( $\pm 1$ )

2 a)

Time in hours ( $t$ )	$t \leq 600$	$t \leq 625$	$t \leq 650$	$t \leq 675$	$t \leq 700$	$t \leq 725$	$t \leq 750$
Cumulative frequency	0	3	21	50	75	88	90

b)

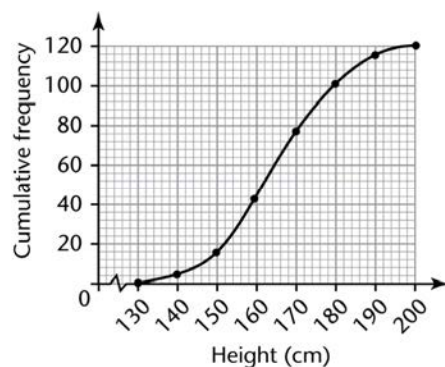


c) 46

## Exercise 46.5

1 a)

Height in cm ( $h$ )	$h \leq 130$	$h \leq 140$	$h \leq 150$	$h \leq 160$	$h \leq 170$	$h \leq 180$	$h \leq 190$	$h \leq 200$
Cumulative frequency	0	5	17	43	78	101	116	120



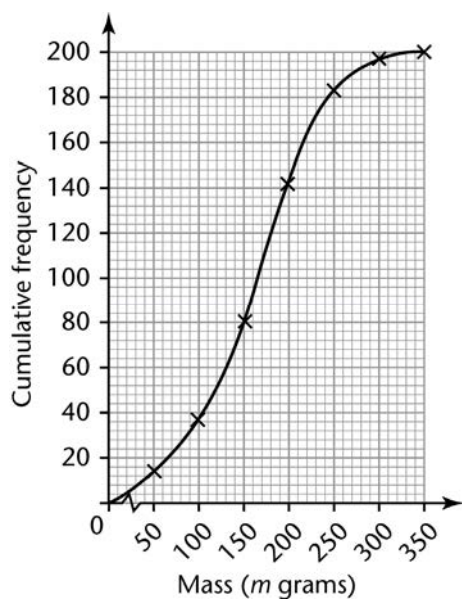
b) i) 164 cm

ii) 155 cm

iii) 175 cm

iv) 20 cm

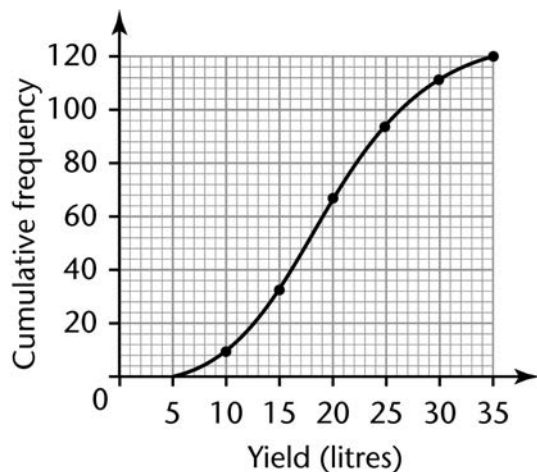
2 a)



b) Median = 165 g; IQR = 90 g

c) 215 g

3 a)



b) Median = 18.5 litres; IQR = 9.5 litres

c) 15 cows

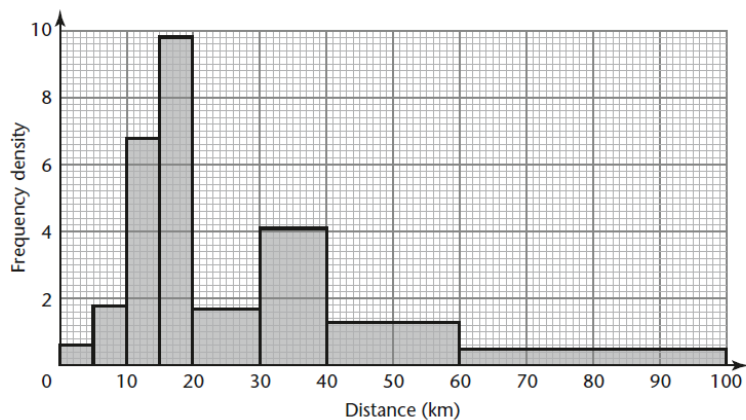
d) 14 litres



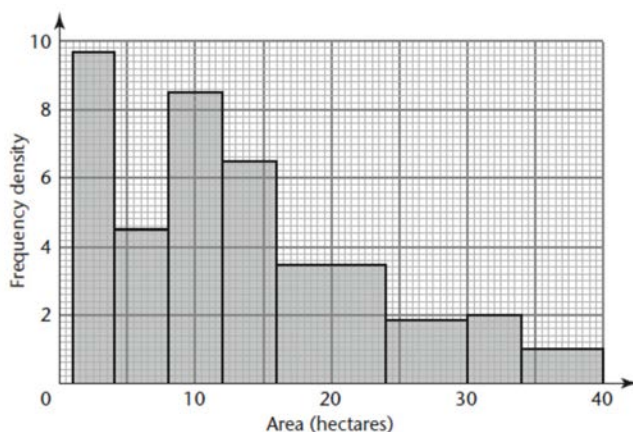
- 4**    **a)**    Road B; the curve is further to the right so the median is higher.
- b)**    Road B; the curve is steeper so the interquartile range is lower and the speeds are more consistent.
- 5**    **a)**    **i)**    62 kg
- ii)**    79 kg
- b)**    **i)**    19 kg
- ii)**    23 kg
- c)**    The masses of the leopards are lower on average because their median is lower.
- The masses of the leopards are more consistent because their interquartile range is lower.

## Exercise 46.6

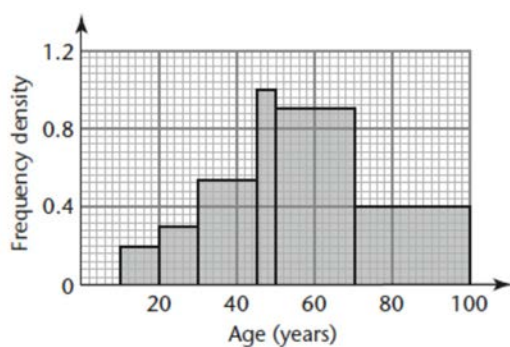
**1**



**2**



3



4 a) 90 students

b) 490 students

c) 140 students

5 a) 100 gym members

b) 81.2 kg to 1 d.p.

<50	6	52,5	315
55<x<60	12	57,5	690
60<x<70	18	65	1170
70<x<90	31	80	2480
90<x<110	25	100	2500
110 <x<130	8	120	960
			81,15