

# Solutions

## 1 Number and language

### Exercise 1.1 page 5

Prime numbers are:

1. 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97

### Exercise 1.2 page 6

1. a) 1, 2, 3, 6  
b) 1, 3, 9  
c) 1, 7  
d) 1, 3, 5, 15  
e) 1, 2, 3, 4, 6, 8, 12, 24  
f) 1, 2, 3, 4, 6, 9, 12, 18, 36  
g) 1, 5, 7, 35  
h) 1, 5, 25  
i) 1, 2, 3, 6, 7, 14, 21, 42  
j) 1, 2, 4, 5, 10, 20, 25, 50, 100

### Exercise 1.3 page 6

1. a) 3, 5      b) 2, 3      c) 2, 3      d) 2  
e) 2, 5      f) 13      g) 3, 11      h) 5, 7  
i) 2, 5, 7    j) 2, 7

### Exercise 1.4 page 7

1. a)  $2^2 \times 3$       b)  $2^5$       c)  $2^2 \times 3^2$   
d)  $2^3 \times 5$       e)  $2^2 \times 11$       f)  $2^3 \times 7$   
g)  $3^2 \times 5$       h)  $3 \times 13$       i)  $3 \times 7 \times 11$   
j)  $3^2 \times 7$

### Exercise 1.5 page 7

1. a) 4      b) 5      c) 6      d) 3      e) 9  
f) 22      g) 8      h) 13      i) 17      j) 12  
2. a) 42      b) 60      c) 70      d) 90      e) 120  
f) 105      g) 20      h) 231      i) 240      j) 200

### Exercise 1.6 page 8

1. a) Rational      b) Rational      c) Irrational  
d) Rational      e) Rational      f) Rational  
g) Irrational      h) Rational      i) Rational

2. a) Irrational      b) Irrational      c) Rational  
d) Rational      e) Rational      f) Rational  
3. a) Rational      b) Irrational      c) Rational  
d) Rational

### Exercise 1.7 page 9

1. a) 5      b) 3      c) 7      d) 10      e) 11  
f) 13      g) 0.1      h) 0.2      i) 0.3      j) 0.5  
2. Students check their answers  
3. a)  $\frac{1}{3}$       b)  $\frac{1}{4}$       c)  $\frac{1}{5}$       d)  $\frac{1}{7}$       e)  $\frac{1}{10}$   
f)  $\frac{2}{3}$       g)  $\frac{3}{10}$       h)  $\frac{7}{9}$       i)  $\frac{5}{3}$       j)  $\frac{5}{2}$

### Exercise 1.8 page 9

1. The following answers are correct to 1 d.p.:  
a) 5.9      b) 6.7      c) 7.4      d) 7.7      e) 1.4  
2. Students check their answers

### Exercise 1.9 page 10

1. a) 2      b) 5      c) 3      d) 0.1      e) 0.3  
f) 6      g) 10      h) 100      i) -2      j) -3  
k) -10      l) -1

### Exercise 1.10 page 10

1. 146 °C  
2. a) -\$35      b) -\$318      c) -\$88  
d) -\$160      e) \$90  
3. 165 m  
4. 695 m

### Student assessment I page 11

1. a) Rational      b) Irrational      c) Rational  
d) Rational      e) Rational      f) Irrational  
2. a)  $\frac{5}{8}$       b) 3      c)  $\frac{11}{25}$   
3. a) 81      b) 225      c) 0.04  
d) 0.49  
4. a) 12.25      b) 16.81      c) 0.0225

5. a) 15      b) 0.1      c) 0.9  
     d)  $\frac{3}{5}$       e)  $\frac{7}{3}$       f)  $\frac{11}{7}$
6. a) 64      b) 0.001      c)  $\frac{8}{27}$   
     d) 3      b) 100      c)  $\frac{4}{5}$
7. a)  $-\$84$       b)  $\$91$       c)  $\$45$   
     d)  $\$74$       e)  $-\$43$       f)  $-\$15$

4. a) 130      b) 80      c) 9  
     d) 4      e) 200      f) 250

5. c), e) and f) are incorrect.

Answers to Q.6 and 7 may vary slightly from those given below:

6. a)  $120 \text{ m}^2$       b)  $40 \text{ m}^2$       c)  $400 \text{ cm}^2$   
     7. a)  $200 \text{ cm}^3$       b)  $4000 \text{ cm}^3$       c)  $2000 \text{ cm}^3$

## 2 Accuracy

### Exercise 2.1 page 12

1. a) 69 000      b) 74 000      c) 89 000  
     d) 4000      e) 100 000      f) 1 000 000
2. a) 78 500      b) 6900      c) 14 100  
     d) 8100      e) 1000      f) 3000
3. a) 490      b) 690      c) 8850  
     d) 80      e) 0      f) 1000

### Exercise 2.2 page 13

1. a) 5.6      b) 0.7      c) 11.9  
     d) 157.4      e) 4.0      f) 15.0  
     g) 3.0      h) 1.0      i) 12.0
2. a) 6.47      b) 9.59      c) 16.48  
     d) 0.09      e) 0.01      f) 9.30  
     g) 100.00      h) 0.00      i) 3.00

### Exercise 2.3 page 13

1. a) 50 000      b) 48 600      c) 7000  
     d) 7500      e) 500      f) 2.57  
     g) 1000      h) 2000      i) 15.0
2. a) 0.09      b) 0.6      c) 0.94  
     d) 1      e) 0.95      f) 0.003  
     g) 0.0031      h) 0.0097      i) 0.01

### Exercise 2.4 page 14

1. a) 419.6      b) 5.0      c) 166.3  
     d) 23.8      e) 57.8      f) 4427.1  
     g) 1.9      h) 4.1      i) 0.6

Answers to Q.2–4 may vary slightly from those given below:

2. a) 1200      b) 3000      c) 3000  
     d) 150 000      e) 0.8      f) 100
3. a) 200      b) 200      c) 30  
     d) 550      e) 500      f) 3000

### Exercise 2.5 page 17

1. a) i) Lower bound = 5.5  
             Upper bound = 6.5  
             ii)  $5.5 \leq x < 6.5$
- b) i) Lower bound = 82.5  
             Upper bound = 83.5  
             ii)  $82.5 \leq x < 83.5$
- c) i) Lower bound = 151.5  
             Upper bound = 152.5  
             ii)  $151.5 \leq x < 152.5$
- d) i) Lower bound = 999.5  
             Upper bound = 1000.5  
             ii)  $999.5 \leq x < 1000.5$
- e) i) Lower bound = 99.5  
             Upper bound = 100.5  
             ii)  $99.5 \leq x < 100.5$
2. a) i) Lower bound = 3.75  
             Upper bound = 3.85  
             ii)  $3.75 \leq x < 3.85$
- b) i) Lower bound = 15.55  
             Upper bound = 15.65  
             ii)  $15.55 \leq x < 15.65$
- c) i) Lower bound = 0.95  
             Upper bound = 1.05  
             ii)  $0.95 \leq x < 1.05$
- d) i) Lower bound = 9.95  
             Upper bound = 10.05  
             ii)  $9.95 \leq x < 10.05$
- e) i) Lower bound = 0.25  
             Upper bound = 0.35  
             ii)  $0.25 \leq x < 0.35$
3. a) i) Lower bound = 4.15  
             Upper bound = 4.25  
             ii)  $4.15 \leq x < 4.25$
- b) i) Lower bound = 0.835  
             Upper bound = 0.845  
             ii)  $0.835 \leq x < 0.845$
- c) i) Lower bound = 415  
             Upper bound = 425  
             ii)  $415 \leq x < 425$

- d)** i) Lower bound = 4950  
Upper bound = 5050  
ii)  $4950 \leq x < 5050$

- e)** i) Lower bound = 0.0445  
Upper bound = 0.0455  
ii)  $0.0445 \leq x < 0.0455$

- f)** i) Lower bound = 24 500  
Upper bound = 25 500  
ii)  $24\ 500 \leq x < 25\ 500$



**b)**  $5.35 \leq M < 5.45$



**b)**  $11.75 \leq T < 11.85$

6. **a)** Lower bound = 615 m<sup>3</sup>  
Upper bound = 625 m<sup>3</sup>  
**b)**  $615 \leq x < 625$

7. **a)** Lower bound = 625 m  
Upper bound = 635 m  
**b)**  $395 \leq W < 405$

### Exercise 2.6 page 18

1. **a)** Lower bound = 263.25  
Upper bound = 297.25
- b)** Lower bound = 3295.25  
Upper bound = 3455.25
- c)** Lower bound = 4925.25  
Upper bound = 5075.25
- d)** Lower bound = 3.76 (2 d.p.)  
Upper bound = 4.26 (2 d.p.)
- e)** Lower bound = 2.83 (2 d.p.)  
Upper bound = 3.19 (2 d.p.)
- f)** Lower bound = 8.03 (2 d.p.)  
Upper bound = 8.66 (2 d.p.)
- g)** Lower bound = 44.95 (2 d.p.)  
Upper bound = 52.82 (2 d.p.)
- h)** Lower bound = 39.77 (2 d.p.)  
Upper bound = 42.23 (2 d.p.)
- i)** Lower bound = 16.14 (2 d.p.)  
Upper bound = 18.88 (2 d.p.)
- j)** Lower bound = 3.55 (2 d.p.)  
Upper bound = 7.12
- k)** Lower bound = 1.47 (2 d.p.)  
Upper bound = 1.63 (2 d.p.)
- l)** Lower bound = 18.51 (2 d.p.)  
Upper bound = 28.59 (2 d.p.)

2. **a)** Lower bound = 6.7  
Upper bound = 6.9
  - b)** Lower bound = 29.69 (2 d.p.)  
Upper bound = 30.80 (2 d.p.)
  - c)** Lower bound = 147.76 (2 d.p.)  
Upper bound = 150.25 (2 d.p.)
  - d)** Lower bound = 13.3  
Upper bound = 13.5
  - e)** Lower bound = 1.75 (2 d.p.)  
Upper bound = 1.81 (2 d.p.)
  - f)** Lower bound = 0.39 (2 d.p.)  
Upper bound = 0.46 (2 d.p.)
  - g)** Lower bound = 34.10 (2 d.p.)  
Upper bound = 40.03 (2 d.p.)
  - h)** Lower bound = 0.98 (2 d.p.)  
Upper bound = 1.02 (2 d.p.)
  - i)** Lower bound = 0  
Upper bound = 0.04
3. **a)** Lower bound = 20 002.5  
Upper bound = 20 962.5
  - b)** Lower bound = 1.06 (2 d.p.)  
Upper bound = 1.15 (2 d.p.)
  - c)** Lower bound = 1 116 250  
Upper bound = 1 188 250
  - d)** Lower bound = 88.43 (2 d.p.)  
Upper bound = 91.60 (2 d.p.)
  - e)** Lower bound = 131.75 (2 d.p.)  
Upper bound = 139.34 (2 d.p.)
  - f)** Lower bound = 18.10 (2 d.p.)  
Upper bound = 20.39 (2 d.p.)
  - g)** Lower bound = 2.24 (2 d.p.)  
Upper bound = 2.53 (2 d.p.)
  - h)** Lower bound = 3.45 (2 d.p.)  
Upper bound = 3.97 (2 d.p.)
  - i)** Lower bound = 60.34 (2 d.p.)  
Upper bound = 68.52 (2 d.p.)

### Exercise 2.7 page 19

1. Lower bound = 3.5 kg  
Upper bound = 4.5 kg
2. Lower bound = 21.8 cm  
Upper bound = 22.2 cm
3. Lower bound = 13.7 m  
Upper bound = 13.74 m
4. Lower bound = 74.13 cm<sup>2</sup> (2 d.p.)  
Upper bound = 75.88 cm<sup>2</sup> (2 d.p.)
5. Lower bound = 68 425 m<sup>2</sup>  
Upper bound = 75 625 m<sup>2</sup>
6. Lower bound = 13.1 (1 d.p.)  
Upper bound = 13.5 (1 d.p.)

7. Lower bound = 9.0 cm (1 d.p.)  
Upper bound = 11.1 cm (1 d.p.)
8. a) Lower bound = 53.1 cm (1 d.p.)  
Upper bound = 53.7 cm (1 d.p.)  
b) Lower bound = 224.3 cm<sup>2</sup> (1 d.p.)  
Upper bound = 229.7 cm<sup>2</sup> (1 d.p.)
9. a) Lower bound = 11.2 cm (1 d.p.)  
Upper bound = 11.4 cm (1 d.p.)  
b) Lower bound = 70.5 cm (1 d.p.)  
Upper bound = 71.3 cm (1 d.p.)
10. Lower bound = 11.5 g/cm<sup>3</sup> (1 d.p.)  
Upper bound = 13.6 g/cm<sup>3</sup> (1 d.p.)
11. Least = 93.3 h (1 d.p.)  
Greatest = 138.5 h (1 d.p.)

### **Student assessment 1** page 21

- |            |         |           |
|------------|---------|-----------|
| 1. a) 2800 | b) 7290 | c) 49 000 |
| d) 1000    |         |           |
| 2. a) 3.8  | b) 6.8  | c) 0.85   |
| d) 1.58    | e) 10.0 | f) 0.008  |
| 3. a) 4    | b) 6.8  | c) 0.8    |
| d) 10      | e) 830  | f) 0.005  |

Answers to Q.4–6 may vary from those given below:

4. 18 000 yards
5. 40 m<sup>2</sup>
6. a) 25                  b) 4                  c) 4
7. 92.3 cm<sup>3</sup> (1 d.p.)

### **Student assessment 2** page 22

1. a)   
b)   
c)   
d) 

2. a)  $205 \leqslant x < 215$       b)  $63.5 \leqslant x < 64.5$   
c)  $2.95 \leqslant x < 3.05$       d)  $0.875 \leqslant x < 0.885$

3. Length:  $349.5 \leqslant L < 350.5$   
Width:  $199.5 \leqslant W < 200.5$

4. 

5.  $0.0035 \leqslant x < 0.0045$
6. a)  $4.825 \leqslant x < 4.835$   
b)  $5.045 \leqslant y < 5.055$   
c)  $9.95 \leqslant z < 10.05$   
d)  $99.995 \leqslant p < 100.005$

### **Student assessment 3** page 22

1. a) Lower bound = 965.25  
Upper bound = 1035.25  
b) Lower bound = 6218.75  
Upper bound = 6381.75  
c) Lower bound = 6.2 (1 d.p.)  
Upper bound = 6.3 (1 d.p.)  
d) Lower bound = 47.7 (1 d.p.)  
Upper bound = 54.7 (1 d.p.)  
e) Lower bound = 0.8 (1 d.p.)  
Upper bound = 1.2 (1 d.p.)  
f) Lower bound = 0.5 (1 d.p.)  
Upper bound = 0.9 (1 d.p.)
2. Lower bound = 118.7 cm<sup>2</sup> (1 d.p.)  
Upper bound = 121.1 cm<sup>2</sup> (1 d.p.)
3. Lower bound = 10.5 cm  
Upper bound = 13.5 cm
4.  $0.8 \leqslant x < 1$
5. Lower bound = 0.46 kg (2 d.p.)  
Upper bound = 0.48 kg (2 d.p.)

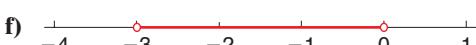
### **Student assessment 4** page 23

1. 255 kg
2. 31 575 cm<sup>3</sup> (5 s.f.)
3. a)  $124.5 \leqslant V < 125.5 \text{ cm}^3$   
b)  $4.99 \leqslant L < 5.01 \text{ cm}$  (2 d.p.)
4. a)  $25.10 \leqslant C < 25.16$  (2 d.p.)  
b)  $50.14 \leqslant A < 50.39 \text{ cm}^2$  (2 d.p.)
5. 22 cups
6. a) Lower bound = 4.5 cm  
Upper bound = 5.5 cm  
b) Upper and lower bounds of 100 matches  $\div 100$   
Lower bound = 5.43 cm  
Upper bound = 5.44 cm

### 3 Calculations and order

#### Exercise 3.1 page 25

1. a)  $<$  b)  $=$  c)  $>$  d)  $<$  e)  $=$  f)  $>$



3. a)  $x > 0$  b)  $x \leq 3$  c)  $0 \leq x \leq 4$   
d)  $-4 < x \leq -1$

4. a)  $x \leq 20\,000$  b)  $135 \leq x \leq 180$   
c)  $5x + 3 < 20$  d)  $x \leq 25$   
e)  $350 \leq x \leq 400$  f)  $11 \leq x \leq 28$

#### Exercise 3.2 page 26

1. 0.06 0.6 0.606 0.66 6.0 6.6 6.606

2.  $\frac{4}{5}$   $\frac{1}{2}$   $\frac{6}{13}$   $\frac{7}{18}$   $\frac{1}{3}$   $\frac{2}{19}$

3. 60 cm 0.75 m 800 mm 180 cm 2 m

4. 4 kg 3500 g 1 kg  $\frac{3}{4}$  kg 700 g

5. 150 cm<sup>3</sup> 430 ml 800 cm<sup>3</sup> 1 litre 120 cl

#### Exercise 3.3 page 27

1. a) 26 b) 10 c) 42 d) 16 e) 8 f) -6  
2. a) 20 b) 34 c) 32 d) 31 e) 20 f) 23  
3. a) 27 b) 64 c) 30 d) 3 e) 144 f) 1.6

#### Exercise 3.4 page 27

1. a)  $6 \times (2 + 1) = 18$   
b)  $1 + 3 \times 5 = 16$   
c)  $(8 + 6) \div 2 = 7$   
d)  $(9 + 2) \times 4 = 44$

e)  $9 \div 3 \times 4 + 1 = 13$   
f)  $(3 + 2) \times (4 - 1) = 15$

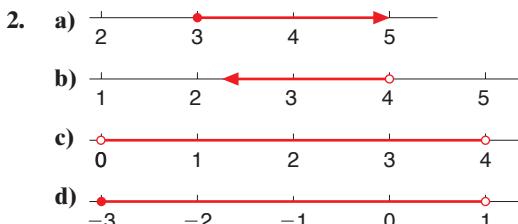
2. a)  $12 \div 4 - 2 + 6 = 7$   
b)  $12 \div (4 - 2) + 6 = 12$   
c)  $12 \div 4 - (2 + 6) = -5$   
d)  $12 \div (4 - 2 + 6) = 1.5$   
e)  $4 + 5 \times 6 - 1 = 33$   
f)  $4 + 5 \times (6 - 1) = 29$   
g)  $(4 + 5) \times 6 - 1 = 53$   
h)  $(4 + 5) \times (6 - 1) = 45$

#### Exercise 3.5 page 28

1. a) 2 b) 3 c) 7 d) 4 e) 23 f) 0  
2. a) 1 b) 5 c) 2 d) 50 e) 7  
f) -1.5

#### Student assessment 1 page 28

1. a)  $x \geq -1$  b)  $x < 2$   
c)  $-2 \leq x < 2$  d)  $-1 \leq x \leq 1$



3.  $\frac{3}{14}, \frac{2}{5}, \frac{1}{2}, \frac{4}{7}, \frac{9}{10}$

#### Student assessment 2 page 29

1. a) 44 b) 13 c) 25 d) 19  
e) 49 f) 3
2. a)  $(7 - 4) \times 2 = 6$   
b)  $12 + 3 \times (3 + 4) = 33$   
c)  $(5 + 5) \times (6 - 4) = 20$   
d)  $(5 + 5) \times 6 - 4 = 56$

3. a) 3.5 b) 10

#### Student assessment 3 page 29

1. a) 20 b) 15 c) 11 d) 13 e) 1 f) 4
2. a)  $(7 - 5) \times 3 = 6$   
b)  $16 + 4 \times (2 + 4) = 40$   
c)  $(4 + 5) \times (6 - 1) = 45$   
d)  $(1 + 5) \times 6 - 6 = 30$
3. a) 5.5 b) 9

## ④ Integers, fractions, decimals and percentages

### Exercise 4.1 page 30

1. a) 9      b) 16      c) 20      d) 40      e) 18  
 f) 72      g) 30      h) 48      i) 210      j) 52

### Exercise 4.2 page 31

1. a)  $\frac{14}{3}$       b)  $\frac{18}{5}$       c)  $\frac{47}{8}$       d)  $\frac{17}{6}$       e)  $\frac{17}{2}$   
 f)  $\frac{68}{7}$       g)  $\frac{58}{9}$       h)  $\frac{17}{4}$       i)  $\frac{59}{11}$       j)  $\frac{55}{7}$   
 k)  $\frac{43}{10}$       l)  $\frac{146}{13}$
2. a)  $7\frac{1}{4}$       b)  $6\frac{3}{5}$       c)  $6\frac{5}{6}$       d)  $6\frac{5}{8}$       e)  $5\frac{4}{9}$   
 f)  $1\frac{5}{12}$       g)  $9\frac{3}{7}$       h)  $3\frac{3}{10}$       i)  $9\frac{1}{2}$       j)  $6\frac{1}{12}$

### Exercise 4.3 page 31

1. a) 4.5      b) 6.3      c) 17.8      d) 3.07  
 e) 9.27      f) 11.36      g) 4.006      h) 5.027  
 i) 4.356      j) 9.204
2. a) 19.14      b) 83.812      c) 6.6      d) 11.16  
 e) 35.81      f) 5.32      g) 67.14      h) 6.06  
 i) 1.4      j) 0.175

### Exercise 4.4 page 32

1. a)  $\frac{29}{50} = \frac{58}{100} = 58\%$       b)  $\frac{17}{25} = \frac{68}{100} = 68\%$   
 c)  $\frac{11}{20} = \frac{55}{100} = 55\%$       d)  $\frac{3}{10} = \frac{30}{100} = 30\%$   
 e)  $\frac{23}{25} = \frac{92}{100} = 92\%$       f)  $\frac{19}{50} = \frac{38}{100} = 38\%$   
 g)  $\frac{3}{4} = \frac{75}{100} = 75\%$       h)  $\frac{2}{5} = \frac{40}{100} = 40\%$

2.

| Fraction                     | Decimal | Percentage |
|------------------------------|---------|------------|
| $\frac{1}{10}$               | 0.1     | 10         |
| $\frac{1}{5}$                | 0.2     | 20         |
| $\frac{3}{10}$               | 0.3     | 30         |
| $\frac{4}{10} = \frac{2}{5}$ | 0.4     | 40         |
| $\frac{1}{2}$                | 0.5     | 50         |
| $\frac{3}{5}$                | 0.6     | 60         |
| $\frac{7}{10}$               | 0.7     | 70         |
| $\frac{4}{5}$                | 0.8     | 80         |
| $\frac{9}{10}$               | 0.9     | 90         |
| $\frac{1}{4}$                | 0.25    | 25         |
| $\frac{3}{4}$                | 0.75    | 75         |

### Exercise 4.5 page 34

1. a) 9      b) 3
2. a)  $6 \times (4 + 6) \div 3 = 20$   
 b)  $(9 - 3) \times (7 + 2) = 54$
3. a) 29 830      b) 41 492
4. a) 2      b) 7
5. a) 224      b) 28
6. a) 1127.4      b) 526.1

### Exercise 4.6 page 35

1. a)  $\frac{1}{2}$       b)  $\frac{1}{3}$       c)  $\frac{2}{3}$       d)  $\frac{4}{9}$       e)  $\frac{3}{4}$       f)  $\frac{9}{10}$

### Exercise 4.7 page 35

1. a)  $1\frac{2}{5}$       b)  $\frac{10}{11}$       c)  $\frac{11}{12}$       d)  $1\frac{2}{45}$       e)  $1\frac{1}{65}$       f)  $1\frac{11}{12}$
2. a)  $1\frac{1}{8}$       b)  $1\frac{5}{7}$       c)  $1\frac{1}{12}$       d)  $\frac{47}{60}$       e)  $1\frac{29}{40}$       f)  $\frac{51}{52}$
3. a)  $\frac{1}{7}$       b)  $\frac{1}{10}$       c)  $\frac{5}{9}$       d)  $\frac{1}{12}$       e)  $\frac{9}{40}$       f)  $1\frac{1}{20}$
4. a)  $\frac{17}{60}$       b)  $\frac{45}{88}$       c)  $\frac{17}{20}$       d)  $\frac{44}{195}$       e)  $\frac{9}{20}$       f)  $\frac{1}{18}$
5. a)  $5\frac{3}{4}$       b)  $5\frac{3}{10}$       c)  $3\frac{1}{10}$       d)  $6\frac{7}{24}$       e)  $1\frac{1}{8}$       f)  $\frac{25}{36}$
6. a)  $5\frac{1}{8}$       b)  $7\frac{9}{40}$       c)  $-\frac{3}{8}$       d)  $\frac{7}{20}$       e)  $-2\frac{39}{140}$       f)  $1\frac{1}{4}$

### Exercise 4.8 page 37

1. a) 8      b)  $\frac{12}{7}$       c)  $\frac{5}{3}$       d)  $\frac{2}{3}$       e)  $\frac{4}{15}$       f)  $\frac{1}{6}$
2. a)  $\frac{1}{6}$       b)  $\frac{3}{5}$       c)  $\frac{4}{21}$       d)  $\frac{2}{3}$       e)  $\frac{1}{4}$       f)  $\frac{7}{20}$
3. a)  $\frac{5}{6}$       b)  $2\frac{1}{2}$       c)  $1\frac{1}{7}$       d)  $4\frac{1}{6}$       e)  $\frac{1}{5}$       f)  $\frac{2}{3}$
4. a)  $\frac{3}{5}$       b)  $\frac{7}{12}$       c)  $\frac{9}{70}$       d)  $\frac{21}{25}$       e)  $\frac{3}{8}$       f)  $1\frac{25}{56}$
5. a)  $\frac{3}{5}$       b)  $3\frac{107}{120}$       c)  $\frac{8}{15}$       d)  $12\frac{1}{4}$

### Exercise 4.9 page 37

1. a) 0.75      b) 0.8      c) 0.45      d) 0.34  
 e) 0.3̄      f) 0.375      g) 0.4375      h) 0.2̄  
 i) 0.6̄3
2. a) 2.75      b) 3.6      c) 4.35      d) 6.22  
 e) 5.6̄      f) 6.875      g) 5.5625      h) 4.2̄  
 i) 5.428571

### Exercise 4.10 page 38

1. a)  $\frac{1}{2}$       b)  $\frac{7}{10}$       c)  $\frac{3}{5}$       d)  $\frac{3}{4}$       e)  $\frac{33}{40}$   
 f)  $\frac{1}{20}$       g)  $\frac{1}{20}$       h)  $\frac{201}{500}$       i)  $\frac{1}{5000}$
2. a)  $2\frac{2}{5}$       b)  $6\frac{1}{2}$       c)  $8\frac{1}{5}$       d)  $3\frac{3}{4}$       e)  $10\frac{11}{20}$   
 f)  $9\frac{51}{250}$       g)  $15\frac{91}{200}$       h)  $30\frac{1}{1000}$       i)  $1\frac{41}{2000}$

**Exercise 4.11** page 40

1. a)  $\frac{1}{3}$       b)  $\frac{7}{9}$       c)  $\frac{42}{99} = \frac{14}{33}$       d)  $\frac{65}{99}$
2. a)  $\frac{55}{990} = \frac{1}{18}$       b)  $\frac{62}{990} = \frac{31}{495}$   
c)  $\frac{92}{90} = 1\frac{1}{45}$       d)  $\frac{39638}{9900} = 4\frac{19}{4950}$
3.  $\frac{1}{5}$
4.  $\frac{1}{6}$

**Student assessment 1** page 41

1. a) 12      b) 33      c) 6      d) 90
2. a) 30%      b) 29%      c) 50%      d) 70%  
e) 80%      f) 219%      g) 6%      h) 75%  
i) 31%      j) 7%      k) 340%      l) 200%
3. a) 23      b) 18
4. 22 977
5. 360.2
6. a)  $2\frac{1}{16}$       b) 9
7. a) 0.4      b) 1.75      c) 0.8̄      d) 1.̄
8. a)  $4\frac{1}{5}$       b)  $\frac{3}{50}$       c)  $1\frac{17}{20}$       d)  $2\frac{1}{200}$
9. a)  $\frac{37}{99}$       b)  $\frac{8}{99}$       c)  $1\frac{19}{90}$
10.  $\frac{650}{900} = \frac{13}{18}$

**Student assessment 2** page 42

1. a) 21      b) 27      c) 22      d) 39
2. a) 60%      b) 49%      c) 25%      d) 90%  
e) 150%      f) 327%      g) 5%      h) 35%  
i) 77%      j) 3%      k) 290%      l) 400%
3. a) 0      b) 19
4. 18 032
5. 340.7
6. a)  $1\frac{7}{10}$       b) 2
7. a) 0.875      b) 1.4      c) 0.̄8      d) 3.285714
8. a)  $6\frac{1}{2}$       b)  $\frac{1}{25}$       c)  $3\frac{13}{20}$       d)  $3\frac{1}{125}$
9. a)  $\frac{7}{99}$       b)  $\frac{1}{1000}$       c)  $3\frac{2}{99}$
10.  $\frac{11}{50}$

**5 Further percentages****Exercise 5.1** page 44

1. a) 60%      b) 40%
2. a) 87.5%      b) 73.3%  
c) 29.16%      d) 14.29% (2 d.p.)
3. a) 0.39      b) 0.47      c) 0.83      d) 0.07  
e) 0.02      f) 0.2
4. a) 31%      b) 67%      c) 9%      d) 5%  
e) 20%      f) 75%

**Exercise 5.2** page 44

1. a) 25%      b) 66.̄%      c) 62.5%  
d) 180%      e) 490%      f) 387.5%
2. a) 0.75      b) 0.8      c) 0.2  
d) 0.07      e) 1.875      f) 0.16
3. a) 20      b) 100      c) 50  
d) 36      e) 4.5      f) 7.5
4. a) 8.5      b) 8.5      c) 52  
d) 52      e) 17.5      f) 17.5
5. a) Black 6      b) Blonde 3      c) Brown 21
6. Lamb 66 Chicken 24 Turkey 12 Duck 18
7. Australian 143 Pakistani 44 Greek 11 Other 22
8. Newspapers 69 Pens 36 Books 18 Other 27

**Exercise 5.3** page 45

1. a) 48%      b) 36.8%      c) 35%  
d) 50%      e) 45%      f) 40%  
g)  $33\frac{1}{3}\%$       h) 57% (2 s.f.)
2. Win 50%      Lose  $33\frac{1}{3}\%$       Draw  $16\frac{2}{3}\%$
3. A = 34.5% (1 d.p.)      B = 25.6% (1 d.p.)  
C = 23.0% (1 d.p.)      D = 16.9% (1 d.p.)
4. Red 35.5%      Blue 31.0%      White 17.7%  
Silver 6.6%      Green 6.0%      Black 3.2%

**Exercise 5.4** page 47

1. a) 187.5      b) 322      c) 7140  
d) 245      e) 90      f) 121.5
2. a) 90      b) 38      c) 9  
d) 900      e) 50      f) 43.5

3. a) 20%      b) 80%      c) 110%  
     d) 5%      e) 85%      f) 225%
4. a) 50%      b) 30%      c) 5%  
     d) 100%      e) 36%      f) 5%
5. 7475 tonnes
6. \$6825
7. a) \$75      b) \$93.75
8. a) 43      b) 17.2%
9. 1100

**Exercise 5.5** page 48

1. a) 600      b) 350      c) 900  
     d) 250      e) 125      f) 1.5
2. a) 56      b) 65      c) 90  
     d) 20      e) 0.25      f) -38
3. 280 pages
4. 12 500 families
5. 22
6. 12 200 000 m<sup>3</sup>

**Student assessment 1** page 49

1. 640 m
2. \$345.60
3. \$10 125
4. a) 20%      b) 41.7% (3 s.f.)  
     c) 22.5%      d) 85.7% (3 s.f.)  
     e) 7%      f) 30%
5. 16% profit
6. a) \$36      b) 25%

**Student assessment 2** page 49

1. 750 m
2. \$525
3. \$97 200
4. a) 29.2% (3 s.f.)      b) 21.7% (3 s.f.)  
     c) 125%      d) 8.33% (3 s.f.)  
     e) 20%      f) 10%
5. 8.3%
6. a) \$650      b) 61.8% (3 s.f.)

**Student assessment 3** page 50

1. \$3500      \$12 000      \$1      \$56
2. \$500      \$250      \$20 000      \$137 500
3. 15
4. \$15 000
5. 40 000 tonnes

**Student assessment 4** page 51

1. \$200      \$25      \$524      \$10
2. \$462      \$4000      \$4500      \$5500
3. 15 marks
4. 35 000
5. 25 000 units
6. 46 500 units

**6 Ratio and proportion****Exercise 6.1** page 52

1. 48
2. 16 h 40 min
3. 11 units
4. a) 7500 bricks      b) 53 h
5. a) 6250 litres      b) 128 km
6. 1110 km (3 s.f.)
7. a) 450      b) 75      c) 120
8. a) 480 km      b) 96 km/h

**Exercise 6.2** page 54

1. a) 450 kg      b) 1250 kg
2. a) Butter 600 g      Flour 2 kg      Sugar 200 g  
     Currants 400 g  
     b) 120 cakes
3. a) 16.8 litres  
     b) Red 1.2 litres      White 14.3 litres
4. a) 125  
     b) Red 216      Yellow 135  
     c) 20
5. a) 42 litres  
     b) Orange juice 495 litres  
     Mango juice 110 litres

**Exercise 6.3** page 55

1.  $60 : 90$
2.  $16 : 24 : 32$
3.  $3.25 : 1.75$
4.  $18 : 27$
5.  $10 : 50$
6.  $7 : 1$
7. Orange 556 ml (3 s.f.) Water 444 ml (3 s.f.)
8. a)  $11 : 9$   
b) 440 boys 360 girls
9.  $\frac{3}{5}$
10. 32 cm
11. 4 km and 3 km
12.  $40^\circ, 80^\circ, 120^\circ, 120^\circ$
13.  $45^\circ, 75^\circ, 60^\circ$
14. 24 yr old \$400 000 28 yr old \$466 667  
32 yr old \$533 333
15. Alex \$2000 Maria \$3500 Ahmet \$2500

**Exercise 6.4** page 56

1. 4
2. 

|              |    |    |    |     |                |                |    |
|--------------|----|----|----|-----|----------------|----------------|----|
| Speed (km/h) | 60 | 40 | 30 | 120 | 90             | 50             | 10 |
| Time (h)     | 2  | 3  | 4  | 1   | $1\frac{1}{3}$ | $2\frac{2}{5}$ | 12 |
3. a) i) 12 h ii) 4 h iii) 48 h  
b) i) 16 ii) 3 iii) 48
4. a) 30 rows b) 42 chairs
5. 6 h 40 min
6. 4
7. 18 h

**Exercise 6.5** page 57

1. a) 160 b) 250 c) 175  
d) 110 e) 225 f) 128
2. a)  $93\frac{1}{3}$  b)  $116\frac{2}{3}$  c) 80  
d)  $157\frac{1}{2}$  e) 154 f) 85
3. a) 40 b) 50 c) 35  
d) 36 e) 15 f) 52
4. a)  $22\frac{1}{2}$  b)  $6\frac{2}{3}$  c)  $17\frac{1}{2}$   
d)  $5\frac{5}{8}$  e)  $18\frac{3}{4}$  f)  $13\frac{1}{2}$
5. 50

6. 32
7. 210
8. 90

**Exercise 6.6** page 58

1. 22 cm by 16.5 cm
2. 28 cm by 21 cm
3. 5 : 2
4. Min. = 32 : 1 Max. = 35 : 1
5. a) i)  $28 \text{ cm}^2$  ii)  $112 \text{ cm}^2$  b) 4 : 1
6. a) i)  $9 \text{ cm}^2$  ii)  $81 \text{ cm}^2$  b) 9 : 1
7. a) i)  $30 \text{ cm}^3$  ii)  $240 \text{ cm}^3$  b) 8 : 1
8. a) i)  $64 \text{ cm}^3$  ii)  $1728 \text{ cm}^3$  b) 27 : 1
9. a)  $16 \text{ cm}^2$  b)  $4 \text{ cm}^2$  c) 1 : 4
10. Student's own answer.

**Student assessment 1** page 59

1. a) 15 km b) 6 km/h
2. 16 cm and 14 cm
3. 1200 g
4. 200 g
5. a) 2 km b) 48 cm
6. a) 26 litres of petrol and 4 litres of oil  
b) 3250 ml
7. a) 1 : 40 b) 13.75 cm
8. Girl \$1040 Boy \$960
9.  $24^\circ, 60^\circ, 96^\circ$
10. a) 15 s b) 8 copiers
11. 6 h
12. 2

**Student assessment 2** page 60

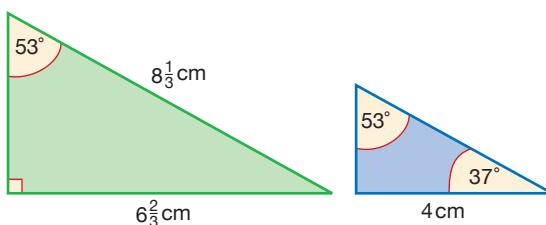
1. a) 30 km b) 30 km/h
2. a)  $\frac{7}{10}$  b) 45 cm
3. a) 375 g b) 625 g
4. a) 450 m b) 80 cm
5. a) 1 : 25 b) 1.75 m
6. 300 : 750 : 1950
7.  $60^\circ, 90^\circ, 90^\circ, 120^\circ$

8.  $150^\circ$

9. a) 13.5 h

b) 12 pumps

10.



11. a) 4 min 48 s

b) 1.6 litres/min

12. 21.6 cm by 9 cm

## 7 Indices and standard form

### Exercise 7.1

page 62

- |   |                     |                                |
|---|---------------------|--------------------------------|
| 1. a) $3^3$   | b) $2^5$            | c) $4^2$                       |
| d) $6^4$  | e) $8^6$            | f) $5^1$                       |
| 2. a) $2^3 \times 3^2$  | b) $4^5 \times 5^2$ | c) $3^2 \times 4^3 \times 5^2$ |
| d) $2 \times 7^4$   | e) $6^2$            | f) $3^3 \times 4^2 \times 6^5$ |
| 3. a) $4 \times 4$  |                     |                                |
| b) $5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5$                            |                     |                                |
| c) $3 \times 3 \times 3 \times 3 \times 3$  |                     |                                |
| d) $4 \times 4 \times 4 \times 6 \times 6 \times 6$                                     |                     |                                |
| e) $7 \times 7 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$          |                     |                                |
| f) $3 \times 3 \times 4 \times 4 \times 4 \times 4 \times 2 \times 2 \times 2 \times 2$ |                     |                                |
| 4. a) 32  | b) 81               | c) 64                          |
| d) 216  | e) 1 000 000        | f) 256                         |
| g) 72   | h) 125 000          |                                |

### Exercise 7.2

page 63

- |                                |                                   |                     |
|--------------------------------|-----------------------------------|---------------------|
| 1. a) $3^6$                    | b) $8^7$                          | c) $5^9$            |
| d) $4^{10}$                    | e) $2^4$                          | f) $3^5 \times 6^6$ |
| g) $4^8 \times 5^9 \times 6^2$ | h) $2^4 \times 5^{10} \times 6^8$ |                     |
| 2. a) $4^4$                    | b) $5^3$                          | c) 2                |
| d) $6^3$                       | e) $6^3$                          | f) 8                |
| g) $4^3$                       | h) $3^7$                          |                     |
| 3. a) $5^4$                    | b) $4^{12}$                       | c) $10^{10}$        |
| d) $3^{15}$                    | e) $6^8$                          | f) $8^6$            |
| 4. a) $2^3$                    | b) 3                              | c) $5^3$            |
| d) $4^5$                       | e) $4^3 \times 2^2 (= 2^8)$       | f) $6^4 \times 8^5$ |
| g) $4^3 \times 5^2$            | h) $4 \times 6^7$                 |                     |

### Exercise 7.3

page 64

- |                     |                  |                     |
|---------------------|------------------|---------------------|
| 1. a) 8             | b) 25            | c) 1                |
| d) 1                | e) 1             | f) $\frac{1}{4}$    |
| 2. a) $\frac{1}{4}$ | b) $\frac{1}{9}$ | c) $\frac{3}{50}$   |
| d) $\frac{1}{200}$  | e) 1             | f) $\frac{1}{1000}$ |
| 3. a) 1             | b) 2             | c) 4                |
| d) $\frac{1}{2}$    | e) $\frac{1}{6}$ | f) 10               |
| 4. a) 12            | b) 32            | c) 225              |
| d) 80               | e) 7             | f) 64               |

### Exercise 7.4

page 65

- |                   |       |                   |
|-------------------|-------|-------------------|
| 1. a) 2           | b) 4  | c) 3              |
| d) 3              | e) 4  | f) 0              |
| 2. a) 4           | b) 1  | c) $\frac{3}{2}$  |
| d) -1             | e) 2  | f) 0              |
| 3. a) -3          | b) -4 | c) -5             |
| d) $-\frac{2}{3}$ | e) -2 | f) $-\frac{1}{2}$ |
| 4. a) -3          | b) -7 | c) -3             |
| d) 2              | e) 8  | f) 5              |

### Exercise 7.5

page 67

- |  |                          |                          |
|--|--------------------------|--------------------------|
| 1. d and e   |                          |                          |
| 2. a) $6 \times 10^5$  | b) $4.8 \times 10^7$     | c) $7.84 \times 10^{11}$ |
| d) $5.34 \times 10^5$  | e) $7 \times 10^6$       | f) $8.5 \times 10^6$     |
| 3. a) $6.8 \times 10^6$  | b) $7.2 \times 10^8$     | c) $8 \times 10^5$       |
| d) $7.5 \times 10^7$   | e) $4 \times 10^9$       | f) $5 \times 10^7$       |
| 4. a) 3800   | b) 4250 000              | c) 90 030 000            |
| d) 101 000   |                          |                          |
| 5. a) $6 \times 10^5$  | b) $2.4 \times 10^7$     | c) $1.4 \times 10^8$     |
| d) $3 \times 10^9$   | e) $1.2 \times 10^{13}$  | f) $1.8 \times 10^7$     |
| 6. $1.44 \times 10^{11} \text{ m} = 1.44 \times 10^8 \text{ km}$ |                          |                          |
| 7. a) $8.8 \times 10^8$  | b) $2.04 \times 10^{11}$ | c) $3.32 \times 10^{11}$ |
| d) $4.2 \times 10^{22}$  | e) $5.1 \times 10^{22}$  | f) $2.5 \times 10^{25}$  |
| 8. a) $2 \times 10^2$  | b) $3 \times 10^5$       | c) $4 \times 10^6$       |
| d) $2 \times 10^4$   | e) $2.5 \times 10^6$     | f) $4 \times 10^4$       |
| 9. a) $4.26 \times 10^5$   | b) $8.48 \times 10^9$    | c) $6.388 \times 10^7$   |
| d) $3.157 \times 10^9$   | e) $4.5 \times 10^8$     | f) $6.01 \times 10^7$    |
| g) $8.15 \times 10^{10}$   | h) $3.56 \times 10^7$    |                          |

### Exercise 7.6

page 68

- |                            |                          |                           |
|----------------------------|--------------------------|---------------------------|
| 1. a) $6 \times 10^{-4}$   | b) $5.3 \times 10^{-5}$  | c) $8.64 \times 10^{-4}$  |
| d) $8.8 \times 10^{-8}$    | e) $7 \times 10^{-7}$    | f) $4.145 \times 10^{-4}$ |
| 2. a) $6.8 \times 10^{-4}$ | b) $7.5 \times 10^{-7}$  | c) $4.2 \times 10^{-10}$  |
| d) $8 \times 10^{-9}$      | e) $5.7 \times 10^{-11}$ | f) $4 \times 10^{-11}$    |

3. a) 0.008      b) 0.00042      c) 0.0903  
 d) 0.0000101

4. a) -4      b) -3      c) -8  
 d) -5      e) -7      f) 3

5.  $6.8 \times 10^5$        $6.2 \times 10^3$        $8.414 \times 10^2$   
 $6.741 \times 10^{-4}$        $3.2 \times 10^{-4}$        $5.8 \times 10^{-7}$   
 $5.57 \times 10^{-9}$

### Exercise 7.7

- page 70
- a) 4      b) 5      c) 10      d) 3      e) 9      f) 10
  - a) 2      b) 3      c) 2      d) 2      e) 6      f) 4
  - a) 8      b) 32      c) 27      d) 64      e) 1      f) 9
  - a) 25      b) 8      c) 32      d) 100      e) 32      f) 27
  - a)  $\frac{1}{2}$       b)  $\frac{1}{3}$       c)  $\frac{1}{2}$       d)  $\frac{1}{3}$       e)  $\frac{1}{2}$       f)  $\frac{1}{6}$
  - a)  $\frac{1}{3}$       b)  $\frac{1}{2}$       c)  $\frac{1}{4}$       d)  $\frac{1}{3}$       e)  $\frac{1}{6}$       f)  $\frac{1}{3}$

### Exercise 7.8

- page 70
- a) 1      b) 7      c) 2      d) 1      e) 81      f) 6
  - a) 25      b) 2      c) 2      d) 27      e) 4      f) 2
  - a) 4      b) 2      c) 64      d) 9      e) 3      f) 27

### Student assessment 1

- page 71
- a)  $2^3 \times 5^2$       b)  $2^2 \times 3^5$
  - a)  $4 \times 4 \times 4$       b)  $6 \times 6 \times 6 \times 6$
  - a) 800      b) 27
  - a)  $3^7$       b)  $6^5 \times 3^9$       c)  $2^7$   
 d) 6      e)  $3^2 \times 4^2$       f) 1
  - a) 4      b) 9      c) 5      d) 1
  - a) 7      b) -2      c) -1      d)  $\frac{1}{3}$

### Student assessment 2

- page 71
- a)  $2^2 \times 3^5$       b)  $2^{14}$
  - a)  $6 \times 6 \times 6 \times 6 \times 6$   
 b) 
$$\frac{1}{2 \times 2 \times 2 \times 2 \times 2}$$
  - a) 27 000      b) 125
  - a)  $2^7$       b)  $7^7 \times 3^{12}$       c)  $2^6$   
 d)  $3^3$       e)  $4^{-1}$       f)  $2^2$
  - a) 5      b) 16      c) 49      d) 48
  - a) 2.5      b) -0.5      c) 0      d)  $\frac{2}{9}$

### Student assessment 3

- page 72
- a)  $8 \times 10^6$       b)  $7.2 \times 10^{-4}$       c)  $7.5 \times 10^{10}$   
 d)  $4 \times 10^{-4}$       e)  $4.75 \times 10^9$       f)  $6.4 \times 10^{-7}$
  - a) 20 700      b) 0.00145      c) 0.0523
  - $7.41 \times 10^{-9}$        $3.6 \times 10^{-5}$        $5.5 \times 10^{-3}$   
 $4.21 \times 10^7$        $6.2 \times 10^7$        $4.9 \times 10^8$
  - a)  $6 \times 10^6$        $8.2 \times 10^5$        $4.4 \times 10^{-3}$   
 $8 \times 10^{-1}$        $5.2 \times 10^4$   
 b)  $6 \times 10^6$        $8.2 \times 10^5$        $5.2 \times 10^4$   
 $8 \times 10^{-1}$        $4.4 \times 10^{-3}$
  - a) 2      b) 8      c) -4  
 d) 5      e) -5      f) -5
  - a)  $1.2 \times 10^8$       b)  $5.6 \times 10^8$       c)  $2 \times 10^5$   
 d)  $2.5 \times 10^5$
  - 6 minutes
  - $4.73 \times 10^{15}$  km correct to three significant figures (3 s.f.)

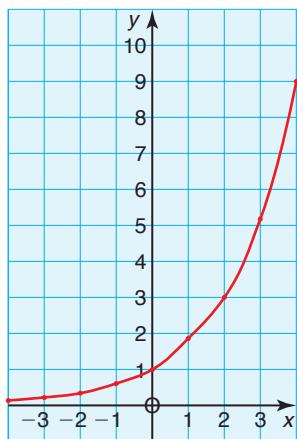
### Student assessment 4

- page 73
- a)  $6 \times 10^6$       b)  $4.5 \times 10^{-3}$       c)  $3.8 \times 10^9$   
 d)  $3.61 \times 10^{-7}$       e)  $4.6 \times 10^8$       f)  $3 \times 10^0$
  - a) 8112 000      b) 440 000      c) 0.000305
  - $4.05 \times 10^8$        $3.6 \times 10^2$        $9 \times 10^1$   
 $1.5 \times 10^{-2}$        $7.2 \times 10^{-3}$        $2.1 \times 10^{-3}$
  - a)  $1.5 \times 10^7$        $4.3 \times 10^5$        $4.35 \times 10^{-4}$   
 $4.8 \times 10^0$        $8.5 \times 10^{-3}$        $8.5 \times 10^{-3}$   
 b)  $4.35 \times 10^{-4}$        $8.5 \times 10^{-3}$        $4.3 \times 10^5$   
 $1.5 \times 10^7$
  - a) 3      b) 9      c) -3  
 d) 6      e) -1      f) 8
  - a)  $1.2 \times 10^8$       b)  $1.48 \times 10^{11}$       c)  $6.73 \times 10^7$   
 d)  $3.88 \times 10^6$
  - 43.2 minutes (3 s.f.)
  - $2.84 \times 10^{15}$  km (3 s.f.)

### Student assessment 5

- page 74
- a) 9      b) 3      c) 3      d) 125  
 e) 49      f) 0.5      g) 5      h) 16
  - a) 1      b) 9      c) 4      d) 25  
 e) 2      f) 8      g) 1      h) 45

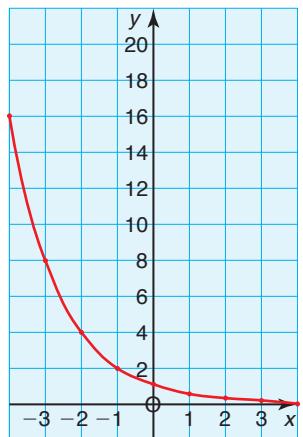
3. a)



b) Approx. 2.9

**Student assessment 6** page 74

- |          |       |                  |         |
|----------|-------|------------------|---------|
| 1. a) 2  | b) 81 | c) $\frac{1}{3}$ | d) 64   |
| e) 3     | f) 2  | g) 6             | h) 32   |
| 2. a) 15 | b) 4  | c) 3             | d) 3125 |
| e) 4     | f) 1  | g) 27            | h) 10   |
| 3. a)    |       |                  |         |



b) Approx. -2.6

**8 Money and finance****Exercise 8.1** page 75

- |                |                |
|----------------|----------------|
| 1. a) A\$31.25 | b) 3500 rupees |
| c) ZIM\$9400   | d) 3300 rand   |
| e) L299        | f) 4120 yen    |
| g) 160 dinar   | h) US\$195     |
| 2. a) €400     | b) €2.86       |
| c) €2.13       | d) €45.45      |
| e) €326.09     | f) €11.65      |
| g) €125        | h) €115.38     |

**Exercise 8.2** page 76

- |                |                |
|----------------|----------------|
| 1. \$154.82    |                |
| 2. \$182       |                |
| 3. \$131       |                |
| 4. \$290.50    |                |
| 5. a) \$195.05 | b) \$132.63    |
| 6. \$137.50    |                |
| 7. €525        |                |
| 8. a) 298 rand | b) 253.30 rand |

**Exercise 8.3** page 77

- \$1.80 loss
- \$2.88 profit
- \$54.65 profit per seat
- \$240 extra
- \$250 loss

**Exercise 8.4** page 78

- a) 11%      b) 25%
- a) 30%      b) 20%
- Type A = 30%  
Type B = 15.4%  
Type C = 33.3%  
Type C makes most profit.
- 80%

**Exercise 8.5** page 80

- a) \$72      b) \$420
- a)  $t = 5$       b)  $t = 7$

3. a)  $r = 7$       b)  $r = 4$
4. a)  $P = 200$     b)  $P = 850$
5.  $r = 4$
6.  $t = 2$
7.  $r = 4.5$
8.  $r = 9.5$
9. \$315
10.  $r = 6$

**Exercise 8.6** page 82

1. \$11 033 750
2. \$52 087.50
3. \$10 368
4. 1331 students
5. 3 276 800 tonnes
6. 2 years
7. 5 years
8. 3 years

**Student assessment 1** page 83

1. a) 2880 rupees      b) HK\$83.33
2. a) €625                b) €192.31
3. \$122.40
4. \$26.16                (\$12.96 + \$13.20)
5. a) \$72                b) 8%                c) 4 years  
d) 7.5%                e) \$1250
6. \$6000
7. 30%

**Student assessment 2** page 84

1. a) \$82.50      b) \$4800      c) \$2187.50
2. 3.5%
3. 5 years
4. a) \$24.36      b) \$2969.24    c) \$9953.45
5. a) i) \$10 625  
ii) \$9031.25  
b) 16 years

**9 Time****Exercise 9.1** page 85

1. 0840
2. 1845
3. 0825
4. a) 2 h 18 min  
b) 1 h 24 min
5. 1st: 30 min                2nd: 32 min 44 s  
3rd: 34 min 17 s            4th: 35 min 7 s  
5th: 36 min
6. 2.10 a.m. on Wednesday
7. 2145
8. 1115

**Student assessment 1** page 86

1. 09 03
2. 5 h 54 min
3. 49 km
4. 11 h 5 min

**Student assessment 2** page 86

1. 08 18
2. 2 h 15 min
3. 154 km
4. a) 3 h 30 min or 3.5 h  
b) 90 km/h

**10 Set notation and Venn diagrams****Exercise 10.1** page 88

1. a) i) Continents of the world  
ii) Student's own answers
- b) i) Even numbers  
ii) Student's own answers
- c) i) Days of the week  
ii) Student's own answers
- d) i) Months with 31 days  
ii) Student's own answers

- e) i) Triangle numbers  
ii) Student's own answers
- f) i) Boy's names beginning with the letter m  
ii) Student's own answers
- g) i) Prime numbers greater than 7  
ii) Student's own answers
- h) i) Vowels  
ii) o, u
- i) i) Planets of the solar system  
ii) Student's own answers
- j) i) Numbers between 3 and 12  
ii) Student's own answers
- k) i) Numbers between  $-5$  and 5  
ii) Student's own answers
2. a) 7                    c) 7                    d) 7  
f) Unquantifiably finite, though theoretically infinite  
h) 5                    i) 9

### **Exercise 10.2** page 89

1. a)  $Q = \{2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28\}$   
 b)  $R = \{1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29\}$   
 c)  $S = \{2, 3, 5, 7, 11, 13, 17, 19, 23, 29\}$   
 d)  $T = \{1, 4, 9, 16, 25\}$   
 e)  $U = \{1, 3, 6, 10, 15, 21, 28\}$
2. a)  $B = \{55, 60, 65\}$   
 b)  $C = \{51, 54, 57, 60, 63, 66, 69\}$   
 c)  $D = \{64\}$
3. a)  $\{p, q, r\}, \{p, q\}, \{p, r\}, \{q, r\}, \{p\}, \{q\}, \{r\}, \{\}$   
 b)  $\{p, q\}, \{p, r\}, \{q, r\}, \{p\}, \{q\}, \{r\}$
4. a) True      b) True      c) True      d) False  
 e) False      f) True      g) True      h) False

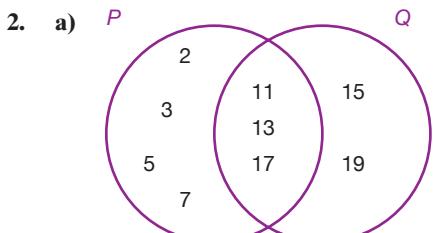
### **Exercise 10.3** page 91

1. a) True      b) True      c) False  
 d) False      e) False      f) True
2. a)  $A \cap B = \{4, 6\}$   
 b)  $A \cap B = \{4, 9\}$   
 c)  $A \cap B = \{\text{yellow, green}\}$
3. a)  $A \cup B = \{2, 3, 4, 6, 8, 9, 10, 13, 18\}$   
 b)  $A \cup B = \{1, 4, 5, 6, 7, 8, 9, 16\}$   
 c)  $A \cup B = \{\text{red, orange, blue, indigo, violet, yellow, green, purple, pink}\}$

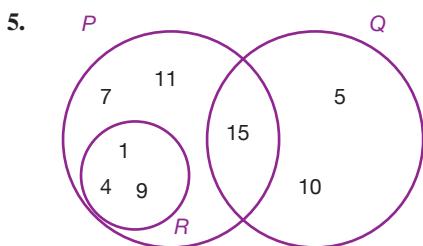
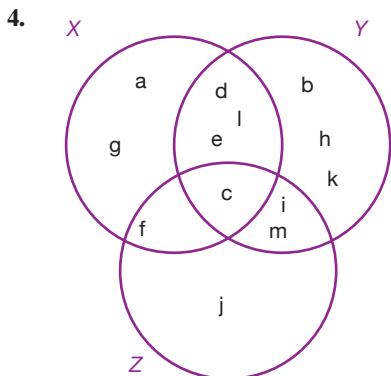
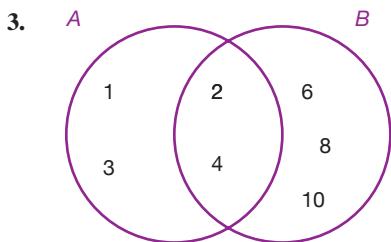
4. a)  $E = \{a, b, p, q, r, s, t\}$   
 b)  $A' = \{a, b\}$
5. a)  $E = \{1, 2, 3, 4, 5, 6, 7, 8\}$   
 b)  $A' = \{1, 4, 6, 8\}$   
 c)  $A \cap B = \{2, 3\}$   
 d)  $A \cup B = \{1, 2, 3, 4, 5, 7, 8\}$   
 e)  $(A \cap B)' = \{1, 4, 5, 6, 7, 8\}$   
 f)  $A \cap B' = \{5, 7\}$
6. a) i)  $A = \{\text{even numbers from 2 to 14}\}$   
 ii)  $B = \{\text{multiples of 3 from 3 to 15}\}$   
 iii)  $C = \{\text{multiples of 4 from 4 to 20}\}$   
 b) i)  $A \cap B = \{6, 12\}$   
 ii)  $A \cap C = \{4, 8, 12\}$   
 iii)  $B \cap C = \{12\}$   
 iv)  $A \cap B \cap C = \{12\}$   
 v)  $A \cup B = \{2, 3, 4, 6, 8, 9, 10, 12, 14, 15\}$   
 vi)  $C \cup B = \{3, 4, 6, 8, 9, 12, 15, 16, 20\}$
7. a) i)  $A = \{1, 2, 4, 5, 6, 7\}$   
 ii)  $B = \{3, 4, 5, 8, 9\}$   
 iii)  $C' = \{1, 2, 3, 4, 5, 8, 9\}$   
 iv)  $A \cap B = \{4, 5\}$   
 v)  $A \cup B = \{1, 2, 3, 4, 5, 6, 7, 8, 9\}$   
 vi)  $(A \cap B)' = \{1, 2, 3, 6, 7, 8, 9\}$   
 b)  $C \subset A$
8. a) i)  $W = \{1, 2, 4, 5, 6, 7, 9, 10\}$   
 ii)  $X = \{2, 3, 6, 7, 8, 9\}$   
 iii)  $Z' = \{1, 4, 5, 6, 7, 8, 10\}$   
 iv)  $W \cap Z = \{2, 9\}$   
 v)  $W \cap X = \{2, 6, 7, 9\}$   
 vi)  $Y \cap Z = \{\} \text{ or } \emptyset$   
 b)  $Z$

### **Exercise 10.4** 93

1. a)
- 
- b) i)  $A \cap B = \{\text{Egypt}\}$   
 ii)  $A \cup B = \{\text{Libya, Morocco, Chad, Egypt, Iran, Iraq, Turkey}\}$

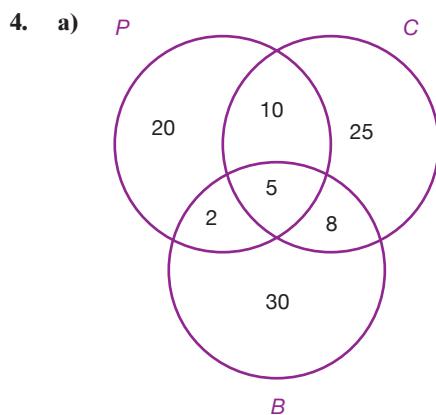


- b) i)  $P \cap Q = \{11, 13, 17\}$   
 ii)  $P \cup Q = \{2, 3, 5, 7, 11, 13, 15, 17, 19\}$



### Exercise 10.5 page 94

1. a) 5                  b) 14                  c) 13  
 2. 45  
 3. a) 10                  b) 50



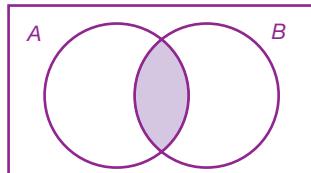
b) 100

### Student assessment 1 page 94

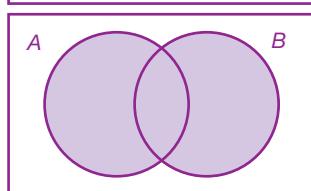
1. a) {even numbers from 2 to 8}  
 b) {even numbers}  
 c) {square numbers}  
 d) {oceans}

2. a) 7                  b) 2                  c) 6                  d) 366

3. a)



- b)



4. {a, b}, {a}, {b}, { }

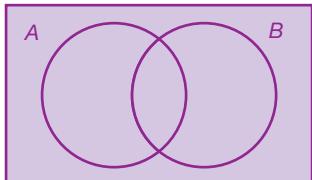
5.  $A' = \{m, t, h\}$

### Student assessment 2 page 95

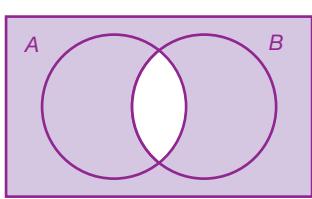
1. a) {odd numbers from 1 to 7}  
 b) {odd numbers}  
 c) {triangle numbers}  
 d) {countries in South America}

2. a) 12                  b) 3                  c) 7  
 d) Student's own answer

3. a)  $\mathcal{E}$



b)  $\mathcal{E}$



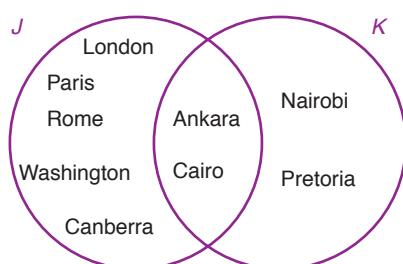
4.  $\{o, r, k\}, \{w, r, k\}, \{w, o, k\}, \{w, o, r\}, \{w, o, r, k\}$

5.  $P' = \{1, 3, 5, 7\}$

### **Student assessment 3** page 95

1.  $\{2, 4\}, \{2, 6\}, \{2, 8\}, \{4, 6\}, \{4, 8\}, \{6, 8\}, \{2, 4, 6\}, \{2, 4, 8\}, \{2, 6, 8\}, \{4, 6, 8\}$

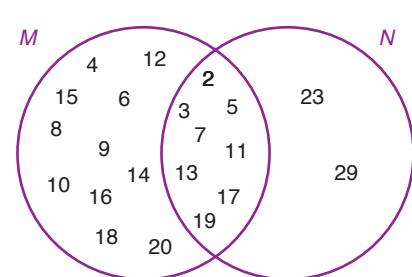
2. a)  $J$



b) {Ankara, Cairo}

c) {Nairobi, Pretoria}

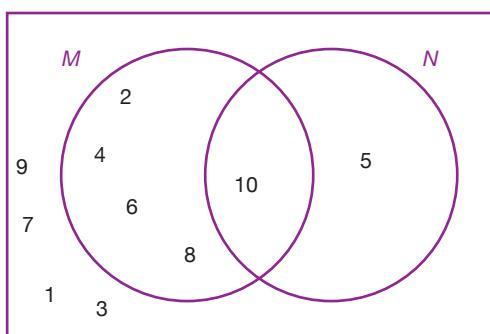
3. a)



b)  $\{2, 3, 5, 7, 11, 13, 17, 19\}$

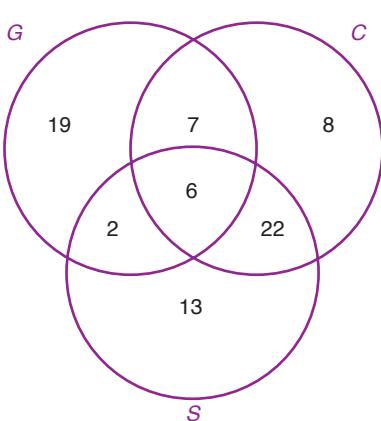
c)  $\{4, 6, 8, 9, 10, 12, 14, 15, 16, 18, 20, 23, 29\}$

4. a)  $\mathcal{E}$



b)  $X = \{\text{multiples of } 10\}$

5. a)  $G$



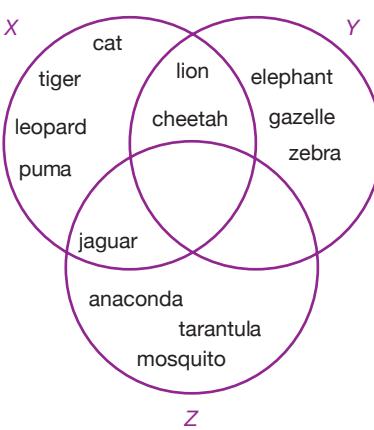
b) 6

### **Student assessment 4** page 96

1. a) 32

b)  $\{a, e, i, o, u\}, \{a, e, i, o\}, \{a, e, i, u\}, \{a, e, o, u\}, \{a, i, o, u\}, \{e, i, o, u\}$

2. a)  $X$

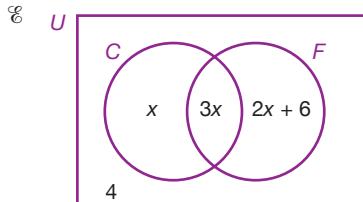


b) {lion, cheetah}

c)  $\emptyset$

d)  $\emptyset$

3. a) Let the number liking only cricket be  $x$ .



- b) 15      c) 5      d) 16  
 4. a) 5      b) 35      c) 40      d) 50      e) 15  
 f) 12      g) 10      h) 78      i) 78

## Topic 1 Mathematical investigations and ICT

### Primes and squares

page 100

- $2^2 + 3^2 = 13$   
 $4^2 + 5^2 = 41$
- 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97
- 5, 13, 17, 29, 37, 41, 53, 61, 73, 89, 97
- If a number generated by the rule  $4n + 1$  is a prime, then it can be expressed as the sum of two square numbers. (This was proved by Fermat in the 17th century.) Alternatively, add 1 to the prime number and divide the result by 2. If the answer is even then the prime number cannot be expressed as the sum of two squares.
- The rule works for the numbers shown, but this does not prove that it always works.

### Football leagues

page 100

- $(17 + 16 + 15 + \dots + 1) \times 2 = 306$
- $n = t(t - 1)$

### ICT activity 1

page 101

- Student's spreadsheet
- e.g. in cell C4 enter =B4/B\$3\*100
- Student's spreadsheet
- Student's report

### ICT activity 2

page 101

Student's graphs and responses will vary except:

- The gradient of the tangent at a point represents the speed of the runner at that point.

## 11 Algebraic representation and manipulation

### Exercise 11.1

page 104

- a)  $4x - 12$   
 b)  $10p - 20$   
 c)  $-42x + 24y$   
 d)  $6a - 9b - 12c$   
 e)  $-14m + 21n$   
 f)  $-16x + 6y$
- a)  $3x^2 - 9xy$   
 b)  $a^2 + ab + ac$   
 c)  $8m^2 - 4mn$   
 d)  $-15a^2 + 20ab$   
 e)  $4x^2 - 4xy$   
 f)  $24p^2 - 8pq$
- a)  $-2x^2 + 3y^2$   
 b)  $a - b$   
 c)  $7p - 2q$   
 d)  $3x - 4y + 2z$   
 e)  $3x - \frac{3}{2}y$   
 f)  $2x^2 - 3xy$
- a)  $12r^3 - 15rs + 6rt$   
 b)  $a^3 + a^2b + a^2c$   
 c)  $6a^3 - 9a^2b$   
 d)  $p^2q + pq^2 - p^2q^2$   
 e)  $m^3 - m^2n + m^3n$   
 f)  $a^6 + a^5b$

### Exercise 11.2

page 104

- a)  $-a - 8$   
 b)  $4x - 20$   
 c)  $3p - 16$   
 d)  $21m - 6n$   
 e) 3  
 f)  $-p - 3p^2$
- a)  $8m^2 + 28m + 2$   
 b)  $x - 4$   
 c)  $2p + 22$   
 d)  $m - 12$   
 e)  $a^2 + 6a + 2$   
 f)  $7ab - 16ac + 3c$
- a)  $4x + 4$   
 b)  $5x - \frac{3}{2}y$   
 c)  $\frac{3}{4}x - \frac{5}{2}y$   
 d)  $\frac{3}{2}x + \frac{1}{2}y$   
 e)  $7x - 4y$   
 f) 0

### Exercise 11.3

page 105

- a)  $x^2 + 5x + 6$   
 b)  $x^2 + 7x + 12$   
 c)  $x^2 + 7x + 10$   
 d)  $x^2 + 7x + 6$   
 e)  $x^2 + x - 6$   
 f)  $x^2 + 5x - 24$
- a)  $x^2 + 2x - 24$   
 b)  $x^2 - 3x - 28$   
 c)  $x^2 - 2x - 35$   
 d)  $x^2 - 2x - 15$   
 e)  $x^2 - 2x - 3$   
 f)  $x^2 + 2x - 63$
- a)  $x^2 - 5x + 6$   
 b)  $x^2 - 7x + 10$   
 c)  $x^2 - 12x + 32$   
 d)  $x^2 + 6x + 9$   
 e)  $x^2 - 6x + 9$   
 f)  $x^2 - 12x + 35$
- a)  $x^2 - 9$   
 b)  $x^2 - 49$   
 c)  $x^2 - 64$   
 d)  $x^2 - y^2$   
 e)  $a^2 - b^2$   
 f)  $p^2 - q^2$

**Exercise 11.4** page 106

1. a)  $2(2x - 3)$       b)  $6(3 - 2p)$   
c)  $3(2y - 1)$       d)  $2(2a - 3b)$   
e)  $3(p - q)$       f)  $4(2m + 3n + 4r)$
2. a)  $a(3b + 4c - 5d)$       b)  $2p(4q + 3r - 2s)$   
c)  $a(a - b)$       d)  $2x(2x - 3y)$   
e)  $ab(c + d + f)$       f)  $3m(m + 3)$
3. a)  $3pq(r - 3s)$       b)  $5m(m - 2n)$   
c)  $4xy(2x - y)$       d)  $b^2(2a^2 - 3c^2)$   
e)  $12(p - 3)$       f)  $6(7x - 9)$
4. a)  $6(3 + 2y)$       b)  $7(2a - 3b)$   
c)  $11x(1 + y)$       d)  $4(s - 4t + 5r)$   
e)  $5q(p - 2r + 3s)$       f)  $4y(x + 2y)$
5. a)  $m(m + n)$       b)  $3p(p - 2q)$   
c)  $qr(p + s)$       d)  $ab(1 + a + b)$   
e)  $p^3(3 - 4p)$       f)  $b^2c(7b + c)$
6. a)  $m(m^2 - mn + n^2)$   
b)  $2r^2(2r - 3 + 4s)$   
c)  $28xy(2x - y)$   
d)  $18mn(4m + 2n - mn)$

**Exercise 11.5** page 106

1. a) 0      b) 30      c) 14  
d) 20      e) -13      f) -4
2. a) -3      b) -30      c) 20  
d) -16      e) -40      f) 42
3. a) -160      b) -23      c) 42  
d) -17      e) -189      f) 113
4. a) 48      b) -8      c) 15  
d) 16      e) -5      f) 9
5. a) 12      b) -5      c) -5  
d) 7      e) 7      f) 36

**Exercise 11.6** page 107

1. a)  $n = r - m$       b)  $m = p - n$   
c)  $n = 3p - 2m$       d)  $q = 3x - 2p$   
e)  $a = \frac{cd}{b}$       f)  $d = \frac{ab}{c}$
2. a)  $x = \frac{4m}{3y}$       b)  $r = \frac{7pq}{5}$   
c)  $x = \frac{c}{3}$       d)  $x = \frac{y - 7}{3}$   
e)  $y = \frac{3r + 9}{5}$       f)  $x = \frac{5y - 9}{3}$

3. a)  $b = \frac{2a - 5}{6}$       b)  $a = \frac{6b + 5}{2}$   
c)  $z = \frac{3x - 7y}{4}$       d)  $x = \frac{4z + 7y}{3}$   
e)  $y = \frac{3x - 4z}{7}$       f)  $p = \frac{8 + q}{2r}$
4. a)  $p = 4r$       b)  $p = \frac{4}{3r}$       c)  $p = \frac{n}{10}$   
d)  $n = 10p$       e)  $p = \frac{2t}{q + r}$       f)  $q = \frac{2t}{p} - r$
5. a)  $r = \frac{3m - n}{t(p + q)}$       b)  $t = \frac{3m - n}{r(p + q)}$   
c)  $m = \frac{rt(p + q) + n}{3}$   
d)  $n = 3m - rt(p + q)$   
e)  $p = \frac{3m - n}{rt} - q$   
f)  $q = \frac{3m - n}{rt} - p$
6. a)  $d = \frac{ab}{ce}$       b)  $a = \frac{dec}{b}$   
c)  $c = \frac{ab}{de}$       d)  $a = cd - b$   
e)  $b = d - \frac{a}{c}$       f)  $c = \frac{a}{d - b}$

**Exercise 11.7** page 108

1. a)  $2y^2 + 7y + 6$       b)  $3y^2 + 25y + 28$   
c)  $2y^2 + 17y + 8$       d)  $4y^2 + 6y + 2$   
e)  $6y^2 + 23y + 20$       f)  $18y^2 + 15y + 3$
2. a)  $2p^2 + 13p - 24$       b)  $4p^2 + 23p - 35$   
c)  $6p^2 + p - 12$       d)  $12p^2 + 13p - 35$   
e)  $18p^2 - 2$       f)  $28p^2 + 44p - 24$
3. a)  $4x^2 - 4x + 1$       b)  $9x^2 + 6x + 1$   
c)  $16x^2 - 16x + 4$       d)  $25x^2 - 40x + 16$   
e)  $4x^2 + 24x + 36$       f)  $4x^2 - 9$
4. a)  $-4x^2 + 9$       b)  $16x^2 - 9$   
c)  $-16x^2 + 9$       d)  $-25y^2 + 49$   
e)  $8y^2 - 18$       f)  $25y^2 - 70y + 49$

**Exercise 11.8** page 109

1. a)  $(x + y)(a + b)$       b)  $(x - y)(a + b)$   
c)  $(3 + x)(m + n)$       d)  $(m + n)(4 + x)$   
e)  $(m - n)(3 + x)$       f)  $(x + z)(6 + y)$
2. a)  $(p + q)(r - s)$       b)  $(p + 3)(q - 4)$   
c)  $(q - 4)(p + 3)$       d)  $(r + 2t)(s + t)$   
e)  $(s + t)(r - 2t)$       f)  $(b + c)(a - 4c)$

3. a)  $(y+x)(x+4)$  b)  $(x-2)(x-y)$   
 c)  $(a-7)(b+3)$  d)  $(b-1)(a-1)$   
 e)  $(p-4)(q-4)$  f)  $(m-5)(n-5)$

4. a)  $(m-3)(n-2)$  b)  $(m-3r)(n-2r)$   
 c)  $(p-4q)(r-4)$  d)  $(a-c)(b-1)$   
 e)  $(x-2y)(x-2z)$  f)  $(2a+b)(a+b)$

### Exercise 11.9

page 109

1. a)  $(a-b)(a+b)$  b)  $(m-n)(m+n)$   
 c)  $(x-5)(x+5)$  d)  $(m-7)(m+7)$   
 e)  $(9-x)(9+x)$  f)  $(10-y)(10+y)$
2. a)  $(12-y)(12+y)$  b)  $(q-13)(q+13)$   
 c)  $(m-1)(m+1)$  d)  $(1-t)(1+t)$   
 e)  $(2x-y)(2x+y)$  f)  $(5p-8q)(5p+8q)$
3. a)  $(3x-2y)(3x+2y)$   
 b)  $(4p-6q)(4p+6q)$   
 c)  $(8x-y)(8x+y)$   
 d)  $(x-10y)(x+10y)$   
 e)  $(qr-2p)(qr+2p)$   
 f)  $(ab-cd)(ab+cd)$
4. a)  $(mn-3y)(mn+3y)$   
 b)  $(\frac{1}{2}x-\frac{1}{3}y)(\frac{1}{2}x+\frac{1}{3}y)$   
 c)  $(2x-9y^2)(2x+9y^2)$   
 d)  $(p^2-q^2)(p^2+q^2)=(p-q)(p+q)(p^2+q^2)$   
 e)  $4(m^2-3y^2)(m^2+3y^2)$   
 f)  $(4x^2-9y^2)(4x^2+9y^2)$   
 $= (2x-3y)(2x+3y)(4x^2+9y^2)$

### Exercise 11.10

page 110

- |            |              |         |
|------------|--------------|---------|
| 1. a) 60   | b) 240       | c) 2400 |
| d) 280     | e) 7600      | f) 9200 |
| 2. a) 2000 | b) 9800      | c) 200  |
| d) 3200    | e) 998 000   | f) 161  |
| 3. a) 68   | b) 86        | c) 1780 |
| d) 70      | e) 55        | f) 5    |
| 4. a) 72.4 | b) 0.8       | c) 65   |
| d) 15      | e) 1 222 000 | f) 231  |

### Exercise 11.11

page 111

1. a)  $(x+4)(x+3)$  b)  $(x+6)(x+2)$   
 c)  $(x+12)(x+1)$  d)  $(x-3)(x-4)$   
 e)  $(x-6)(x-2)$  f)  $(x-12)(x-1)$
2. a)  $(x+5)(x+1)$  b)  $(x+4)(x+2)$   
 c)  $(x+3)^2$  d)  $(x+5)^2$   
 e)  $(x+11)^2$  f)  $(x-6)(x-7)$

3. a)  $(x+12)(x+2)$  b)  $(x+8)(x+3)$   
 c)  $(x-6)(x-4)$  d)  $(x+12)(x+3)$   
 e)  $(x+18)(x+2)$  f)  $(x-6)^2$

4. a)  $(x+5)(x-3)$  b)  $(x-5)(x+3)$   
 c)  $(x+4)(x-3)$  d)  $(x-4)(x+3)$   
 e)  $(x+6)(x-2)$  f)  $(x-12)(x-3)$

5. a)  $(x-4)(x+2)$  b)  $(x-5)(x+4)$   
 c)  $(x+6)(x-5)$  d)  $(x+6)(x-7)$   
 e)  $(x+7)(x-9)$  f)  $(x+9)(x-6)$

6. a)  $(2x+1)(x+1)$  b)  $(2x+3)(x+2)$   
 c)  $(2x-3)(x+2)$  d)  $(2x-3)(x-2)$   
 e)  $(3x+2)(x+2)$  f)  $(3x-1)(x+4)$   
 g)  $(2x+3)^2$  h)  $(3x-1)^2$   
 i)  $(3x+1)(2x-1)$

### Exercise 11.12

page 112

1. a)  $x = \frac{P}{2m}$  b)  $x = \pm \sqrt{\frac{T}{3}}$  c)  $x = \pm \sqrt{\frac{y^2}{m}}$

d)  $x = \pm \sqrt{p^2 - q^2 - y^2}$

e)  $x = \pm \sqrt{y^2 - n^2 - m^2}$

f)  $x = \pm \sqrt{\frac{p^2 - q^2 + y^2}{4}}$

2. a)  $x = \frac{P}{Qr}$  b)  $x = \pm \sqrt{\frac{P}{Qr}}$  c)  $x = \pm \sqrt{\frac{Pr}{Q}}$

d)  $x = \pm \sqrt{\frac{n}{m}}$  e)  $x = \pm \sqrt{\frac{wst}{r}}$

f)  $x = \pm \sqrt{\frac{wr}{p+q}}$

3. a)  $x = (rp)^2$  b)  $x = \left(\frac{mn}{p}\right)^2$  c)  $x = \frac{k}{g^2}$

d)  $x = \frac{r^2 g}{4\pi^2}$  e)  $x = \frac{4m^2 r}{p^2}$

f)  $x = \frac{4m^2 r}{p^2}$

### Exercise 11.13

page 113

1. a)  $t = \frac{v-u}{a}$  b)  $u = \pm \sqrt{v^2 - 2as}$

c)  $s = \frac{v^2 - u^2}{2a}$  d)  $u = \frac{s - \frac{1}{2}at^2}{t}$

e)  $a = \frac{2(s-ut)}{t^2}$  f)  $t = \pm \sqrt{\frac{2(s-ut)}{a}}$

2. a)  $r = \frac{A}{\pi\sqrt{s^2 + r^2}}$  b)  $h = \pm\sqrt{\left(\frac{A}{\pi r}\right)^2 - r^2}$

c)  $u = \frac{vf}{v-f}$  d)  $v = \frac{fu}{u-f}$

e)  $l = \left(\frac{t}{2\pi}\right)^2 g$  f)  $g = l\left(\frac{2\pi}{t}\right)^2$

3. a)  $x = \pm\sqrt{\frac{7(p+2)}{3t}}$  b)  $a = \pm\sqrt{4 + (b-3)^2}$

### Exercise 11.14

page 113

1. a)  $0.53 \text{ m}^3$  (2 d.p.) b)  $r = \sqrt{\frac{V}{\pi h}}$   
c) 5.05 cm

2. a)  $66^\circ\text{C}$  (2 s.f.) b)  $-11^\circ\text{C}$  (2 s.f.)  
c)  $F = \frac{9C}{5} + 32$  d)  $320^\circ\text{F}$

3. a) 15 hours b)  $H = 1200(T - k)$   
c) 5000 m

4. a)  $524 \text{ cm}^3$  (3 s.f.) b)  $r = \sqrt[3]{\frac{3V}{4\pi}}$   
c)  $r = 8.42 \text{ m}$  (3 s.f.)

5. a) \$251.50 b)  $n = \frac{x - 1.5}{0.05}$   
c)  $n = 470$

### Exercise 11.15

page 114

1. a)  $\frac{xp}{yq}$  b)  $\frac{q}{y}$  c)  $\frac{p}{r}$   
d)  $\frac{d}{c}$  e)  $\frac{bd}{c^2}$  f)  $p$

2. a)  $m^2$  b)  $r^5$  c)  $x^6$   
d)  $xy^2$  e)  $abc^3$  f)  $\frac{r^3}{pq}$

3. a)  $\frac{2x}{y}$  b)  $4q^2$  c)  $5n$   
d)  $3x^3y$  e)  $3p$  f)  $\frac{2}{3mn}$

4. a)  $\frac{2a}{3b}$  b)  $\frac{2y}{x}$  c) 2  
d)  $3xy$  e) 3 f)  $6xy$

5. a)  $\frac{8y}{3}$  b)  $\frac{5p}{2}$  c)  $\frac{p^3}{s}$   
d)  $\frac{ef}{c^2}$

6. a)  $\frac{20x}{3}$  b)  $\frac{9b}{8}$

### Exercise 11.16

page 115

1. a)  $\frac{4}{7}$  b)  $\frac{a+b}{7}$  c)  $\frac{11}{13}$   
d)  $\frac{c+d}{13}$  e)  $\frac{x+y+z}{3}$  f)  $\frac{p^2+q^2}{5}$

2. a)  $\frac{3}{11}$  b)  $\frac{c-d}{11}$  c)  $\frac{4}{a}$   
d)  $\frac{2a-5b}{3}$  e)  $\frac{2x-3y}{7}$  f)  $-\frac{1}{2x}$

3. a)  $\frac{1}{2}$  b)  $\frac{3}{2a}$  c)  $\frac{5}{3c}$   
d)  $\frac{7}{2x}$  e)  $\frac{3}{2p}$  f)  $-\frac{1}{2w}$

4. a)  $\frac{3p-q}{12}$  b)  $\frac{x-2y}{4}$  c)  $\frac{3m-n}{9}$   
d)  $\frac{x-2y}{12}$  e)  $\frac{5r+m}{10}$  f)  $\frac{5s-t}{15}$

5. a)  $\frac{7x}{12}$  b)  $\frac{9x-2y}{15}$  c)  $\frac{m}{2}$   
d)  $\frac{m}{p}$  e)  $\frac{x}{2y}$  f)  $\frac{4r}{7s}$

### Exercise 11.17

page 116

1. a)  $\frac{3a+2b}{6}$  b)  $\frac{5a+3b}{15}$  c)  $\frac{7p+4q}{28}$   
d)  $\frac{6a+5b}{15}$  e)  $\frac{9x+20y}{36}$  f)  $\frac{10x+14y}{35}$

2. a)  $\frac{a}{6}$  b)  $\frac{2a}{15}$  c)  $\frac{11p}{28}$   
d)  $\frac{11a}{15}$  e)  $\frac{29x}{36}$  f)  $\frac{24x}{35}$

3. a)  $\frac{m}{10}$  b)  $\frac{r}{10}$  c)  $-\frac{x}{4}$   
d)  $\frac{29x}{28}$  e)  $\frac{23x}{6}$  f)  $\frac{p}{6}$

4. a)  $\frac{p}{2}$  b)  $\frac{2c}{3}$  c)  $\frac{4x}{5}$   
d)  $\frac{m}{3}$  e)  $\frac{q}{5}$  f)  $\frac{w}{4}$

5. a)  $\frac{3m}{2}$  b)  $\frac{7m}{3}$  c)  $-\frac{m}{2}$   
d)  $\frac{5m}{2}$  e)  $\frac{p}{3}$  f)  $\frac{36q}{7}$

6. a)  $\frac{pr - p}{r}$  b)  $\frac{x + xy}{y}$  c)  $\frac{mn + m}{n}$   
 d)  $\frac{a + ab}{b}$  e)  $\frac{2xy - x}{y}$  f)  $\frac{2pq - 3p}{q}$
7. a)  $\frac{5a + 12}{6}$  b)  $\frac{11b - 20}{15}$   
 c)  $\frac{3c - 2}{4}$  d)  $\frac{25d - 54}{14}$

**Exercise 11.18** page 118

1. a)  $\frac{3x + 4}{(x + 2)(x + 1)}$  b)  $\frac{m - 7}{(m + 2)(m - 1)}$   
 c)  $\frac{3p - 7}{(p - 3)(p - 2)}$  d)  $\frac{w + 11}{(w - 1)(w + 3)}$   
 e)  $\frac{-12}{(y + 4)(y + 1)}$  f)  $\frac{12 - m}{(m - 2)(m + 3)}$
2. a)  $\frac{x}{x + 2}$  b)  $\frac{y}{y + 3}$  c)  $\frac{m + 2}{m - 3}$   
 d)  $\frac{p}{p - 5}$  e)  $\frac{m}{m + 4}$  f)  $\frac{m + 1}{m + 2}$
3. a)  $\frac{x}{x + 3}$  b)  $\frac{x}{x + 4}$  c)  $\frac{y}{y - 3}$   
 d)  $\frac{x}{x + 3}$  e)  $\frac{x}{x + 2}$  f)  $\frac{x}{x + 1}$
4. a)  $\frac{x}{x + 1}$  b)  $\frac{x}{x + 3}$  c)  $\frac{x}{x - 3}$   
 d)  $\frac{x}{x + 2}$  e)  $\frac{x}{x - 3}$  f)  $\frac{x}{x + 7}$

**Student assessment 1** page 119

1. a)  $10a - 30b + 15c$  b)  $15x^2 - 27x$   
 c)  $-15xy^2 - 5y^3$  d)  $15x^3y + 9x^2y^2 - 3x^5$   
 e)  $12 - p$  f)  $14m^2 - 14m$   
 g)  $4x + 3$  h)  $\frac{13}{2}m^2 - 3m$
2. a)  $4(3a - b)$  b)  $x(x - 4y)$   
 c)  $4p^2(2p - q)$  d)  $8xy(3 - 2x + y)$
3. a)  $-21$  b)  $26$  c)  $43$   
 d)  $7$  e)  $12$  f)  $12$
4. a)  $q = x - 3p$  b)  $n = \frac{3m - 8r}{5}$   
 c)  $y = \frac{2mt}{3}$  d)  $w = \frac{2y}{x} - y$   
 e)  $p = \frac{xyt}{2rs}$  f)  $x = w(m + n) - y$

**Student assessment 2** page 119

1. a)  $6x - 9y + 15z$  b)  $8pm - 28p$   
 c)  $-8m^2n + 4mn^2$  d)  $20p^3q - 8p^2q^2 - 8p^3$   
 e)  $-2x - 2$  f)  $22x^2 - 14x$   
 g)  $2$  h)  $\frac{5}{2}x^2 - x$
2. a)  $8(2p - q)$  b)  $p(p - 6q)$   
 c)  $5pq(p - 2q)$  d)  $3pq(3 - 2p + 4q)$
3. a)  $0$  b)  $-7$  c)  $29$   
 d)  $7$  e)  $7$  f)  $35$
4. a)  $n = p - 4m$  b)  $y = \frac{4x - 5z}{3}$   
 c)  $y = \frac{10px}{3}$  d)  $y = \frac{3w}{m} - x$   
 e)  $r = \frac{pqt}{4mn}$  f)  $q = r(m - n) - p$

**Student assessment 3** page 120

1. a)  $(m - 5n)(x - 5)$   
 b)  $(2x - 9y)(2x + 9y)$   
 c)  $7600$   
 d)  $(x^2 - y^2)(x^2 + y^2) = (x - y)(x + y)(x^2 + y^2)$
2. a)  $x^2 + 8x + 15$  b)  $x^2 - 14x + 49$   
 c)  $x^2 + 10x + 25$  d)  $x^2 - 5x - 14$   
 e)  $6x^2 + 13x - 8$  f)  $25y^2 - 70y + 49$
3. a)  $(x - 16)(x - 2)$  b)  $(x + 4)(x - 6)$   
 c)  $(x - 6)(x - 3)$  d)  $(x - 1)^2$   
 e)  $(2x - 1)(x + 3)$  f)  $(3x - 2)^2$
4. a)  $a = \frac{v^2 - u^2}{2s}$  b)  $h = \pm\sqrt{p^2 - r^2}$   
 c)  $s = \pm\sqrt{\frac{rn}{m}}$  d)  $g = \frac{4\pi^2l}{t^2}$   
 e)  $x = \frac{7 - 2y}{2}$  f)  $x = \frac{5w}{3}$
5. a)  $b^2$  b)  $x^4$  c)  $\frac{4n^2}{m}$   
 d)  $\frac{p^3q}{r^2}$  e)  $\frac{5t^2}{6}$  f)  $\frac{2s^3}{3r}$
6. a)  $\frac{12m + 5n}{16}$  b)  $\frac{3m}{4y}$  c)  $\frac{5r}{12x}$   
 d)  $\frac{8x - 9y}{12}$  e)  $\frac{6r}{7}$  f)  $\frac{-5x - 2}{3}$
7. a)  $\frac{5m + 13}{(m + 2)(m + 3)}$  b)  $\frac{y + 3}{y - 3}$   
 c)  $\frac{x}{x + 7}$

**Student assessment 4** page 121

1. a)  $(q+r)(p-3r)$   
b)  $(1-t^2)(1+t^2) = (1-t)(1+t)(1+t^2)$   
c) 750 000 d) 50
2. a)  $x^2 - 2x - 8$  b)  $x^2 - 16x + 64$   
c)  $x^2 + 2xy + y^2$  d)  $x^2 - 121$   
e)  $6x^2 - 13x + 6$  f)  $9x^2 - 30x + 25$
3. a)  $(x-11)(x+7)$  b)  $(x-3)^2$   
c)  $(x-12)(x+12)$  d)  $3(x-2)(x+3)$   
e)  $(2x-3)(x+4)$  f)  $(2x-5)^2$
4. a)  $f = \pm\sqrt{\frac{p}{m}}$  b)  $t = \pm\sqrt{\frac{m}{5}}$   
c)  $p = \left(\frac{A}{\pi r}\right)^2 - q$  d)  $x = \frac{ty}{y-t}$   
e)  $p = 4q$  f)  $t = \frac{r(s-1)}{2+r}$
5. a)  $x^4$  b)  $nq$  c)  $y^3$   
d)  $\frac{4}{q}$  e)  $\frac{n^3}{2}$  f)  $\frac{21bc^2}{4}$
6. a)  $\frac{2m}{11}$  b)  $-\frac{3p}{16}$  c)  $\frac{3x}{4y}$   
d)  $\frac{6m+13n}{30p}$  e)  $\frac{14-y}{3}$  f)  $\frac{2y+3}{2}$
7. a)  $\frac{7x-23}{(x-5)(x-2)}$  b)  $\frac{a-b}{a+b}$   
c)  $\frac{1}{x+3}$

**Student assessment 5** page 122

1. a) 0.204 m<sup>3</sup> (3 s.f.) b)  $r = \sqrt{\frac{V}{\pi h}}$   
c)  $r = 5.40$  cm
2. a) 2410 cm<sup>2</sup> b)  $h = \frac{A}{2\pi r} - r$   
c) 10.9 cm
3. a) 5.39 cm (3 s.f.)  
b) 3.68 m (3 s.f.)  
c)  $x = \sqrt{d^2 - y^2 - z^2}$   
d) 0.713 m (3 s.f.)
4. a) 4.44 s (3 s.f.) b)  $l = \frac{T^2 g}{4\pi^2}$   
c) 2.28 m (3 s.f.)

**12 Algebraic indices****Exercise 12.1** page 123

1. a)  $c^8$  b)  $m^2$  c)  $b^9$   
d)  $m^3 n^6$  e)  $2a^4 b$  f)  $3x^3 y^2$   
g)  $\frac{uv^3}{2}$  h)  $\frac{x^2 y^3 z^2}{3}$
2. a)  $12a^5$  b)  $8a^5 b^3$  c)  $8p^6$   
d)  $16m^4 n^6$  e)  $200p^{13}$  f)  $32m^5 n^{11}$   
g)  $24xy^3$  h)  $ab^{(d+e)}$

**Exercise 12.2** page 124

1. a)  $c^3$  b)  $g$   
c)  $q^{-2}$  d)  $m^{-1}$  or  $\frac{1}{m}$
2. a)  $a^2$  b)  $\frac{r^6}{p^6}$  or  $\frac{p^6}{r^6}$   
c)  $t^{16}$  d)  $m^9$

**Exercise 12.3** page 125

1. a)  $a^{\frac{3}{5}}$  b)  $a^{\frac{1}{3}}$  c)  $a$  d)  $a^{\frac{3}{7}}$
2. a)  $(\sqrt[7]{b})^2$  b)  $(\sqrt[3]{b})^8$  c)  $(\sqrt[5]{b})^{-2}$  d)  $(\sqrt[3]{b})^{-4}$
3. a)  $a^{\frac{3}{4}}$  b)  $a^{\frac{3}{20}}$  c)  $a^{\frac{5}{2}}$  d)  $a^{-\frac{1}{6}}$
4. a)  $(\sqrt[20]{b})^{19}$  b)  $(\sqrt[5]{b})^{-7}$  c)  $(\sqrt[3]{b})^{14}$  d)  $(\sqrt[6]{b})^{-11}$
5. a)  $\frac{x^{\frac{5}{2}}}{12}$  b)  $2y^{-\frac{1}{3}}$  c)  $4p^{-\frac{5}{2}}$  d)  $\frac{9}{2x^{\frac{1}{3}}}$

**Student assessment 1** page 126

1. a)  $a^3 b^2$  b)  $d^2 e^5$
2. a)  $m \times m \times m$  b)  $r \times r \times r \times r$
3. a)  $a^7$  b)  $p^5 \times q^9$  c)  $b^3$  d)  $e^6$
4. a)  $r^4$  b)  $\frac{1}{b^2}$  or  $b^{-2}$  c)  $\frac{1}{n^{-3}}$  or  $n^3$
5. a)  $p^{-9}$  b)  $h^7$

**Student assessment 2** page 126

1. a)  $a^{\frac{7}{8}}$  b)  $a^{-\frac{2}{5}}$
2. a)  $(\sqrt[9]{b^4})$  b)  $(\sqrt[3]{b^{-2}})$
3. a)  $a^{\frac{11}{6}}$  b)  $a^{\frac{19}{6}}$
4. a)  $(\sqrt[15]{t})^3$  b)  $(\sqrt[15]{t})^{-19}$

## 13 Equations and inequalities

### Exercise 13.1 page 127

- |                          |              |               |
|--------------------------|--------------|---------------|
| 1. a) $x = -4$           | b) $y = 5$   | c) $y = -5$   |
| d) $p = -4$              | e) $y = 8$   | f) $x = -5.5$ |
| 2. a) $x = 4\frac{1}{3}$ | b) $x = 5$   | c) $x = 6$    |
| d) $y = -8$              | e) $y = 4$   | f) $m = 10$   |
| 3. a) $m = 1$            | b) $p = 3$   | c) $k = -1$   |
| d) $x = -21$             | e) $x = 2$   | f) $y = 3$    |
| 4. a) $x = 6$            | b) $y = 14$  | c) $x = 4$    |
| d) $m = 12$              | e) $x = 35$  | f) $p = 20$   |
| 5. a) $x = 15$           | b) $x = -5$  | c) $x = 7.5$  |
| d) $x = 8$               | e) $x = 2.5$ | f) $x = 10$   |
| 6. a) $x = 5$            | b) $x = 14$  | c) $x = 22$   |
| d) $x = 5$               | e) $x = 8$   | f) $x = 2$    |
| 7. a) $y = 10$           | b) $x = 17$  | c) $x = 13$   |
| d) $y = -5$              | e) $x = 4$   | f) $x = 6.5$  |

### Exercise 13.2 page 129

- |   |              |
|---|--------------|
| 1. a) i) $3x + 60 = 180$                        | ii) $x = 40$ |
| iii) $40^\circ, 60^\circ, 80^\circ$             |              |
| b) i) $3x = 180$                                | ii) $x = 60$ |
| iii) $20^\circ, 80^\circ, 80^\circ$             |              |
| c) i) $18x = 180$                               | ii) $x = 10$ |
| iii) $20^\circ, 50^\circ, 110^\circ$            |              |
| d) i) $6x = 180$                                | ii) $x = 30$ |
| iii) $30^\circ, 60^\circ, 90^\circ$             |              |
| e) i) $7x - 30 = 180$                           | ii) $x = 30$ |
| iii) $10^\circ, 40^\circ, 130^\circ$            |              |
| f) i) $9x - 45 = 180$                           | ii) $x = 25$ |
| iii) $25^\circ, 55^\circ, 100^\circ$            |              |
| 2. a) i) $12x = 360$                            | ii) $x = 30$ |
| iii) $90^\circ, 120^\circ, 150^\circ$           |              |
| b) i) $11x + 30 = 360$                          | ii) $x = 30$ |
| iii) $90^\circ, 135^\circ, 135^\circ$           |              |
| c) i) $12x + 60 = 360$                          | ii) $x = 25$ |
| iii) $35^\circ, 80^\circ, 90^\circ, 155^\circ$  |              |
| d) i) $10x + 30 = 360$                          | ii) $x = 33$ |
| iii) $33^\circ, 94^\circ, 114^\circ, 119^\circ$ |              |
| 3. a) i) $11x - 80 = 360$                       | ii) $x = 40$ |
| iii) $40^\circ, 80^\circ, 80^\circ, 160^\circ$  |              |
| b) i) $10x + 60 = 360$                          | ii) $x = 30$ |
| iii) $45^\circ, 90^\circ, 95^\circ, 130^\circ$  |              |
| c) i) $16x + 8 = 360$                           | ii) $x = 22$ |
| iii) $44^\circ, 96^\circ, 100^\circ, 120^\circ$ |              |

- d) i)  $9x + 45 = 360$  ii)  $x = 35$   
 iii)  $35^\circ, 55^\circ, 120^\circ, 150^\circ$   
 e) i)  $6x + 18 = 180$  ii)  $x = 27$   
 iii)  $50^\circ, 50^\circ, 130^\circ, 130^\circ$

4. a) 20 b) 25 c) 14 d) 25  
 e) 31 f) 40  
 5. a) 50 b) 13 c) 40 d) 40  
 6. a) 5 b) 2 c) 7 d) 1.1  
 e) 25 f) 15

### Exercise 13.3 page 133

- |                |                    |                        |        |
|----------------|--------------------|------------------------|--------|
| 1. a) $x = 4$  | b) $x = 6$         | c) $x = 5$             |        |
| c) $x = 6$     | y = -1             | d) $x = 5$             |        |
| e) $x = 5$     | y = 2              | f) $x = 4$             |        |
| 2. a) $x = 3$  | y = 2              | b) $x = 7$             | y = 4  |
| c) $x = 1$     | y = 1              | d) $x = 1$             | y = 5  |
| e) $x = 1$     | y = 10             | f) $x = 8$             | y = 2  |
| 3. a) $x = 5$  | y = 4              | b) $x = 4$             | y = 3  |
| c) $x = 10$    | y = 5              | d) $x = 6$             | y = 4  |
| e) $x = 4$     | y = 4              | f) $x = 10$            | y = -2 |
| 4. a) $x = 5$  | y = 4              | b) $x = 4$             | y = 2  |
| c) $x = 5$     | y = 3              | d) $x = 5$             | y = -2 |
| e) $x = 1$     | y = 5              | f) $x = -3$            | y = -3 |
| 5. a) $x = -5$ | y = -2             | b) $x = -3$            | y = -4 |
| c) $x = 4$     | y = $3\frac{2}{3}$ | d) $x = 2$             | y = 7  |
| e) $x = 1$     | y = 1              | f) $x = 2$             | y = 9  |
| 6. a) $x = 2$  | y = 3              | b) $x = 5$             | y = 10 |
| c) $x = 4$     | y = 6              | d) $x = 4$             | y = 4  |
| e) $x = 5$     | y = 1              | f) $x = -3$            | y = -3 |
| 7. a) $x = 1$  | y = -1             | b) $x = 11\frac{2}{3}$ | y = 8  |
| c) $x = 4$     | y = 0              | d) $x = 3$             | y = 4  |
| e) $x = 2$     | y = 8              | f) $x = 1$             | y = 1  |

### Exercise 13.4 page 135

- |                      |                   |                      |                   |
|----------------------|-------------------|----------------------|-------------------|
| 1. a) $x = 2$        | y = 3             | b) $x = 1$           | y = 4             |
| c) $x = 5$           | y = 2             | d) $x = 3$           | y = 3             |
| e) $x = 4$           | y = 2             | f) $x = 6$           | y = 1             |
| 2. a) $x = 1$        | y = 4             | b) $x = 5$           | y = 2             |
| c) $x = 3$           | y = 3             | d) $x = 6$           | y = 1             |
| e) $x = 2$           | y = 3             | f) $x = 2$           | y = 3             |
| 3. a) $x = 0$        | y = 3             | b) $x = 5$           | y = 2             |
| c) $x = 1$           | y = 7             | d) $x = 6$           | y = 4             |
| e) $x = 2$           | y = 5             | f) $x = 3$           | y = 0             |
| 4. a) $x = 1$        | y = 0.5           | b) $x = 2.5$         | y = 4             |
| c) $x = \frac{1}{5}$ | y = 4             | d) $x = \frac{3}{4}$ | y = $\frac{1}{2}$ |
| e) $x = 5$           | y = $\frac{1}{3}$ | f) $x = \frac{1}{2}$ | y = 1             |

### **Exercise 13.5** page 135

1. 10 and 7
2. 16 and 9
3.  $x = 1$   $y = 4$
4.  $x = 5$   $y = 2$
5. 60 and 20 years old
6. 60 and 6 years old

### **Exercise 13.6** page 137

1. a) 7      b) 3      c) 6  
d) 7      e) 10      f) 15
2. a) 7      b) 6      c) 6  
d) 10      e) 3
3. a) 8      b) 5      c) 8  
d) 6      e) 6
4. a) 6, 18, 26  
b) 160, 214, 246, 246  
c)  $50^\circ, 80^\circ, 100^\circ, 140^\circ, 170^\circ$   
d)  $80^\circ, 80^\circ, 80^\circ, 160^\circ, 160^\circ, 160^\circ$   
e)  $150^\circ, 150^\circ, 150^\circ, 150^\circ, 120^\circ, 120^\circ, 120^\circ, 120^\circ, 120^\circ$

### **Exercise 13.7** page 139

1. a) -4 and -3      b) -2 and -6  
c) -1 and -12      d) 2 and 5  
e) 2 and 3      f) 2 and 4
2. a) -5 and 2      b) -2 and 5      c) -7 and 2  
d) -2 and 7      e) -5 and 3      f) -3 and 5
3. a) -3 and -2      b) -3      c) -8 and -3  
d) 4 and 6      e) -4 and 3      f) -2 and 6
4. a) -2 and 4      b) -4 and 5      c) -6 and 5  
d) -6 and 7      e) -7 and 9      f) -9 and 6

### **Exercise 13.8** page 139

1. a) -3 and 3      b) -4 and 4  
c) -5 and 5      d) -11 and 11  
e) -12 and 12      f) -15 and 15
2. a) -2.5 and 2.5      b) -2 and 2  
c) -1.6 and 1.6      d)  $-\frac{1}{2}$  and  $\frac{1}{2}$   
e)  $-\frac{1}{3}$  and  $\frac{1}{3}$       f)  $-\frac{1}{20}$  and  $\frac{1}{20}$
3. a) -4 and -1      b) -5 and -2  
c) -4 and -2      d) 2 and 4  
e) 2 and 5      f) -4 and 2
4. a) -2 and 5      b) -5 and 2      c) -3 and 6  
d) -6 and 3      e) -4 and 6      f) -6 and 8

5. a) -4 and 3      b) -6 and -2      c) -9 and 4  
d) -1      e) -2      f) -9 and -8
6. a) 0 and 8      b) 0 and 7      c) -3 and 0  
d) -4 and 0      e) 0 and 9      f) 0 and 4
7. a) -1.5 and -1      b) -1 and 2.5  
c) -1 and  $\frac{1}{3}$       d) -5 and  $-\frac{1}{2}$   
e) 1.5 and 5      f)  $-1\frac{1}{3}$  and  $\frac{1}{2}$
8. a) -12 and 0      b) -9 and -3      c) -8 and 4  
d) -7 and 2      e) -6 and 6      f) -10 and 10

### **Exercise 13.9** page 140

1. -4 and 3
2. -6 and 7
3. 2
4. 4
5. Height = 3 cm, base length = 12 cm
6. Height = 20 cm, base length = 2 cm
7. Base length = 6 cm, height = 5 cm
8. a)  $9x + 14 = 50$       b)  $x = 4$       c) 11 m  $\times$  6 m

### **Exercise 13.10** page 142

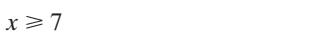
1. a) -3.14 and 4.14      b) -5.87 and 1.87  
c) -6.14 and 1.14      d) -4.73 and -1.27  
e) -6.89 and 1.89      f) 3.38 and 5.62
2. a) -5.30 and -1.70      b) -5.92 and 5.92  
c) -3.79 and 0.79      d) -1.14 and 6.14  
e) -4.77 and 3.77      f) -2.83 and 2.83
3. a) -0.73 and 2.73      b) -1.87 and 5.87  
c) -1.79 and 2.79      d) -3.83 and 1.83  
e) 0.38 and 2.62      f) 0.39 and 7.61
4. a) -0.85 and 2.35      b) -1.40 and 0.90  
c) 0.14 and 1.46      d) -2 and -0.5  
e) -0.39 and 1.72      f) -1.54 and 1.39

### **Exercise 13.11** page 144

1. a)  $x < 4$   

- b)  $x > 1$   

- c)  $x \leq 3$   

- d)  $x \geq 7$   


e)  $x < 2$



f)  $x > 2$



2. a)  $x < 7$



b)  $x \geq -2$



c)  $x > -3$



d)  $x \geq -12$



e)  $x > -24$



f)  $x \geq -3$



3. a)  $x < 2$



b)  $x \leq 12$



c)  $x \geq 2$



d)  $x \geq -2$



e)  $x > -0.5$



f)  $x \geq 2$

**Exercise 13.12** page 144

1. a)  $2 < x \leq 4$



b)  $1 \leq x < 5$



c)  $3.5 \leq x < 5$



d)  $2 \leq x < 4.2$



2. a)  $1 < x \leq 5$



b)  $-1 \leq x < 1$



c)  $2 < x < 3$



d) No solution

**Student assessment 1** page 145

1. a) 9      b) 11      c) -4      d) 6  
 2. a) 1.5      b) 7      c) 4      d) 3  
 3. a) -10      b) 12      c) 10      d)  $11\frac{1}{4}$   
 4. a) 16      b)  $-8\frac{2}{3}$       c) 2      d) 3.5  
 5. a)  $x = 5$   $y = 2$       b)  $x = 3\frac{1}{3}$   $y = 4\frac{1}{3}$   
 c)  $x = 5$   $y = 4$       d)  $x = 5$   $y = 1$

**Student assessment 2** page 145

1. a) -6      b) 6      c) 4      d) 2.4  
 2. a) 0.5      b) 4      c) 9.5      d) 5  
 3. a) 6      b) 15      c) 22      d) 6  
 4. a) 8.5      b)  $4\frac{1}{3}$       c) 8.5      d) 12  
 5. a)  $x = 7$   $y = 4$       b)  $p = 1$   $q = 2$   
 c)  $x = 7$   $y = 1$       d)  $m = 3$   $n = 5$

**Student assessment 3** page 145

1. a)  $4x + 40 = 180$       b)  $x = 35$   
 c)  $35^\circ, 70^\circ, 75^\circ$   
 2. 9  
 3.  $30^\circ, 30^\circ, 30^\circ, 30^\circ, 30^\circ, 45^\circ, 45^\circ, 45^\circ, 45^\circ$   
 4. -5 and -1  
 5. 7.16 and 0.838 (3 s.f.)  
 6.  $6 \leq x < 7$   
  
 7. None

**Student assessment 4** page 146

1. a)  $9x - 90 = 360$  b)  $x = 50$   
c)  $50^\circ, 60^\circ, 100^\circ, 150^\circ$

2. 2

3.  $135^\circ, 85^\circ, 95^\circ, 95^\circ, 130^\circ$

4. -4 and 5

5. 2.77 and -1.27 (3 s.f.)

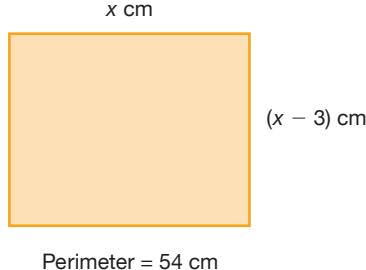
6.  $3 < x \leq 5$



7. All values other than 0

**Student assessment 5** page 147

1. a)



$$\text{Perimeter} = 54 \text{ cm}$$

b)  $4x - 6 = 54$

c) Length = 15 cm Width = 12 cm

2. a)  $x, x - 8, x - 23$

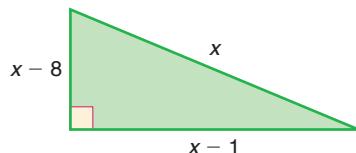
b)  $3x - 31 = 134; 55, 47, 32$

3. b) -0.317 and 6.32 (3 s.f.)

4. a)  $x - y = 18$   $x + y + 70 + 40 = 360$

b)  $x = 134$   $y = 116$

5. a)



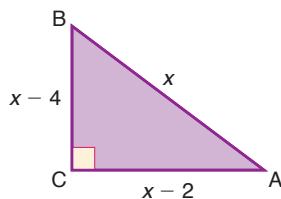
c) 5 cm, 12 cm, 13 cm

**Student assessment 6** page 148

1. a)  $x - y = 30$   $x + y + 40 = 180$   
b)  $x = 85$   $y = 55$
2. b)  $5x + 100$  e)  $92^\circ$   
e)  $92^\circ + 82^\circ + 72^\circ + 62^\circ + 52^\circ = 360^\circ$
3. b)  $120 - 4x^2$   
c)  $4x^2 - 64 = 0$   $x = 4$

4. b) 0.44 and 4.56 (2 d.p.)

5. a)



c) 10 cm, 8 cm, 6 cm

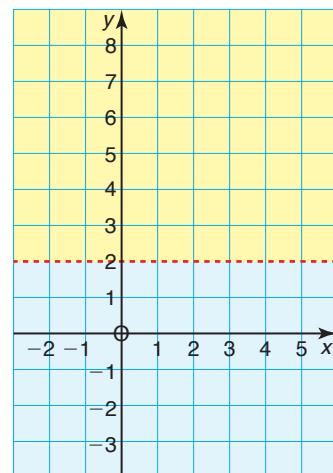
## 14 Linear programming

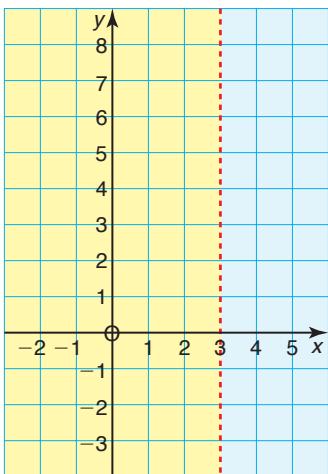
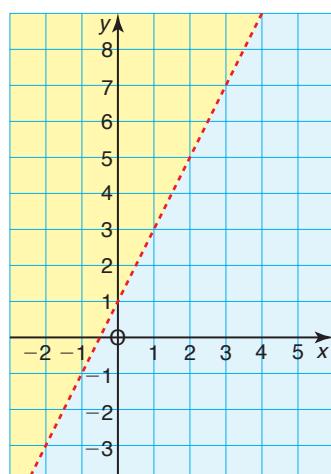
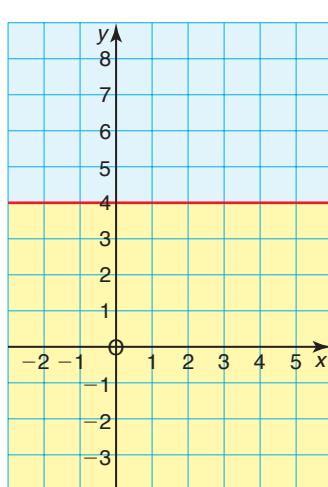
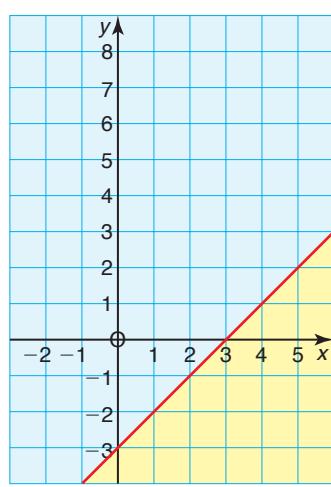
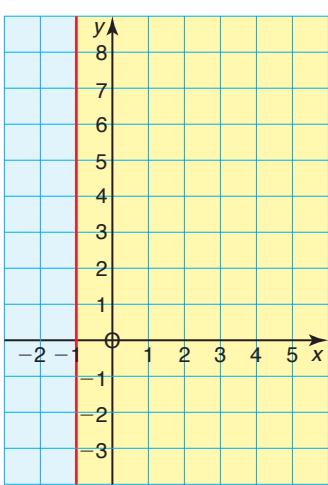
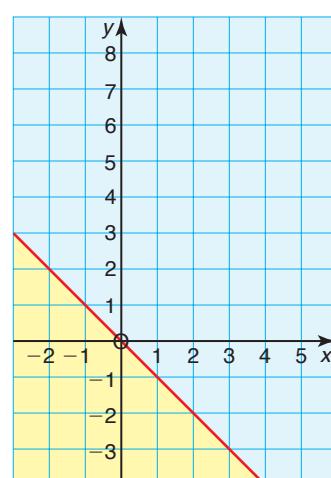
**Exercise 14.1** page 149

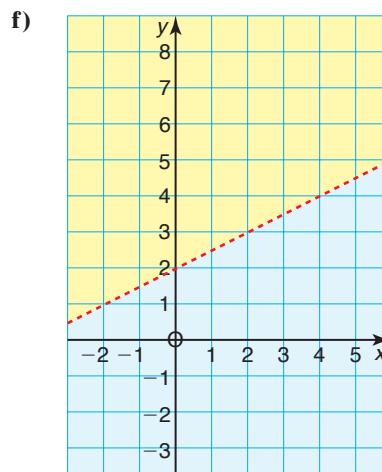
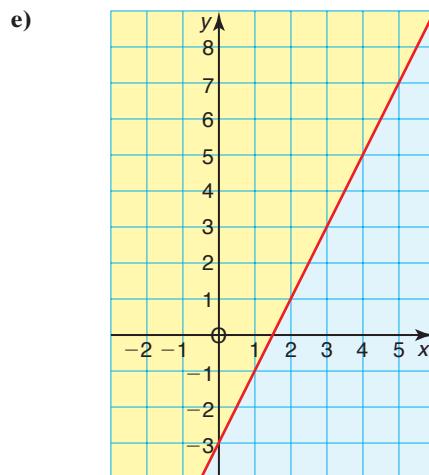
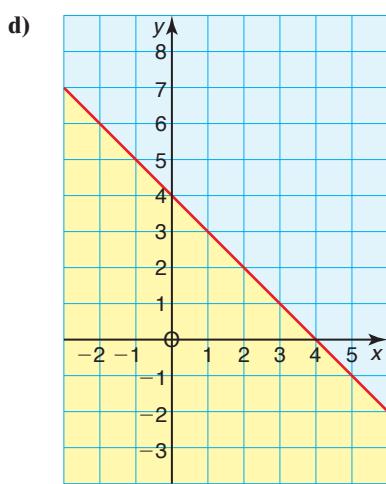
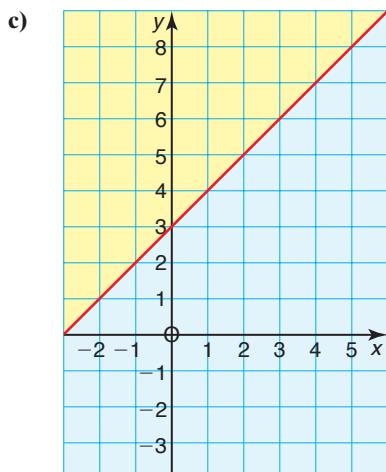
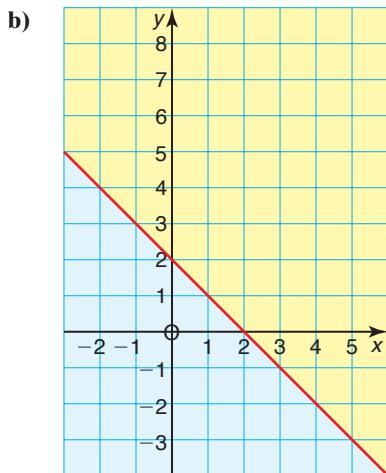
1. a)  $x < 2$  b)  $y \geq 2$  c)  $x \leq -2$   
d)  $y \leq 6$  e)  $t > 0$  f)  $p \leq -3$
2. a)  $2 < y \leq 4$  b)  $1 \leq p < 5$   
c)  $5 \leq m < 7$  d)  $3 < x < 4$

**Exercise 14.2** page 150

1. a)

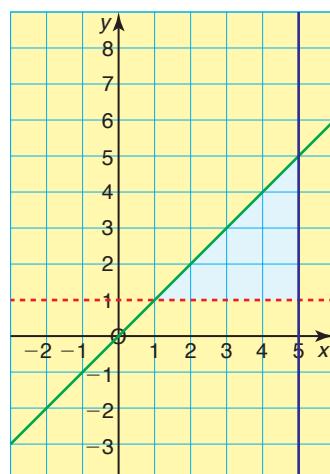


**b)****e)****c)****f)****d)****2. a)**

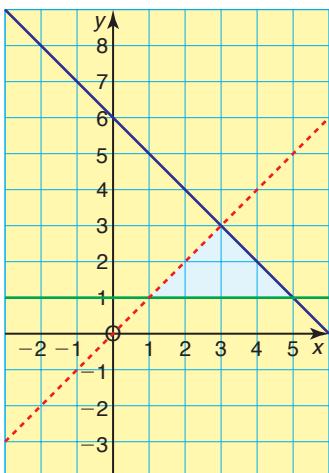


**Exercise 14.3** page 152

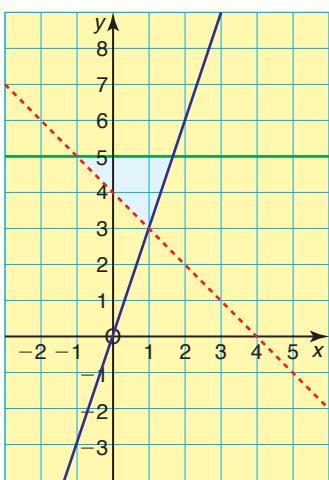
1.



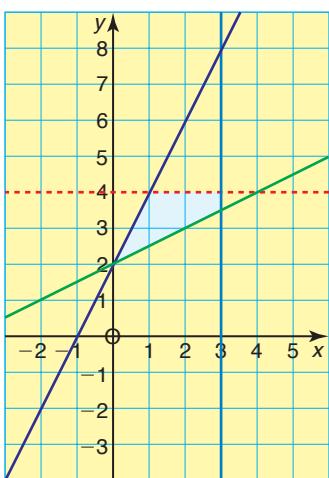
2.



3.



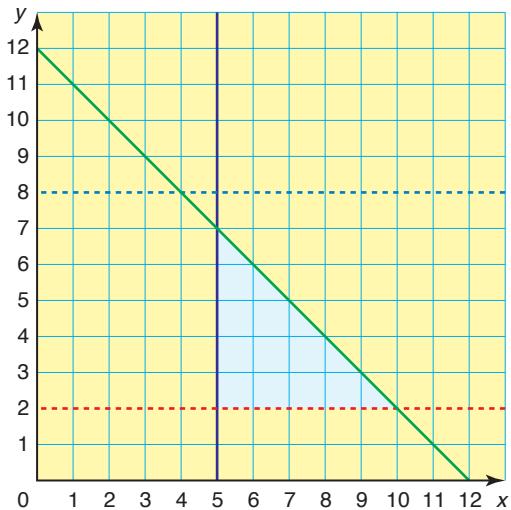
4.



### Exercise 14.4

1. a)  $x \geq 5$     $2 < y < 8$     $x + y \leq 12$

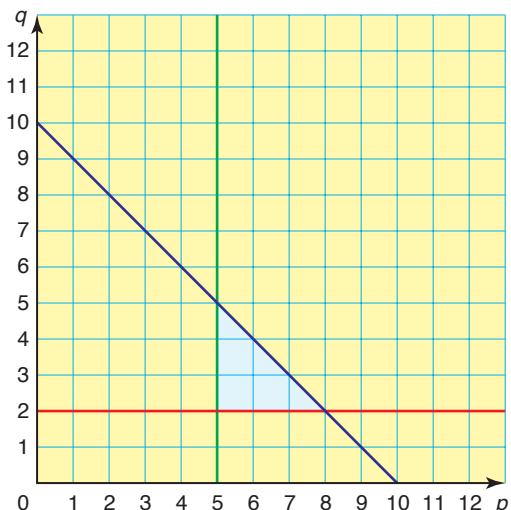
b)



- c) Any integer point in the unshaded region,  
e.g. (5, 3) meaning 5 car trips and 3 minibus  
trips

2. a)  $p \geq 5$     $q \geq 2$     $p + q \leq 10$

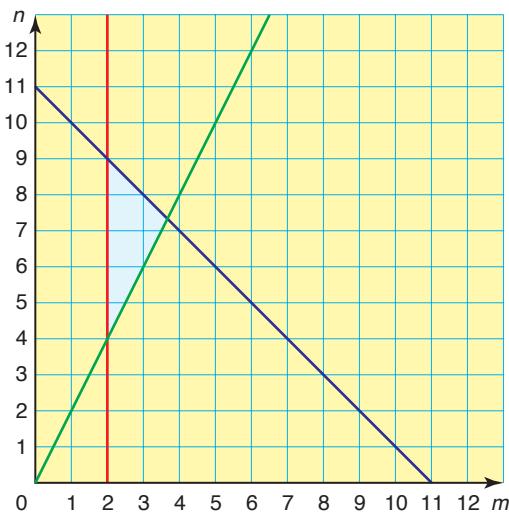
b)



- c) Any integer point in the unshaded region,  
e.g. (5, 2) meaning 5 loaves and 2 cakes

3. a)  $m \geq 2$   $n \geq 2m$   $m + n \leq 11$

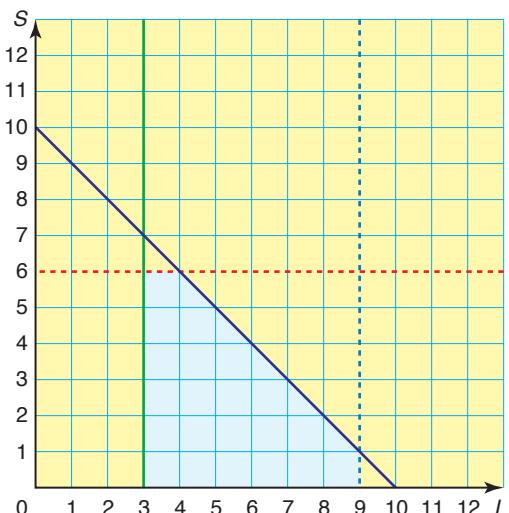
b)



c) Any integer point in the unshaded region, e.g. (2, 4) meaning 2 long curtains and 4 short ones

4. a)  $3 \leq L < 9$   $S < 6$   $L + S \leq 10$

b)



c) Any of the points in the unshaded region, e.g. (3, 0) meaning 3 large oranges and no small ones.

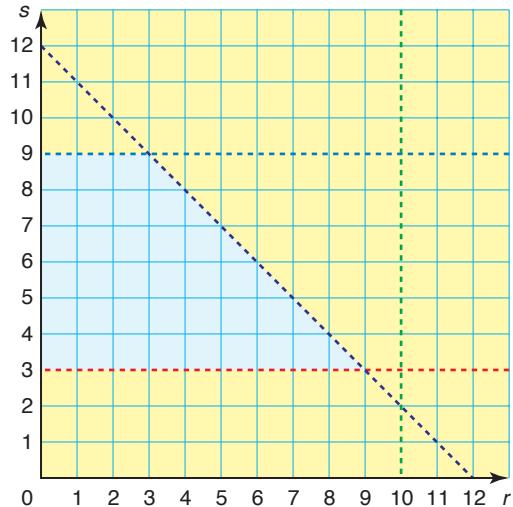
### **Student assessment 1** page 153

1. a)  $x \leq 5$  b)  $y \leq 3$

2. a)  $2 < y \leq 4$  b)  $4 < p \leq 8$

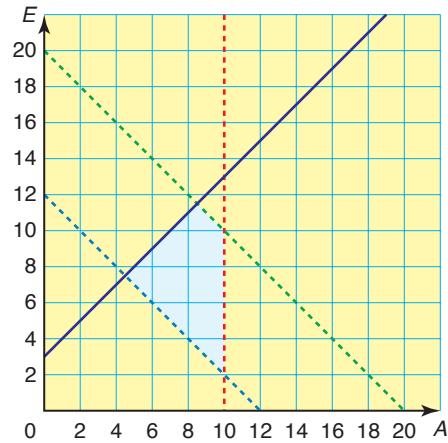
3. a)  $r < 10$   $3 < s < 9$   $s + r < 12$

b)



c) Student's own answer

4. a)  $12 < A + E < 20$   $A < 10$   $E \leq A + 3$   
b)



c) Student's own answers

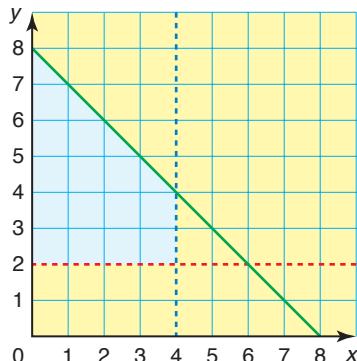
### **Student assessment 2** page 154

1. a)  $x \leq 7$  b)  $y \leq 9$

2. a)  $1 \leq p < 4$  b)  $4 < x \leq 7$

3. a)  $x < 4$     $y > 2$     $x + y \leqslant 8$

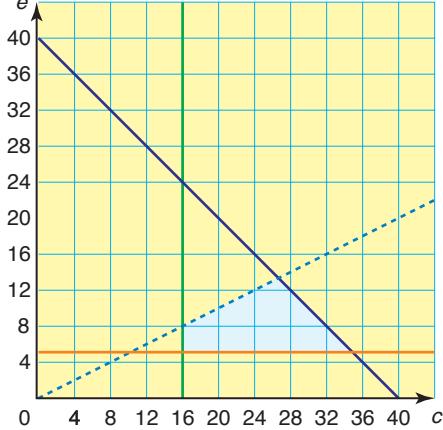
b)



c) Student's own answers

4. a)  $c + e \leqslant 40$     $c \geqslant 16$     $e \geqslant 5$     $c > 2e$

b)



c) Student's own answers

## 15 Sequences

### Exercise 15.1 page 157

1. a) i)  $3n + 2$       b) i)  $4n - 4$   
 ii) 32                      ii) 36  
 c) i)  $n - 0.5$       d) i)  $-3n + 9$   
 ii) 9.5                      ii) -21  
 e) i)  $3n - 10$       f) i)  $-4n - 5$   
 ii) 20                      ii) -45

2. a)

| Position | 1 | 2 | 5  | 12 | 50  | $n$      |
|----------|---|---|----|----|-----|----------|
| Term     | 1 | 5 | 17 | 45 | 197 | $4n - 3$ |

b)

| Position | 1 | 2  | 5  | 10 | 75  | $n$      |
|----------|---|----|----|----|-----|----------|
| Term     | 5 | 11 | 29 | 59 | 449 | $6n - 1$ |

c)

| Position | 1 | 3 | 8  | 50  | 100 | $n$      |
|----------|---|---|----|-----|-----|----------|
| Term     | 2 | 0 | -5 | -47 | -97 | $-n + 3$ |

d)

| Position | 1 | 2 | 3  | 10  | 100  | $n$       |
|----------|---|---|----|-----|------|-----------|
| Term     | 3 | 0 | -3 | -24 | -294 | $-3n + 6$ |

e)

| Position | 2 | 5  | 7  | 10 | 50  | $n$      |
|----------|---|----|----|----|-----|----------|
| Term     | 1 | 10 | 16 | 25 | 145 | $3n - 5$ |

f)

| Position | 1    | 2  | 5     | 20  | 50  | $n$         |
|----------|------|----|-------|-----|-----|-------------|
| Term     | -5.5 | -7 | -11.5 | -34 | -79 | $-1.5n - 4$ |

3. a) i) +4

b) i) +1

ii)  $4n + 1$

ii)  $n - 1$

iii) 201

iii) 49

c) i) +3

d) i) +0.5

ii)  $3n - 13$

ii)  $0.5n + 5.5$

iii) 137

iii) 30.5

e) i) +4

f) i) -3

ii)  $4n - 62$

ii)  $-3n + 75$

iii) 138

iii) -75

### Exercise 15.2 page 161

1.  $u_n = n^2 + 1$

2.  $u_n = n^2 - 1$

3.  $u_n = n^2 + 5$

4.  $u_n = n^2 + 8$

5.  $u_n = n^2 - 3$

6.  $u_n = 2n^2 + 2$

7.  $u_n = 2n^2 - 2$

8.  $u_n = 3n^2 + 2$

9.  $u_n = 4n^2 - 4$

10.  $u_n = 5n^2 - 4$

### **Exercise 15.3** page 161

1.  $u_n = n^3 + 10$
2.  $u_n = n^3 - n$
3.  $u_n = n^3 - 5$
4.  $u_n = n^3 + n^2$
5.  $u_n = n^3 + n^2 + 5n$
6.  $u_n = n^3 + 3n^2 + 5n - 2$
7.  $u_n = n^3 + n^2 - n$
8.  $u_n = n^3 + 5n + 7$

### **Exercise 15.4** page 164

1. a) Geometric      b) Geometric  
c) Not geometric      d) Geometric  
e) Not geometric      f) Not geometric
2. a) i) 3              b) i)  $\frac{1}{5}$   
ii) 162, 486              ii)  $\frac{1}{25}, \frac{1}{125}$   
iii)  $u_n = 2(3)^{n-1}$       iii)  $u_n = 25\left(\frac{1}{5}\right)^{n-1}$   
d) i) -3              ii) -243, 729  
iii)  $u_n = (-3)^n$
3. a) -6, -12, -24      b) 8
4. a) -4              b)  $\frac{1}{4}$               c) -65536
5. \$38203.20
6. a) Because  $0.8^5 \neq 0$   
b) \$3276.80  
c) Because  $0.8^n \neq 0$  where  $n$  is the number of year

### **Student assessment 1** page 165

1. a) i) 45, 54      ii) Terms increasing by 9  
b) i) 30, 24      ii) Terms decreasing by 6  
c) i) 2.25, 1.125      ii) Terms halving  
d) i) -12, -18      ii) Terms decreasing by 6  
e) i) 27, 8      ii) Descending order of cube numbers  
f) i) 81, 243      ii) Terms multiplied by 3
2. a)  $4n + 2$       b)  $6n + 7$       c)  $6n - 3$   
d)  $n^2 + 3$       e)  $10n - 10$       f)  $n^3 - 1$
3. a) i)  $u_n = 4n - 3$   
ii) 37  
b) i)  $u_n = -3n + 4$   
ii) -26

4. a)  $u_5 = 27, u_{100} = 597$

b)  $u_5 = \frac{3}{2}, u_{100} = -46$

5. a)

| Position | 1  | 2  | 3  | 10  | 25  | $n$        |
|----------|----|----|----|-----|-----|------------|
| Term     | 17 | 14 | 11 | -10 | -55 | $-3n + 20$ |

b)

| Position | 2  | 6  | 10 | 80 | $n$                |
|----------|----|----|----|----|--------------------|
| Term     | -4 | -2 | 0  | 35 | $\frac{1}{2}n - 5$ |

### **Student assessment 2** page 166

1. a) \$515.46      b) 3 years
2. a) \$253.50      b) \$8.08
3. a)  $-\frac{1}{3}$       b) 243      c) 10
4.  $u_n = n^3 + 3n^2 + 4$
5.  $u_n = n^3 + n^2 + 3n + 5$

## 16 Variation

### **Exercise 16.1** page 170

1. a) 3      b) 21      c) 27      d) 3      e) 10
2. a) 0.5      b) 8      c) 24.5      d) 8      e) 16
3. a) 24      b)  $\frac{3}{8}$       c)  $\frac{1}{9}$       d) 1
4. a) 0.25      b) 25      c) 4      d)  $\frac{1}{16}$

### **Exercise 16.2** page 170

1. a) i)  $y \propto x^3$       ii)  $y = kx^3$   
b) i)  $y \propto \frac{1}{x^3}$       ii)  $y = \frac{k}{x^3}$   
c) i)  $t \propto P$       ii)  $t = kP$   
d) i)  $s \propto \frac{1}{t}$       ii)  $s = \frac{k}{t}$   
e) i)  $A \propto r^2$       ii)  $A = kr^2$   
f) i)  $T \propto \frac{1}{\sqrt{g}}$       ii)  $T = \frac{k}{\sqrt{g}}$
2. 10.5
3. a)  $\frac{1}{2}$       b) 2
4. 32
5. a)  $\frac{1}{8}$       b) 0.4
6. 75

**Exercise 16.3** page 171

1. a)  $h = kt^2$       b) 5      c) 45 m  
     d) 6 s
2. a)  $v = k\sqrt{e}$       b) 3      c) 49 J
3. a)  $l = km^{\frac{1}{3}}$       b) 3      c)  $l = 6 \text{ cm}$
4. a)  $P = kI^2$       b) 5 amps

**Student assessment 1** page 172

1. a) 1.5      b) 15      c) 3      d) 12
2. a) 10      b) 2.5      c) 1      d) 20
3. a)  $\frac{1}{3}$       b) 72      c)  $\frac{1}{3}$       d) 12
4. a) 5      b)  $\frac{5}{4}$       c)  $\frac{1}{2}$       d) 1
5. a)  $\frac{1}{3}$       b)  $\frac{4}{3}$       c)  $\pm 2$       d)  $\pm 1$

**Student assessment 2** page 173

1. a)

|   |    |    |   |   |    |    |
|---|----|----|---|---|----|----|
| x | 1  | 2  | 4 | 8 | 16 | 32 |
| y | 32 | 16 | 8 | 4 | 2  | 1  |

b) 1.6

2. a)

|   |   |    |    |    |    |
|---|---|----|----|----|----|
| x | 1 | 2  | 4  | 5  | 10 |
| y | 5 | 10 | 20 | 25 | 50 |

b)

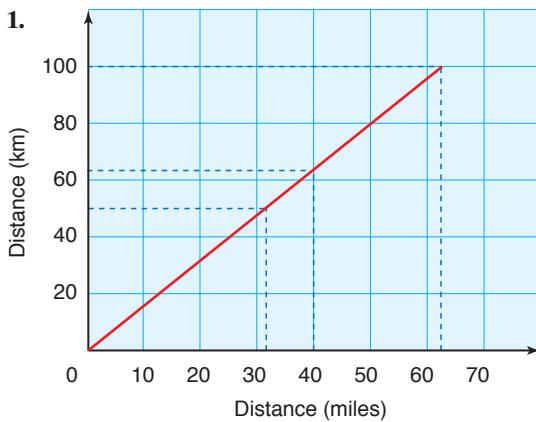
|   |    |    |   |   |    |
|---|----|----|---|---|----|
| x | 1  | 2  | 4 | 5 | 10 |
| y | 20 | 10 | 5 | 4 | 2  |

c)

|   |   |    |    |    |    |
|---|---|----|----|----|----|
| x | 4 | 16 | 25 | 36 | 64 |
| y | 4 | 8  | 10 | 12 | 16 |

3. a) 0.8      b) 0.8

4. a) 1.6 (1 d.p.)      b) 2

**17 Graphs in practical situations****Exercise 17.1** page 175

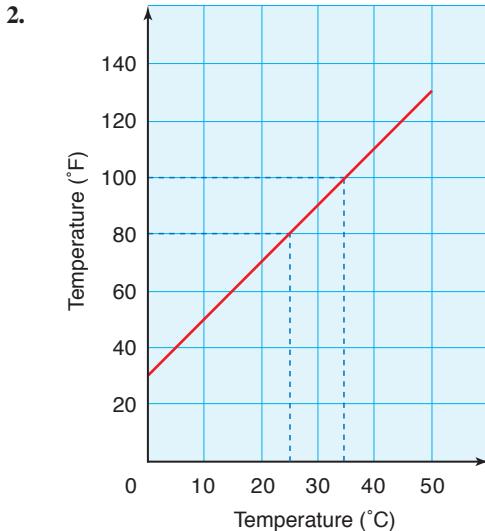
a) 50 km = 31 miles

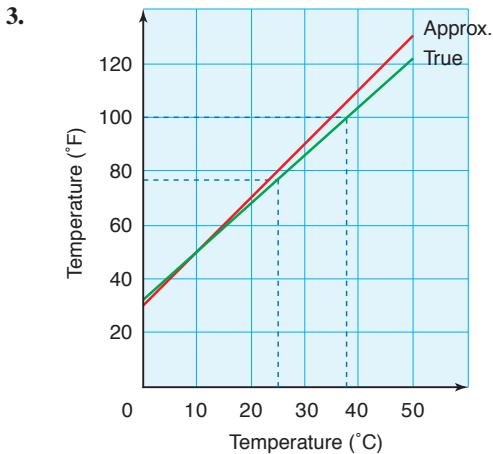
b) 40 miles = 64 km, therefore

80 miles = 128 km

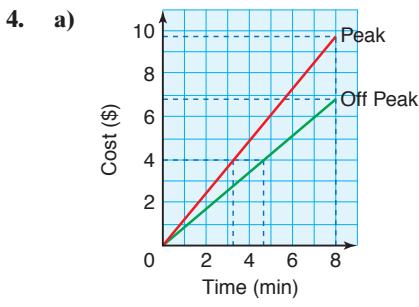
c) 100 km/h = 62 mph

d) 40 mph = 64 km/h

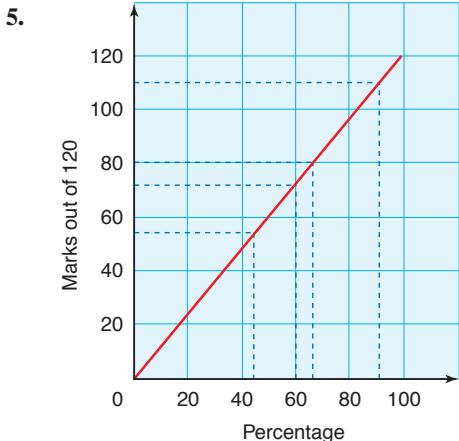
a)  $25^\circ\text{C} = 80^\circ\text{F}$ b)  $100^\circ\text{F} = 35^\circ\text{C}$ c)  $0^\circ\text{C} = 30^\circ\text{F}$ d)  $100^\circ\text{F} = 35^\circ\text{C}$ , therefore  $200^\circ\text{F} = 70^\circ\text{C}$



- i) a)  $25^{\circ}\text{C} = 77^{\circ}\text{F}$    b)  $100^{\circ}\text{F} = 38^{\circ}\text{C}$   
 c)  $0^{\circ}\text{C} = 32^{\circ}\text{F}$   
 d)  $100^{\circ}\text{F} = 38^{\circ}\text{C}$ , therefore  $200^{\circ}\text{F} = 76^{\circ}\text{C}$
- ii) The rough conversion is most useful at lower temperatures (i.e. between 0 and  $20^{\circ}\text{C}$ ).



- b)  $8 \text{ min} = \$6.80$    c)  $8 \text{ min} = \$9.60$   
 d) Extra time = 1 min 20 s

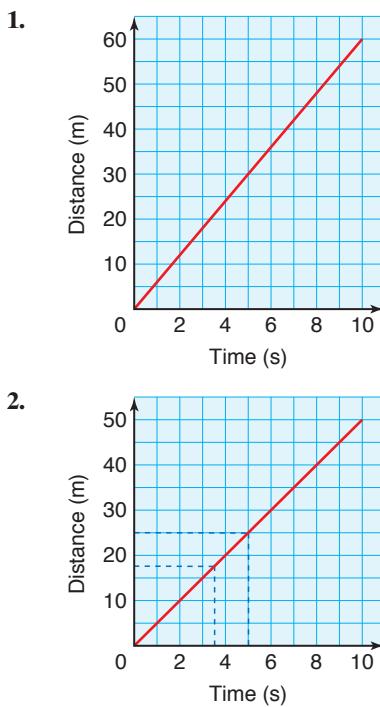


- a)  $80 = 67\%$    b)  $110 = 92\%$   
 c)  $54 = 45\%$    d)  $72 = 60\%$

### Exercise 17.2 page 176

1. a) 6 m/s   b) 4 m/s   c) 39 km/h  
 d) 20 km/h   e) 160 km/h   f) 50 km/h
2. a) 400 m   b) 182 m   c) 210 km  
 d) 255 km   e) 10 km   f) 79.2 km
3. a) 5 s   b) 50 s   c) 4 min  
 d) 1 min 11.4 s   e) 5 s   f) 4 min

### Exercise 17.3 page 176

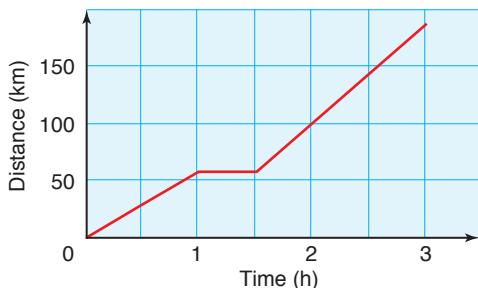


- a) 5 s   b) 17.5 m
3. a) Speed A = 40 m/s   Speed B =  $13\frac{1}{3}$  m/s  
 b) Distance apart =  $453\frac{1}{3}$  m
  4. a)  $\frac{2}{3}$  m/s   b) 6 m/s,  $\frac{2}{3}$  m/s   c) 1 m/s  
 d)  $\frac{1}{2}$  m   e)  $7\frac{1}{3}$  m

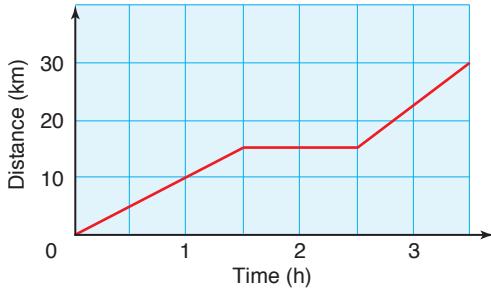
### Exercise 17.4 page 178

1. a) 45 km/h   b) 20 km/h
- c) Paul has arrived at the restaurant and is waiting for Helena.

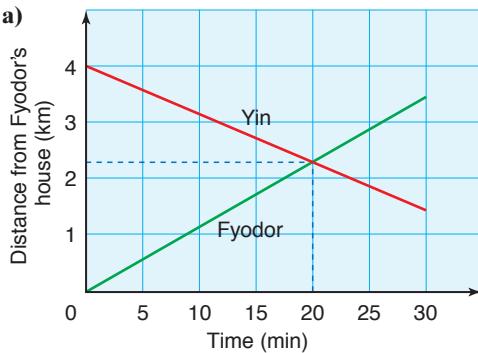
2.



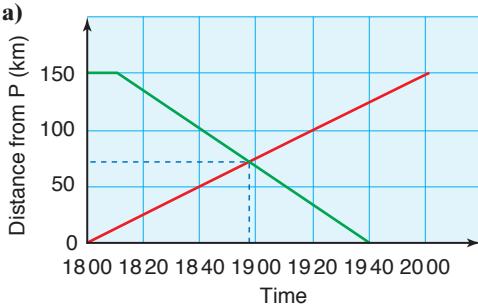
3.



4.

b) After 20 min    c) Distance =  $2\frac{1}{3}$  km

5.

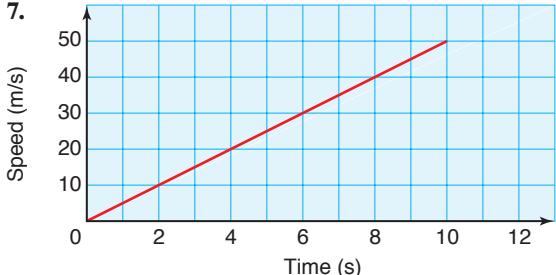
b) Time  $\approx 1857$   
c) Distance from Q  $\approx 79$  km  
d) The 1810 train from station Q arrives first.

6.

a) a:  $133\frac{1}{3}$  km/h    b: 0 km/h    c: 200 km/h  
b) d: 100 km/h    e: 200 km/h**Exercise 17.5** page 180

1. Acceleration is  $0.375 \text{ m/s}^2$
2. Acceleration is  $0.2 \text{ m/s}^2$
3. Acceleration is  $7 \text{ m/s}^2$
4. Acceleration is  $1.75 \text{ m/s}^2$
5. Deceleration is  $0.25 \text{ m/s}^2$
6. Deceleration is  $1 \text{ m/s}^2$

7.



8.

**Exercise 17.6** page 180

1. a)  $1.5 \text{ m/s}^2$     b)  $0 \text{ m/s}^2$     c)  $0.5 \text{ m/s}^2$
2. a) Cheetah    b)  $7.5 \text{ m/s}^2$     c)  $5 \text{ m/s}^2$   
d)  $15 \text{ m/s}^2$
3. a)  $0.5 \text{ m/s}^2$   
b)  $0.25 \text{ m/s}^2$   
c)  $0.104 \text{ m/s}^2$  (3 s.f.)  
d) Travelling at a constant speed of  $30 \text{ m/s}$   
e) Stationary

**Exercise 17.7** page 182

1. a)

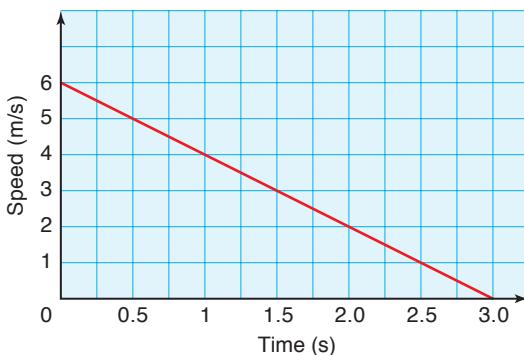


- b)  $0.5 \text{ m/s}^2$     c)  $75 \text{ m}$

2. a)

| Time (s)    | 0 | 0.5 | 1 | 1.5 | 2 | 2.5 | 3 |
|-------------|---|-----|---|-----|---|-----|---|
| Speed (m/s) | 6 | 5   | 4 | 3   | 2 | 1   | 0 |

b)



- c)  $9 \text{ m}$

3. a)  $1.5 \text{ m/s}^2$     b)  $2400 \text{ m}$     c)  $40 \text{ s}$

4. a)  $390 \text{ m}$     b)  $240 \text{ m}$

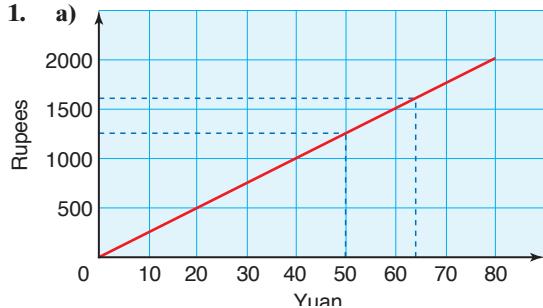
5.  $21.45 \text{ km}$

6.  $720 \text{ m}$

7. a)  $0.37 \text{ m/s}^2$     b)  $2.16 \text{ m/s}^2$     c)  $208 \text{ m}$   
d)  $204 \text{ m}$     e)  $4 \text{ m}$

**Student assessment I** page 184

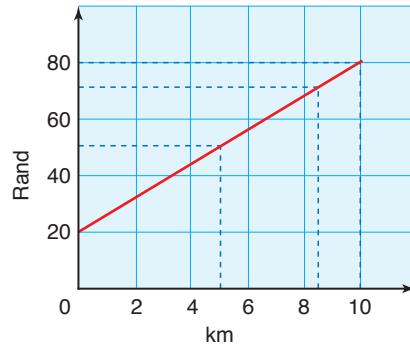
1. a)



- b)  $50 \text{ yuan} = 1250 \text{ rupees}$

- c)  $1600 \text{ rupees} = 64 \text{ yuan}$

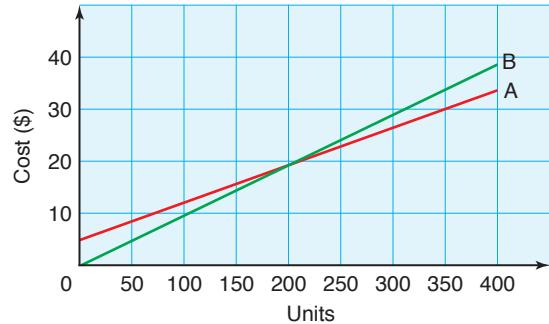
2. a)



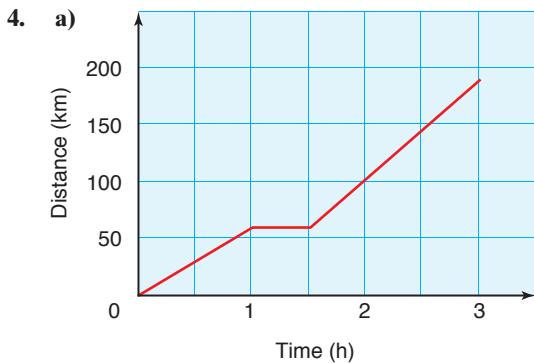
- i)  $5 \text{ km}: 50 \text{ rand}$     ii)  $8.5 \text{ km}: 71 \text{ rand}$

- b)  $80 \text{ rand}: 10 \text{ km}$

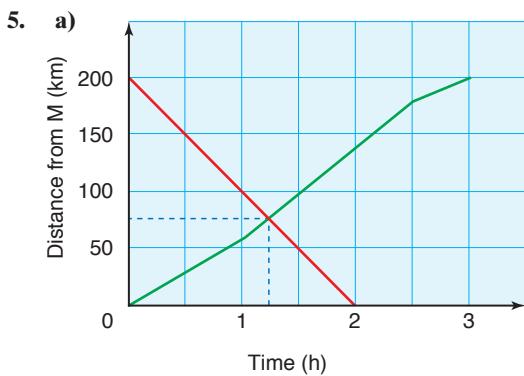
3. a)



- b) If the customer uses under  $200 \text{ units}/\text{quarter}$  then he or she should use account type B.



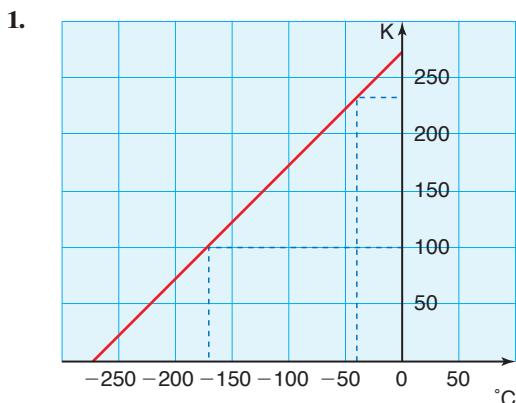
b) 180 km



b) Distance from M  $\approx$  77 km

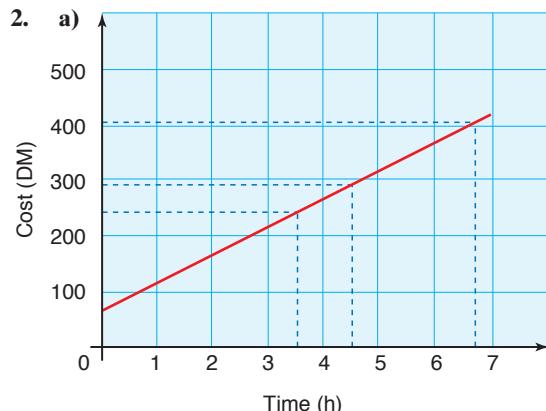
c) Time  $\approx$  1 h 13 min after start

### Student assessment 2 page 185



a)  $-40^{\circ}\text{C} = 233\text{ K}$

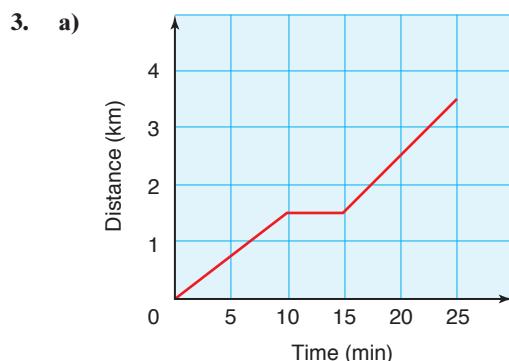
b)  $100\text{ K} = -173^{\circ}\text{C}$



b) \$295

c)  $\approx \$408$

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



b) 25 min

4. a) B, C

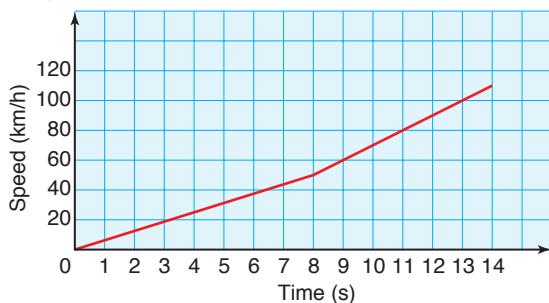
b) B because it illustrates going back in time,  
C because it illustrates infinite speed

### Student assessment 3 page 186

1. a)  $2\text{ m/s}^2$  b) 225 m c) 10.6 s (3 s.f.)

2. a)  $4\text{ m/s}^2$  b)  $3\text{ m/s}^2$  c) 102 m d) 9.83 s

3. a)



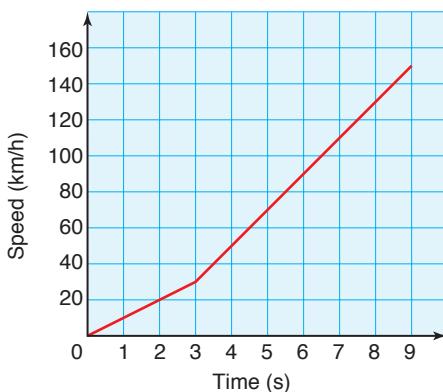
b)  $189 \text{ m}$  (3 s.f.)

4. a)  $1 \text{ m/s}^2$   
 b)  $750 \text{ m}$   
 c)  $1237.5 \text{ m}$

**Student assessment 4** page 187

1. a)  $2.5 \text{ m/s}^2$   
 b)  $180 \text{ m}$   
 c)  $3.5 \text{ s}$  (1 d.p.)
2. a)  $0.278 \text{ m/s}^2$  (3 s.f.)  
 b)  $93.8 \text{ m}$  (3 s.f.)  
 c)  $97.2 \text{ m}$  (3 s.f.)

3. a)



b)  $162.5 \text{ m}$

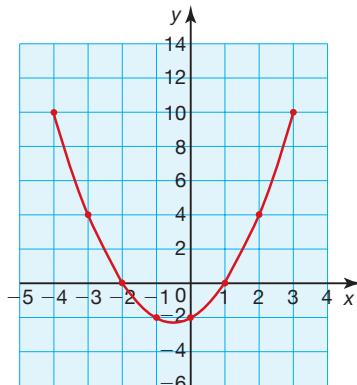
4. a)  $3.33 \text{ m/s}^2$  (3 s.f.)  
 b)  $240 \text{ m}$   
 c)  $212.5 \text{ m}$

## 18 Graphs of functions

**Exercise 18.1** page 190

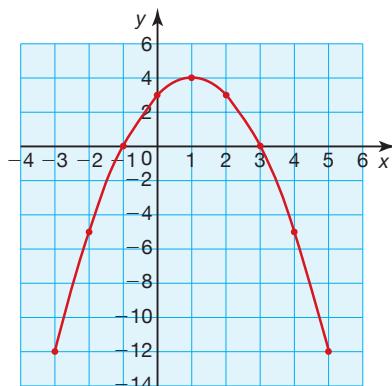
1.

|   |    |    |    |    |    |   |   |    |
|---|----|----|----|----|----|---|---|----|
| x | -4 | -3 | -2 | -1 | 0  | 1 | 2 | 3  |
| y | 10 | 4  | 0  | -2 | -2 | 0 | 4 | 10 |



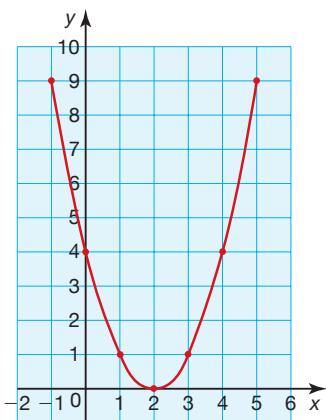
2.

|   |     |    |    |   |   |   |   |    |     |
|---|-----|----|----|---|---|---|---|----|-----|
| x | -3  | -2 | -1 | 0 | 1 | 2 | 3 | 4  | 5   |
| y | -12 | -5 | 0  | 3 | 4 | 3 | 0 | -5 | -12 |

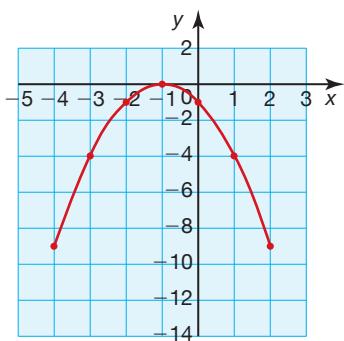


3.

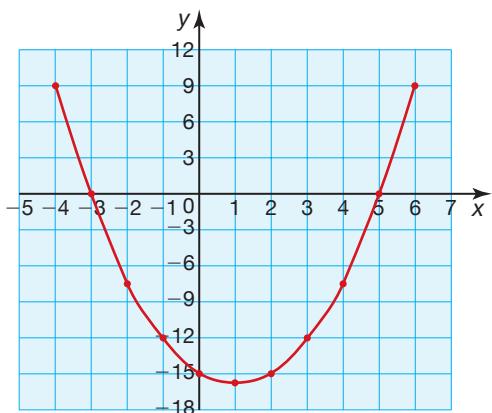
|   |    |   |   |   |   |   |   |
|---|----|---|---|---|---|---|---|
| x | -1 | 0 | 1 | 2 | 3 | 4 | 5 |
| y | 9  | 4 | 1 | 0 | 1 | 4 | 9 |



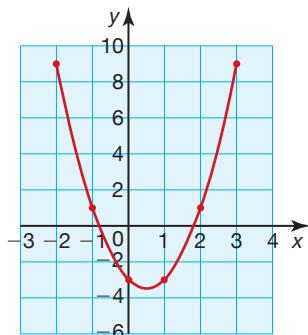
|           |   |     |    |    |    |    |    |   |   |     |    |    |    |   |    |    |    |
|-----------|---|-----|----|----|----|----|----|---|---|-----|----|----|----|---|----|----|----|
| <b>4.</b> | <table border="1"> <tr> <td><math>x</math></td><td>-4</td><td>-3</td><td>-2</td><td>-1</td><td>0</td><td>1</td><td>2</td></tr> <tr> <td><math>y</math></td><td>-9</td><td>-4</td><td>-1</td><td>0</td><td>-1</td><td>-4</td><td>-9</td></tr> </table> | $x$ | -4 | -3 | -2 | -1 | 0  | 1 | 2 | $y$ | -9 | -4 | -1 | 0 | -1 | -4 | -9 |
| $x$       | -4  | -3  | -2 | -1 | 0  | 1  | 2  |   |   |     |    |    |    |   |    |    |    |
| $y$       | -9  | -4  | -1 | 0  | -1 | -4 | -9 |   |   |     |    |    |    |   |    |    |    |

**5.**

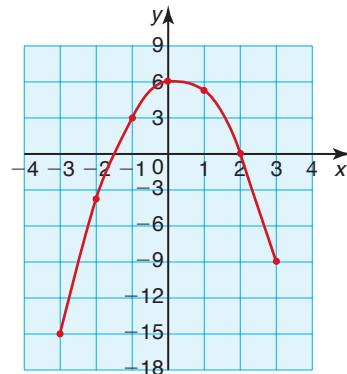
|     |    |    |    |     |     |     |     |     |    |   |   |
|-----|----|----|----|-----|-----|-----|-----|-----|----|---|---|
| $x$ | -4 | -3 | -2 | -1  | 0   | 1   | 2   | 3   | 4  | 5 | 6 |
| $y$ | 9  | 0  | -7 | -12 | -15 | -16 | -15 | -12 | -7 | 0 | 9 |



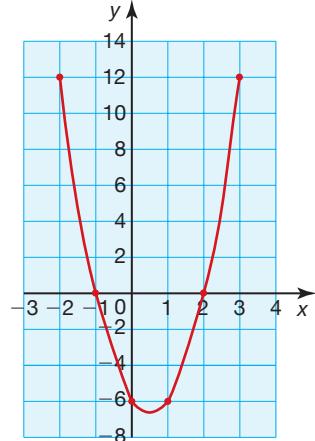
|           |   |     |    |    |   |   |   |   |     |   |   |    |    |   |   |
|-----------|---|-----|----|----|---|---|---|---|-----|---|---|----|----|---|---|
| <b>6.</b> | <table border="1"> <tr> <td><math>x</math></td><td>-2</td><td>-1</td><td>0</td><td>1</td><td>2</td><td>3</td></tr> <tr> <td><math>y</math></td><td>9</td><td>1</td><td>-3</td><td>-3</td><td>1</td><td>9</td></tr> </table> | $x$ | -2 | -1 | 0 | 1 | 2 | 3 | $y$ | 9 | 1 | -3 | -3 | 1 | 9 |
| $x$       | -2  | -1  | 0  | 1  | 2 | 3 |   |   |     |   |   |    |    |   |   |
| $y$       | 9   | 1   | -3 | -3 | 1 | 9 |   |   |     |   |   |    |    |   |   |



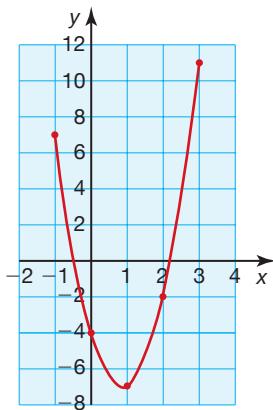
|           |  |     |    |    |    |   |    |   |   |     |     |    |   |   |   |   |    |
|-----------|--|-----|----|----|----|---|----|---|---|-----|-----|----|---|---|---|---|----|
| <b>7.</b> | <table border="1"> <tr> <td><math>x</math></td><td>-3</td><td>-2</td><td>-1</td><td>0</td><td>1</td><td>2</td><td>3</td></tr> <tr> <td><math>y</math></td><td>-15</td><td>-4</td><td>3</td><td>6</td><td>5</td><td>0</td><td>-9</td></tr> </table> | $x$ | -3 | -2 | -1 | 0 | 1  | 2 | 3 | $y$ | -15 | -4 | 3 | 6 | 5 | 0 | -9 |
| $x$       | -3   | -2  | -1 | 0  | 1  | 2 | 3  |   |   |     |     |    |   |   |   |   |    |
| $y$       | -15  | -4  | 3  | 6  | 5  | 0 | -9 |   |   |     |     |    |   |   |   |   |    |



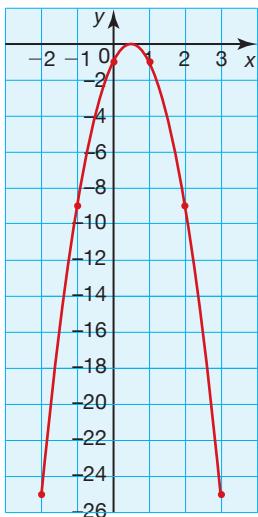
|           |   |     |    |    |   |    |   |   |     |    |   |    |    |   |    |
|-----------|---|-----|----|----|---|----|---|---|-----|----|---|----|----|---|----|
| <b>8.</b> | <table border="1"> <tr> <td><math>x</math></td><td>-2</td><td>-1</td><td>0</td><td>1</td><td>2</td><td>3</td></tr> <tr> <td><math>y</math></td><td>12</td><td>0</td><td>-6</td><td>-6</td><td>0</td><td>12</td></tr> </table> | $x$ | -2 | -1 | 0 | 1  | 2 | 3 | $y$ | 12 | 0 | -6 | -6 | 0 | 12 |
| $x$       | -2  | -1  | 0  | 1  | 2 | 3  |   |   |     |    |   |    |    |   |    |
| $y$       | 12  | 0   | -6 | -6 | 0 | 12 |   |   |     |    |   |    |    |   |    |



| 9.  | <table border="1"> <thead> <tr> <th><math>x</math></th><th>-1</th><th>0</th><th>1</th><th>2</th><th>3</th></tr> </thead> <tbody> <tr> <td><math>y</math></td><td>7</td><td>-4</td><td>-7</td><td>-2</td><td>11</td></tr> </tbody> </table> | $x$ | -1 | 0  | 1  | 2 | 3 | $y$ | 7 | -4 | -7 | -2 | 11 |
|-----|--|-----|----|----|----|---|---|-----|---|----|----|----|----|
| $x$ | -1   | 0   | 1  | 2  | 3  |   |   |     |   |    |    |    |    |
| $y$ | 7  | -4  | -7 | -2 | 11 |   |   |     |   |    |    |    |    |



| 10. | <table border="1"> <thead> <tr> <th><math>x</math></th><th>-2</th><th>-1</th><th>0</th><th>1</th><th>2</th><th>3</th></tr> </thead> <tbody> <tr> <td><math>y</math></td><td>-25</td><td>-9</td><td>-1</td><td>-1</td><td>-9</td><td>-25</td></tr> </tbody> </table> | $x$ | -2 | -1 | 0  | 1   | 2 | 3 | $y$ | -25 | -9 | -1 | -1 | -9 | -25 |
|-----|---|-----|----|----|----|-----|---|---|-----|-----|----|----|----|----|-----|
| $x$ | -2  | -1  | 0  | 1  | 2  | 3   |   |   |     |     |    |    |    |    |     |
| $y$ | -25   | -9  | -1 | -1 | -9 | -25 |   |   |     |     |    |    |    |    |     |



### Exercise 18.2 page 191

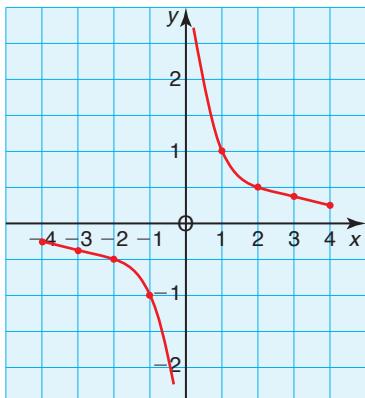
1. -2 and 3
2. -1 and 1
3. 3
4. -4 and 3
5. 2
6. 0.5 and 3
7. 1
8.  $-\frac{1}{3}$  and 2

### Exercise 18.3 page 192

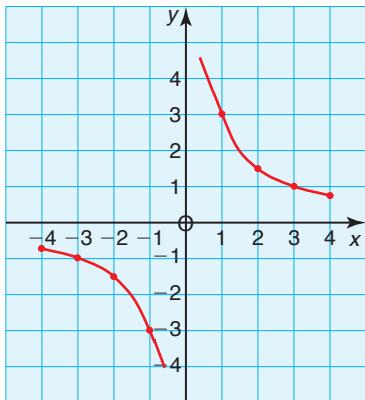
1. -1.6 and 2.6
2. No solution
3. 2 and 4
4. -3.5 and 2.5
5. 0.3 and 3.7
6. 0 and 3.5
7. -0.2 and 2.2
8.  $-\frac{1}{3}$  and 2

### Exercise 18.4 page 193

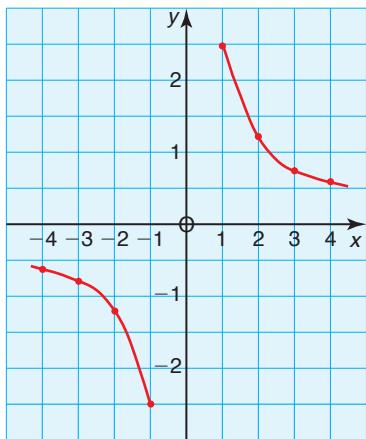
1.



2.



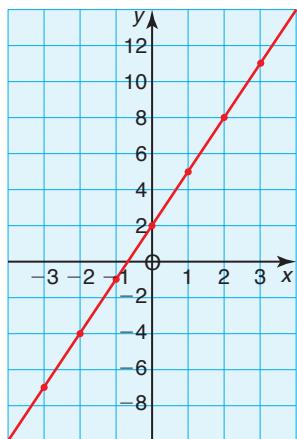
3.

**Exercise 18.5** page 194

1. i)

| $x$    | -3 | -2 | -1 | 0 | 1 | 2 | 3  |
|--------|----|----|----|---|---|---|----|
| $f(x)$ | -7 | -4 | -1 | 2 | 5 | 8 | 11 |

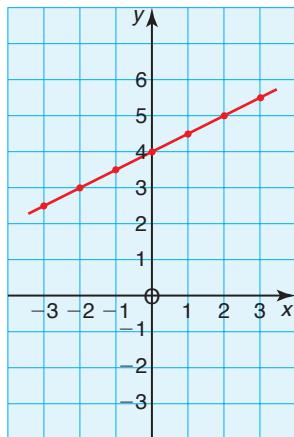
ii)



2. i)

| $x$    | -3  | -2 | -1  | 0 | 1   | 2 | 3   |
|--------|-----|----|-----|---|-----|---|-----|
| $f(x)$ | 2.5 | 3  | 3.5 | 4 | 4.5 | 5 | 5.5 |

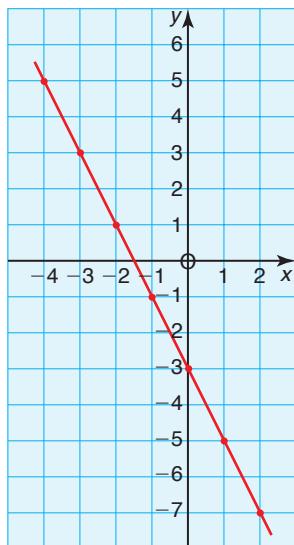
ii)



3. i)

| $x$    | -4 | -3 | -2 | -1 | 0  | 1  | 2  |
|--------|----|----|----|----|----|----|----|
| $f(x)$ | 5  | 3  | 1  | -1 | -3 | -5 | -7 |

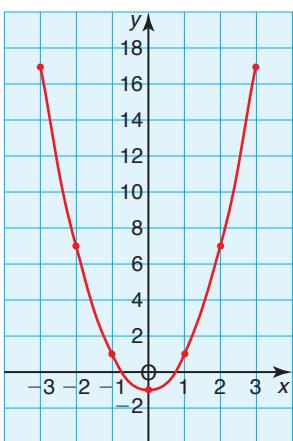
ii)



4. i)

|        |    |    |    |    |   |   |    |
|--------|----|----|----|----|---|---|----|
| $x$    | -3 | -2 | -1 | 0  | 1 | 2 | 3  |
| $f(x)$ | 17 | 7  | 1  | -1 | 1 | 7 | 17 |

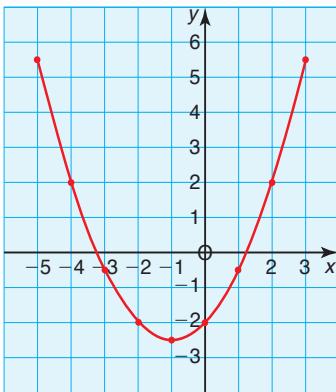
ii)



5. i)

|        |     |    |      |    |      |    |      |   |     |
|--------|-----|----|------|----|------|----|------|---|-----|
| $x$    | -5  | -4 | -3   | -2 | -1   | 0  | 1    | 2 | 3   |
| $f(x)$ | 5.5 | 2  | -0.5 | -2 | -2.5 | -2 | -0.5 | 2 | 5.5 |

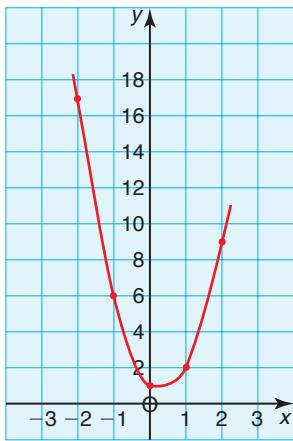
ii)



6. i)

|        |    |    |   |   |   |
|--------|----|----|---|---|---|
| $x$    | -2 | -1 | 0 | 1 | 2 |
| $f(x)$ | 17 | 6  | 1 | 2 | 9 |

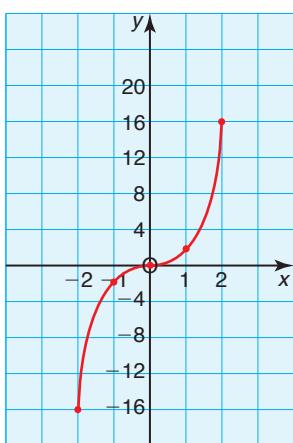
ii)



7. i)

|        |     |    |   |   |    |
|--------|-----|----|---|---|----|
| $x$    | -2  | -1 | 0 | 1 | 2  |
| $f(x)$ | -16 | -2 | 0 | 2 | 16 |

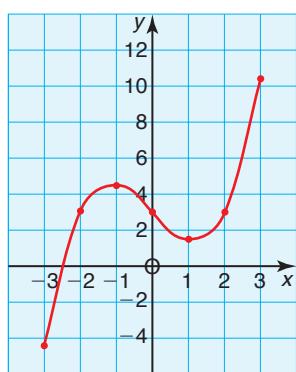
ii)



8. i)

| $x$    | -3   | -2 | -1  | 0 | 1   | 2 | 3    |
|--------|------|----|-----|---|-----|---|------|
| $f(x)$ | -4.5 | 3  | 4.5 | 3 | 1.5 | 3 | 10.5 |

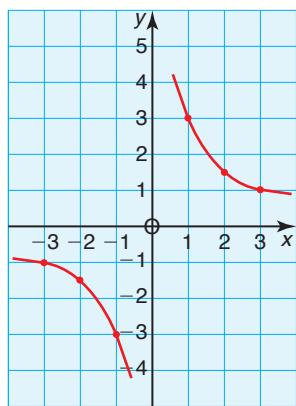
ii)



9. i)

| $x$    | -3 | -2   | -1 | 0 | 1 | 2   | 3 |
|--------|----|------|----|---|---|-----|---|
| $f(x)$ | -1 | -1.5 | -3 | - | 3 | 1.5 | 1 |

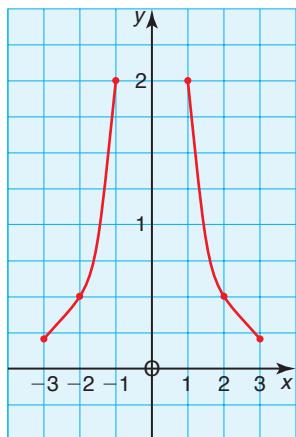
ii)



10. i)

| $x$    | -3   | -2  | -1 | 0 | 1 | 2   | 3    |
|--------|------|-----|----|---|---|-----|------|
| $f(x)$ | 0.22 | 0.5 | 2  | - | 2 | 0.5 | 0.22 |

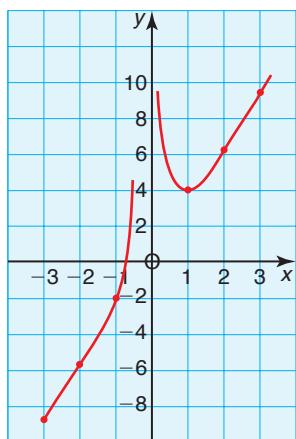
ii)



11. i)

| $x$    | -3    | -2    | -1 | 0 | 1 | 2    | 3    |
|--------|-------|-------|----|---|---|------|------|
| $f(x)$ | -8.88 | -5.75 | -2 | - | 4 | 6.25 | 9.11 |

ii)

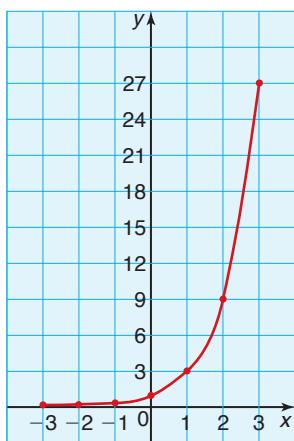


**Exercise 18.6** page 195

1. i)

|        |      |      |      |   |   |   |    |
|--------|------|------|------|---|---|---|----|
| $x$    | -3   | -2   | -1   | 0 | 1 | 2 | 3  |
| $f(x)$ | 0.04 | 0.11 | 0.33 | 1 | 3 | 9 | 27 |

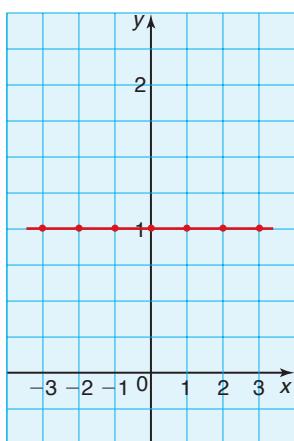
ii)



2. i)

|        |    |    |    |   |   |   |   |
|--------|----|----|----|---|---|---|---|
| $x$    | -3 | -2 | -1 | 0 | 1 | 2 | 3 |
| $f(x)$ | 1  | 1  | 1  | 1 | 1 | 1 | 1 |

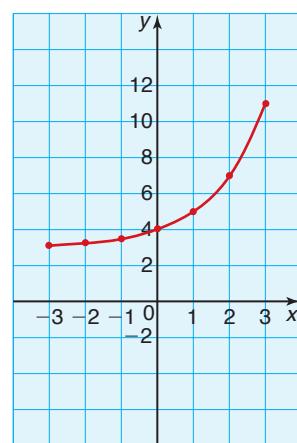
ii)



3. i)

|        |       |      |     |   |   |   |    |
|--------|-------|------|-----|---|---|---|----|
| $x$    | -3    | -2   | -1  | 0 | 1 | 2 | 3  |
| $f(x)$ | 3.125 | 3.25 | 3.5 | 4 | 5 | 7 | 11 |

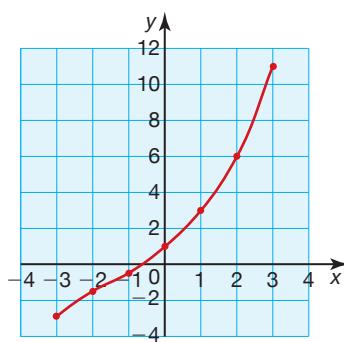
ii)



4. i)

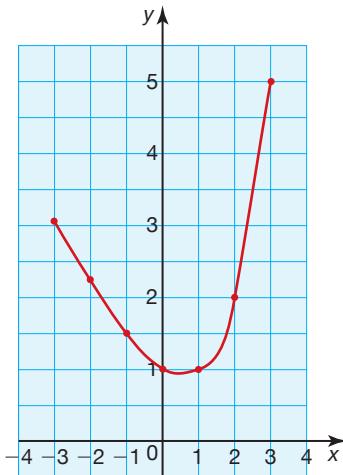
|        |        |       |      |   |   |   |    |
|--------|--------|-------|------|---|---|---|----|
| $x$    | -3     | -2    | -1   | 0 | 1 | 2 | 3  |
| $f(x)$ | -2.875 | -1.75 | -0.5 | 1 | 3 | 6 | 11 |

ii)



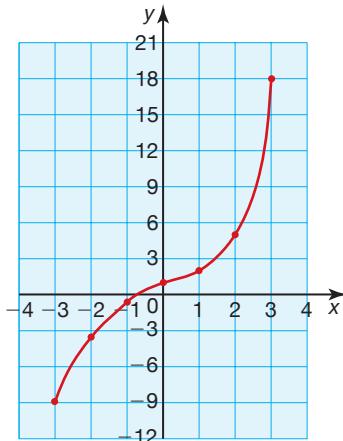
5.

| <b>i)</b> | <table border="1"> <thead> <tr> <th><math>x</math></th><th>-3</th><th>-2</th><th>-1</th><th>0</th><th>1</th><th>2</th><th>3</th></tr> </thead> <tbody> <tr> <td><math>f(x)</math></td><td>3.125</td><td>2.25</td><td>1.5</td><td>1</td><td>1</td><td>2</td><td>5</td></tr> </tbody> </table> | $x$  | -3  | -2 | -1 | 0 | 1 | 2 | 3 | $f(x)$ | 3.125 | 2.25 | 1.5 | 1 | 1 | 2 | 5 |
|-----------|--|------|-----|----|----|---|---|---|---|--------|-------|------|-----|---|---|---|---|
| $x$       | -3   | -2   | -1  | 0  | 1  | 2 | 3 |   |   |        |       |      |     |   |   |   |   |
| $f(x)$    | 3.125  | 2.25 | 1.5 | 1  | 1  | 2 | 5 |   |   |        |       |      |     |   |   |   |   |

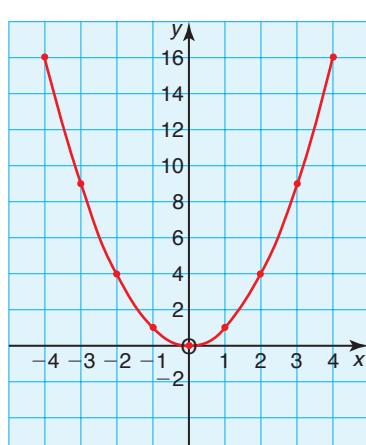
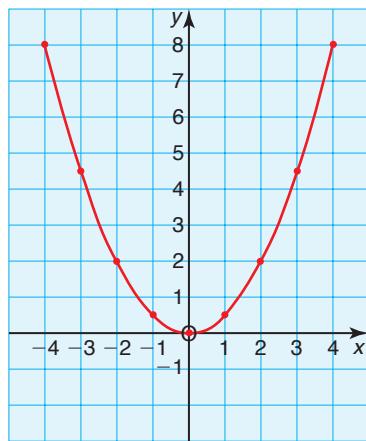
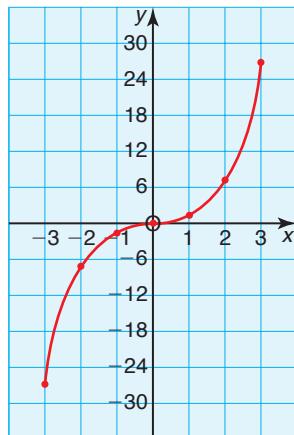
**ii)**

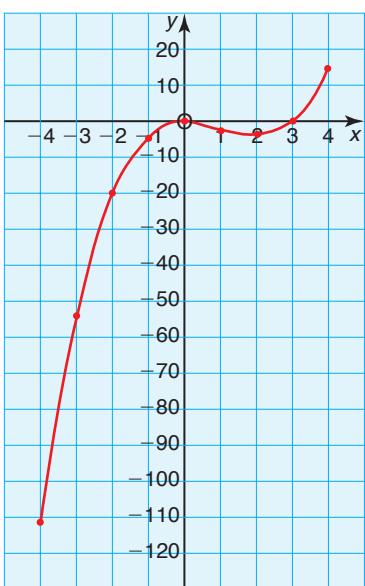
6.

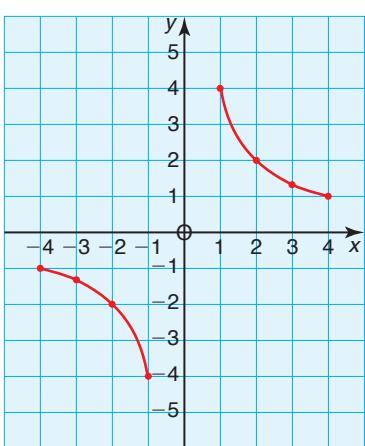
| <b>i)</b> | <table border="1"> <thead> <tr> <th><math>x</math></th><th>-3</th><th>-2</th><th>-1</th><th>0</th><th>1</th><th>2</th><th>3</th></tr> </thead> <tbody> <tr> <td><math>f(x)</math></td><td>-8.96</td><td>-3.89</td><td>-0.67</td><td>1</td><td>2</td><td>5</td><td>18</td></tr> </tbody> </table> | $x$   | -3    | -2 | -1 | 0 | 1  | 2 | 3 | $f(x)$ | -8.96 | -3.89 | -0.67 | 1 | 2 | 5 | 18 |
|-----------|--|-------|-------|----|----|---|----|---|---|--------|-------|-------|-------|---|---|---|----|
| $x$       | -3   | -2    | -1    | 0  | 1  | 2 | 3  |   |   |        |       |       |       |   |   |   |    |
| $f(x)$    | -8.96  | -3.89 | -0.67 | 1  | 2  | 5 | 18 |   |   |        |       |       |       |   |   |   |    |

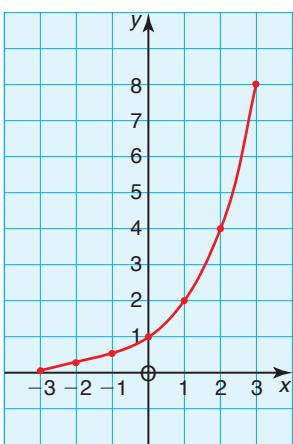
**ii)**

### Exercise 18.7 page 197

1. **i)****ii)** 2**ii)** -23. **i)****ii)** 3

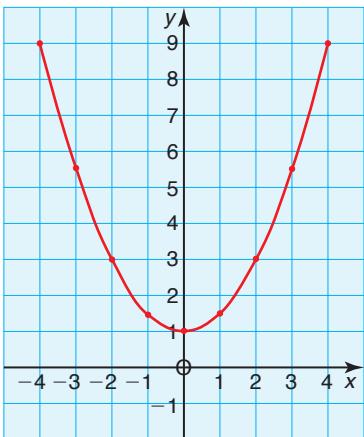
4. i)  ii) 24

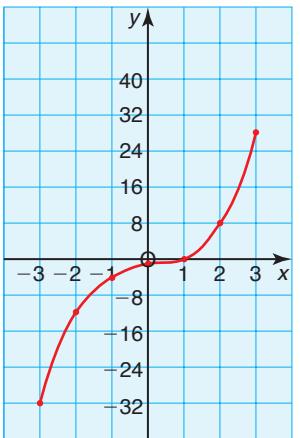
5. i)  ii) -4

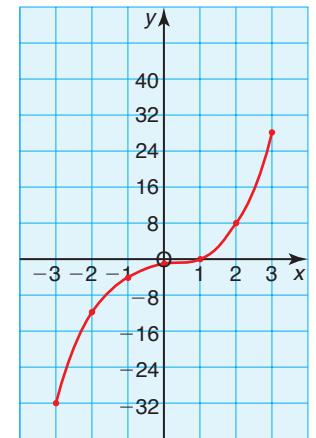
6. i)  ii) 0.7

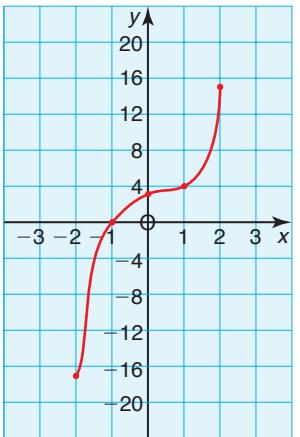
### Exercise 18.8

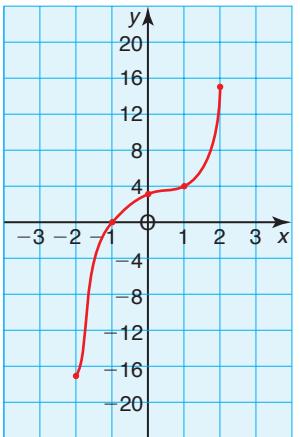
page 198

1. a)  b)  $x = \pm 2.8$

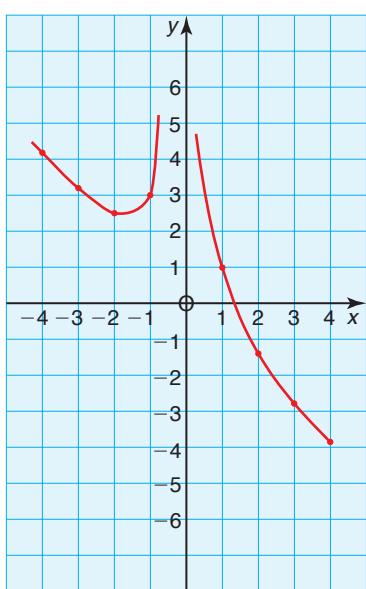
2. a)  b)  $x = 1.7$



3. a)  b)  $x = 1.5$



4. a)

b)  $x = -0.4, 0.5, 2.4$ 

5. a)

b)  $x = -0.7, 3$ 

6. a) 7 cm      b) 0 cm      c) 5 hours  
e) Approx.  $5\frac{1}{2}$  hours

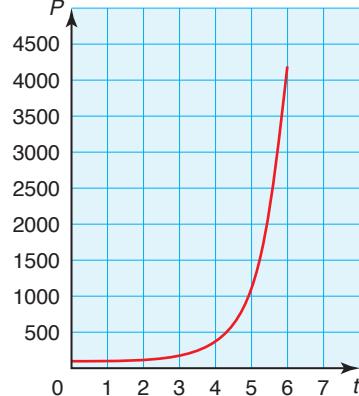
7. a) Approx. 2.5      b)  $-\frac{1}{2}$ 

8. a) Approx. 4.3      b) Approx. 3.3  
c) Approx. 2.3

9. a) 101

b) 1120

c)

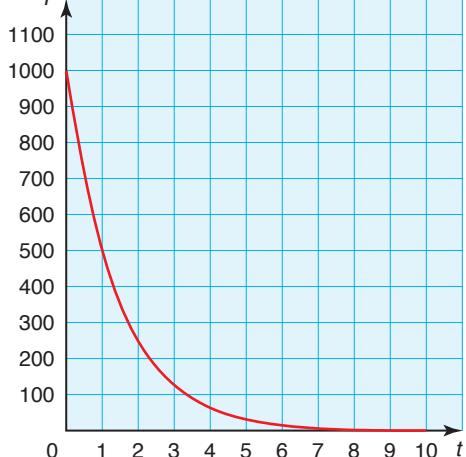


d) Approx. 4.5 hours

10. a)

|     |      |     |     |     |    |    |    |   |   |   |    |
|-----|------|-----|-----|-----|----|----|----|---|---|---|----|
| $t$ | 0    | 1   | 2   | 3   | 4  | 5  | 6  | 7 | 8 | 9 | 10 |
| $P$ | 1000 | 500 | 250 | 125 | 63 | 31 | 16 | 8 | 4 | 2 | 1  |

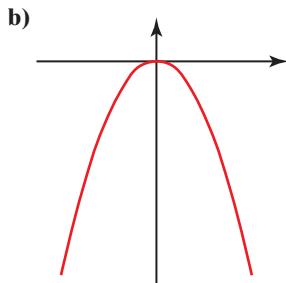
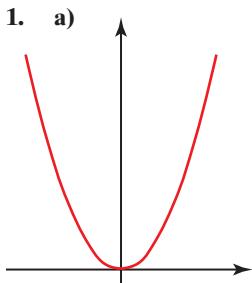
b)



c) Approx. 90 insects

**Student assessment I** page 200

1.

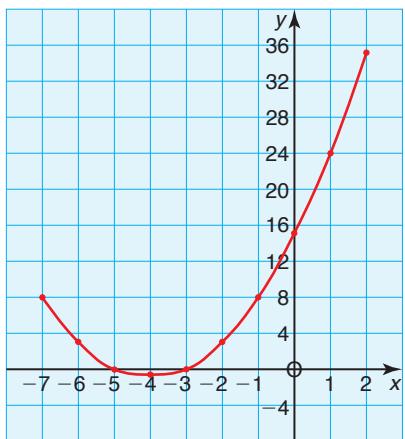


2.

a)

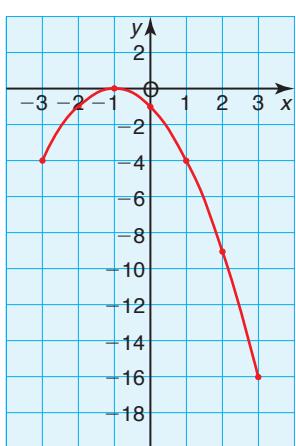
|   |    |    |    |    |    |    |    |    |    |    |
|---|----|----|----|----|----|----|----|----|----|----|
| x | -7 | -6 | -5 | -4 | -3 | -2 | -1 | 0  | 1  | 2  |
| y | 8  | 3  | 0  | -1 | 0  | 3  | 8  | 15 | 24 | 35 |

b)

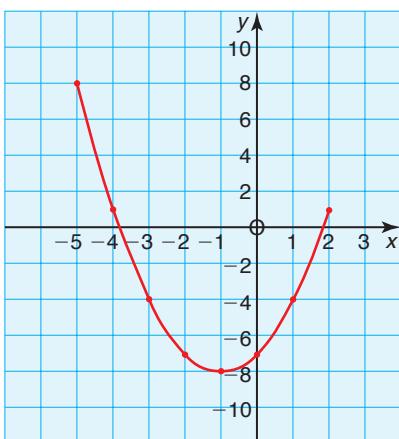


3.

a)

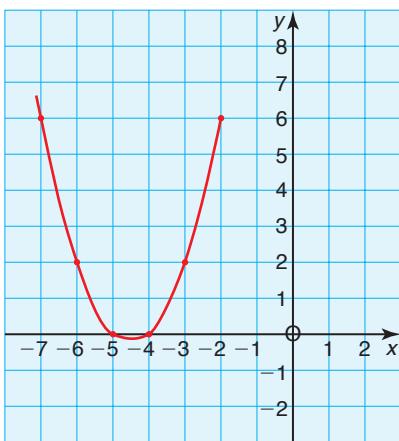


b)



4.

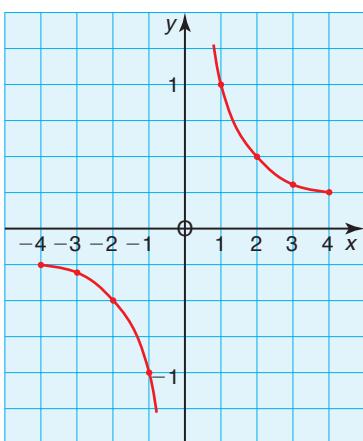
a)



b)  $x = -7$  and  $-2$

5.

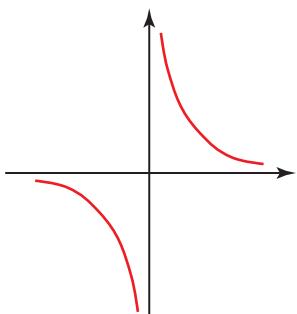
a)



b)  $x = 0.4$  and  $2.6$

**Student assessment 2** page 201

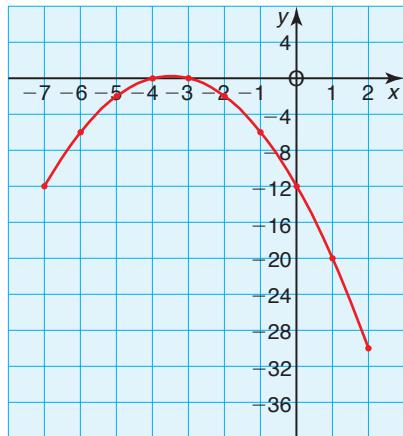
1.



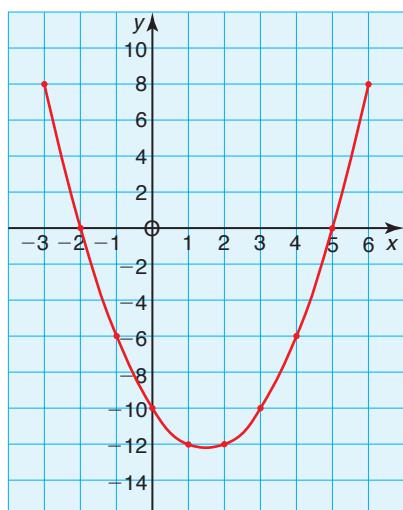
2. a)

| $x$ | -7  | -6 | -5 | -4 | -3 | -2 | -1 | 0   | 1   | 2   |
|-----|-----|----|----|----|----|----|----|-----|-----|-----|
| $y$ | -12 | -6 | -2 | 0  | 0  | -2 | -6 | -12 | -20 | -30 |

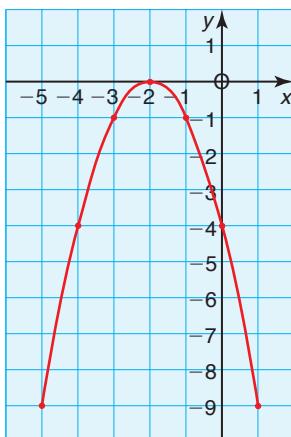
b)



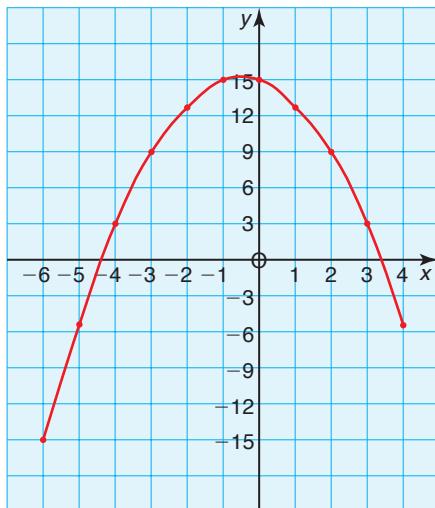
3. a)



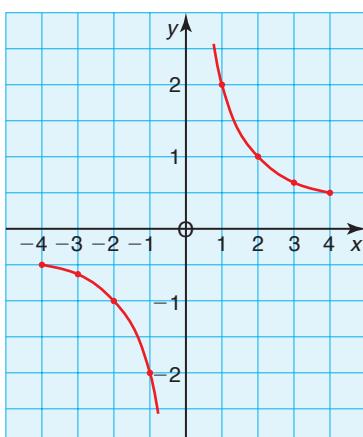
b)



4. a)

b) i)  $x = -3.7$  and  $2.7$  ii)  $x = -1.8$  and  $2.8$ 

5. a)

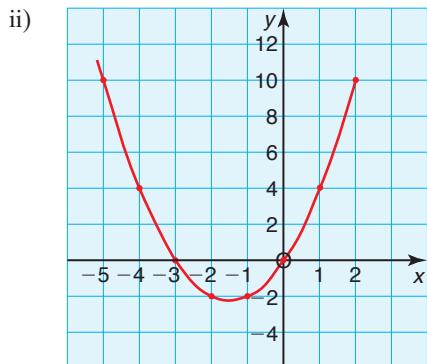
b)  $x = -2$  and  $1$

**Student assessment 3** page 201

1. a) i) Linear ii) Quadratic  
b) Student's own answer

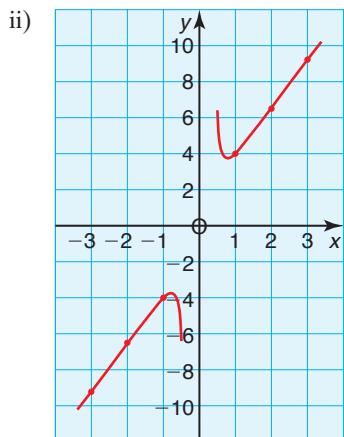
2. a) i)

| $x$    | -5 | -4 | -3 | -2 | -1 | 0 | 1 | 2  |
|--------|----|----|----|----|----|---|---|----|
| $f(x)$ | 10 | 4  | 0  | -2 | -2 | 0 | 4 | 10 |

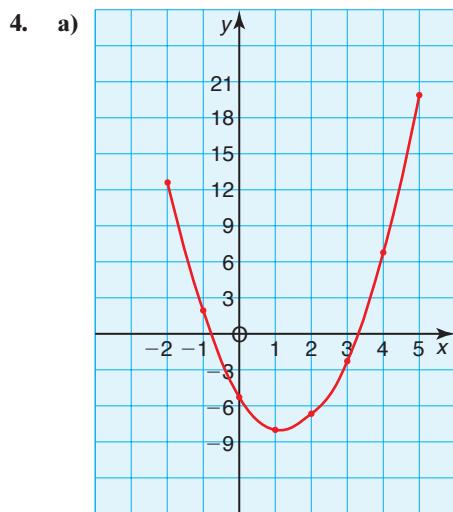
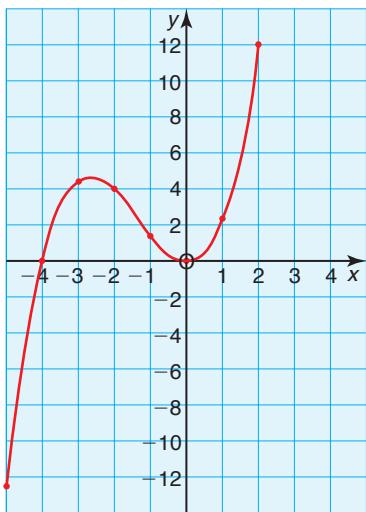


b) i)

| $x$    | -3   | -2   | -1 | 0 | 1 | 2   | 3   |
|--------|------|------|----|---|---|-----|-----|
| $f(x)$ | -9.3 | -6.5 | -4 | - | 4 | 6.5 | 9.3 |



3. a)  
b) i) 5.5 ii) -2.5



- b)  $x = -0.8$  and  $3.3$  c)  $x = -1.6$  and  $3.1$

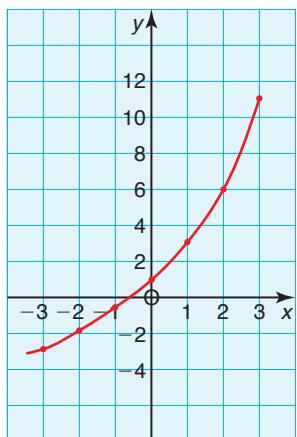
**Student assessment 4** page 202

1. a) i) Reciprocal ii) Exponential  
b) Student's own answer

2. a) i)

| $x$    | -3   | -2   | -1   | 0 | 1 | 2 | 3  |
|--------|------|------|------|---|---|---|----|
| $f(x)$ | -2.9 | -1.8 | -0.5 | 1 | 3 | 6 | 11 |

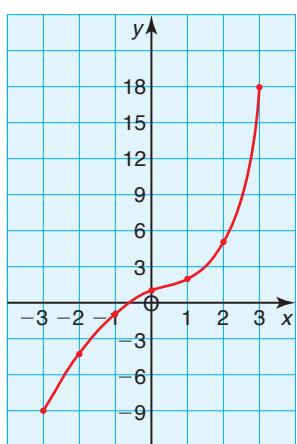
ii)



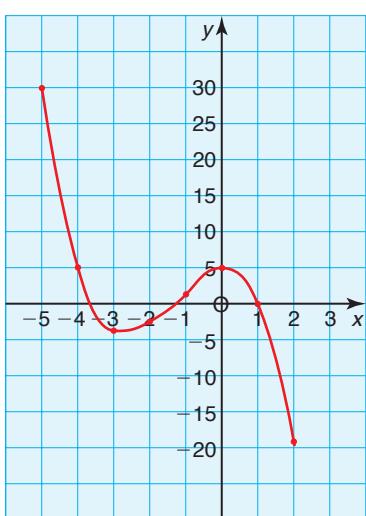
b) i)

| $x$    | -3   | -2   | -1   | 0 | 1 | 2 | 3  |
|--------|------|------|------|---|---|---|----|
| $f(x)$ | -9.0 | -3.9 | -0.7 | 1 | 2 | 5 | 18 |

ii)



3. a)

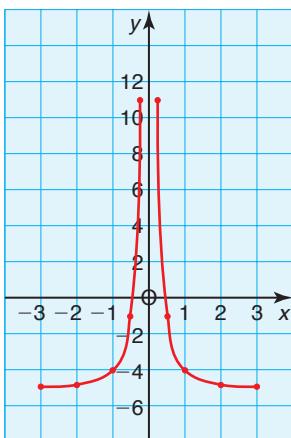


b) i) 0 ii) 4

4. a)

| $x$ | -3   | -2   | -1 | -0.5 | -0.25 | 0 | 0.25 | 0.5 | 1  | 2    | 3    |
|-----|------|------|----|------|-------|---|------|-----|----|------|------|
| $y$ | -4.9 | -4.8 | -4 | -1   | 11    | - | 11   | -1  | -4 | -4.8 | -4.9 |

b)

c)  $x = \pm 0.4$ d)  $x = \pm 0.4$  and  $\pm 2.6$ 

## 19 Functions

### Exercise 19.1

page 204

- a) 6      b) 10      c) 3      d) 5  
e) 2      f) -2      g) -10      h) 1
- a) 10      b) 22      c) 8      d) -4  
e) -5      f) -18      g) -23      h) -6
- a) 2      b) -28      c) -20.5      d) -14  
e) 1.5      f) 12      g) 34.5      h) 13.5
- a) -19      b) -26.5      c) -7      d) -8.2  
e) 20      f) 8      g) -1      h) 3.5

### Exercise 19.2

page 204

- a) 2      b) 6.5      c) 2.375      d) 0.5  
e) 0.125      f) -4      g) -2.5      h) -0.7
- a) 4      b) 9      c) -1      d) -6  
e) -3.5      f) -16      g)  $-\frac{4}{3}$       h)  $-\frac{7}{6}$
- a) 0.5      b) 2      c) -4      d) -0.25  
e) 5      f) 2.75      g) 35      h) 4.25
- a) 4      b) 1.5      c) 2.75      d) 0.25  
e) -3.5      f) 0.5      g) 0.375      h) 0.875

**Exercise 19.3** page 204

1. a) 19      b) 52      c) 4      d) 3  
e) 4      f) 3.25      g) 12      h) 5
2. a) 70      b) 187      c) -2      d) -5  
e) 7      f) 4      g) -4.25      h)  $-4\frac{2}{3}$
3. a) -14      b) 3.5      c) 4      d) -0.5  
e) -28      f) 2      g) -6      h) -68
4. a) -5      b) 32.5      c) 0  
d) -6.875      e) -7.5      f) 15  
g) -6.25      h) 8.125
5. a) 0      b) 24      c) 0  
d) 10.5      e) -13.5      f)  $-\frac{25}{6}$   
g) -97.5      h) 21.9 (3 s.f.)
6. a) 9      b) 0      c) -5  
d) Infinite      e) 0      f) 11.2  
g)  $-\frac{11}{6}$       h) 9

**Exercise 19.4** page 205

1. a)  $2x + 3$       b)  $4x - 5$       c)  $2x^2 + 1$   
d)  $x + 1$       e)  $\frac{x}{2} + 3$       f)  $x + 1$
2. a)  $12x^2 - 4$       b)  $\frac{3x^2}{16} - 4$       c)  $6x - 4$   
d)  $27x^2$       e)  $3x^2 - 6x - 1$   
f)  $12x^2 + 24x + 8$
3. a)  $4x^2 + 3x + 2$       b)  $16x^2 + 6x$   
c)  $4x^2 + 19x$       d)  $4x^2 - 5x$   
e)  $\frac{2x^2 + 3x - 4}{2}$       f)  $36x^2 + 57x + 20$

**Exercise 19.5** page 206

1. a)  $x - 3$       b)  $x - 6$       c)  $x + 5$   
d)  $x$       e)  $\frac{x}{2}$       f)  $3x$
2. a)  $\frac{x}{4}$       b)  $\frac{x - 5}{2}$       c)  $\frac{x + 6}{3}$   
d)  $2x - 4$       e)  $\frac{4x + 2}{3}$       f)  $\frac{5x - 7}{8}$
3. a)  $2(x - 3)$       b)  $4(x + 2)$       c)  $\frac{x + 24}{12}$   
d)  $\frac{x - 18}{6}$       e)  $\frac{x + 4}{6}$       f)  $\frac{3x + 10}{8}$

**Exercise 19.6** page 206

1. a) 6      b) 4      c) -1
2. a) 2      b) -0.5      c) -6
3. a) 3      b) 1.5      c) 2
4. a) 4      b) -2      c) -11
5. a) 4.5      b) 6      c) 0
6. a) 8      b) -2      c) 0.5

**Exercise 19.7** page 207

1. a)  $x + 2$       b)  $x + 3$       c)  $2x$       d)  $x$
2. a)  $2x + 8$       b)  $6x + 1$       c)  $8x + 2$   
d)  $-x + 2$
3. a)  $\frac{2x - 1}{2}$       b)  $\frac{3x - 5}{2}$       c)  $\frac{x + 7}{3}$   
d)  $\frac{8x - 13}{20}$
4. a) 1      b) 8      c) 39      d) -2
5. a) 50      b) -2.9      c) 10      d) -1.6

**Student assessment 1** page 208

1. a) 9      b) -1      c) -16
2. a) 5      b) -1      c) -5.5
3. a) -6      b) 0      c) 15
4. a)  $-x + 4$       b)  $\frac{2x + 18}{3}$
5. a) 5      b) 2
6.  $-4x + 14$

**Student assessment 2** page 208

1. a) 13      b) -2      c) 1
2. a) -2      b) 1      c) -1
3. a) -2      b) 0      c) 18
4. a)  $\frac{x - 9}{-3}$       b)  $4x + 2$
5. a) 1      b) 2
6.  $32x - 6$

## Topic 2 Mathematical investigations and ICT

### House of cards page 209

1. 155
2. 8475
3. The formula can be proved using the method of differences (see Chapter 15) as follows:

| Height of house | 1 | 2 | 3  | 4  | 5  |
|-----------------|---|---|----|----|----|
| Number of cards | 2 | 7 | 15 | 26 | 40 |
| 1st difference  |   | 5 | 8  | 11 | 14 |
| 2nd difference  |   | 3 | 3  | 3  |    |

Comparing with the algebraic table below:

| Position       | 1           | 2             | 3             | 4              | 5              |
|----------------|-------------|---------------|---------------|----------------|----------------|
| Term           | $a + b + c$ | $4a + 2b + c$ | $9a + 3b + c$ | $16a + 4b + c$ | $25a + 5b + c$ |
| 1st difference |             | $3a + b$      | $5a + b$      | $7a + b$       | $9a + b$       |
| 2nd difference |             | $2a$          | $2a$          | $2a$           |                |

It can be deduced that:

$$2a = 3 \quad \text{therefore } a = \frac{3}{2}$$

$$3a + b = 5 \quad \text{therefore } b = \frac{1}{2}$$

$$a + b + c = 2 \quad \text{therefore } c = 0.$$

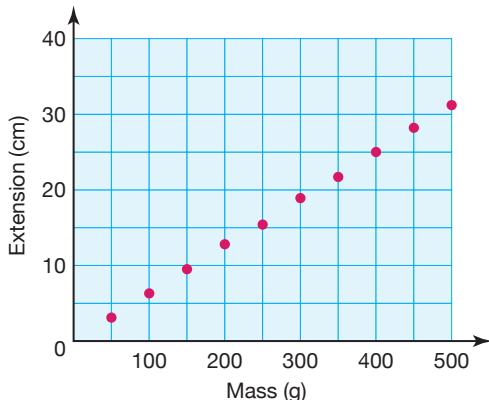
This produces the rule  $c = \frac{3}{2}n^2 + \frac{1}{2}n$  which factorises to  $c = \frac{1}{2}n(3n + 1)$ .

### Chequered boards page 209

1. Student's own diagrams and results, presented in a logical table.
2. Where either  $m$  or  $n$  is even, the number of black and white squares is given by  $\frac{mn}{2}$ . Where both  $m$  and  $n$  are odd, the number of black and white squares differ by one. The number of black squares is  $\frac{mn - 1}{2}$  and the number of white squares is  $\frac{mn + 1}{2}$ , assuming that the bottom right-hand corner is white.

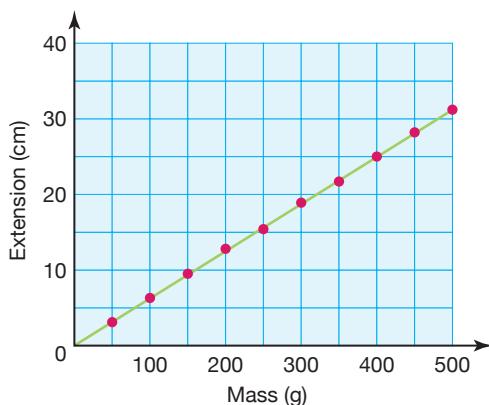
## Modelling: Stretching a spring page 210

1.



2. Linear

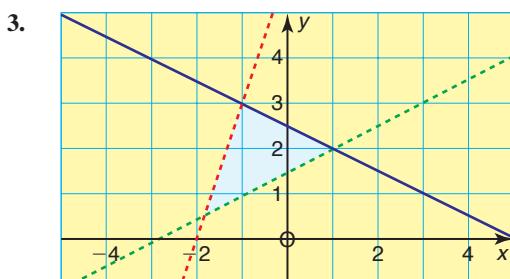
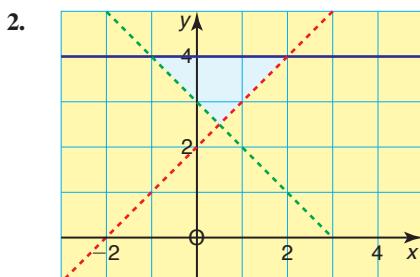
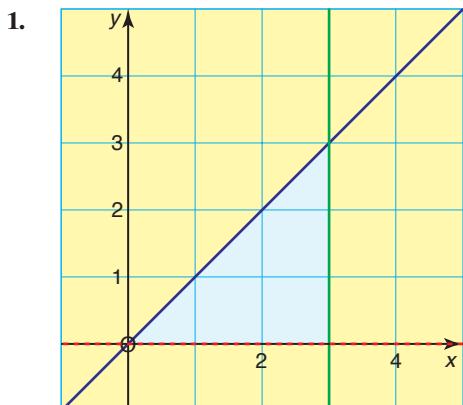
3.



4.  $y \approx 0.06x$

5. 16.5 cm

6. The spring is likely to snap (or exceed its elastic limit).

**ICT activity 1** page 211**ICT activity 2** page 211

1.  $x \approx 2.7$
2.  $x \approx 2.6$
3.  $x \approx 2.1$
4.  $x \approx 0.6$

**20 Geometrical vocabulary****Exercise 20.1** page 216

1. a) and f) – hypotenuse right-angle
- b) and c) – ASA
- d) and e) – SAS
- g) and h) – SSS

**Exercise 20.2** page 218

1.

|                                       | Rectangle | Square | Parallelogram | Kite | Rhombus | Equilateral triangle |
|---------------------------------------|-----------|--------|---------------|------|---------|----------------------|
| Opposite sides equal in length        | Yes       | Yes    | Yes           | No   | Yes     | n/a                  |
| All sides equal in length             | No        | Yes    | No            | No   | Yes     | Yes                  |
| All angles right angles               | Yes       | Yes    | No            | No   | No      | No                   |
| Both pairs of opposite sides parallel | Yes       | Yes    | Yes           | No   | Yes     | n/a                  |
| Diagonals equal in length             | Yes       | Yes    | No            | No   | No      | n/a                  |
| Diagonals intersect at right angles   | No        | Yes    | No            | Yes  | Yes     | n/a                  |
| All angles equal                      | Yes       | Yes    | No            | No   | No      | Yes                  |

**Exercise 20.3** page 219

Student's own diagrams

**Student assessment I** page 220

1. a) Acute    b) Obtuse    c) Reflex  
d) Right angle
2. Student's own diagram
3. a) Obtuse scalene triangle  
b) Right-angled scalene
4. Student's own diagram
5. All sides equal in length  
Both pairs of opposite sides are parallel  
Diagonals intersect at right angles
6. Student's own diagram

## 21 Geometrical constructions and scale drawings

**Exercise 21.1** page 222

1. Student's own construction
2. Student's own construction
3. Student's own construction
4. a) Student's own construction attempt  
b) It is not possible as  $AC + BC < AB$

**Exercise 21.2** page 223

1. Student's own construction
2. Student's own construction

**Exercise 21.3** page 226

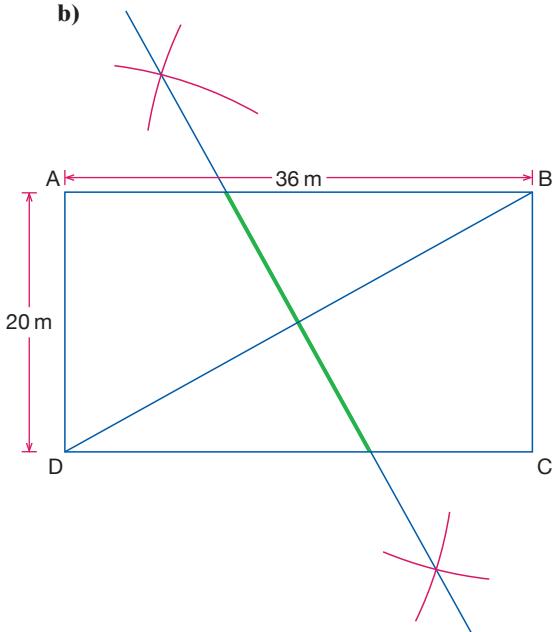
1. Student's own construction
2. Student's own construction

**Exercise 21.4** page 228

1. a) 300 m    b) 250 m    c) 300 m  
d) 416 m
2. a) 10 cm    b) 8 cm    c) 6 cm    d) 6.8 cm

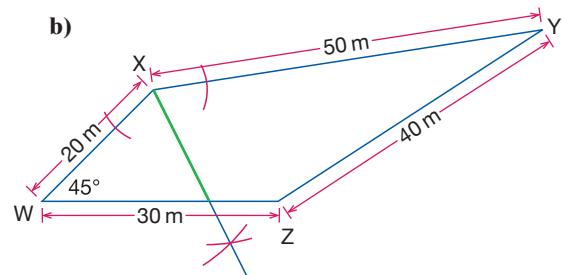
3. a) Student's own construction

b)



c) Approx. 23 m

4. a) Student's own construction
- b) Approx.  $24 \text{ m}^2$
5. a) Student's own construction
- b) Approx. 12 km
6. a) Student's own construction



c) Approx. 16 m

**Student assessment I** page 229

1. Student's own construction
2. Student's own construction
3. a) Student's own construction  
b) Approx.  $53 \text{ m}^2$

**Student assessment 2** page 230

1. Student's own construction
2. a) 22 cm    b) 24.4 cm
3. a) Student's own construction  
b) Approx. 23 cm<sup>2</sup>

**22 Similarity****Exercise 22.1** page 231

1. a) Interior angles are the same, i.e. 60°, 30° and 90°.  
b)  $\frac{5}{8}$   
c)  $x = 6.25 \text{ cm}$     $y = 3.75 \text{ cm}$
2. A, C and F are similar. B and D are similar.
3. a) 6 cm    b) 9 cm
4.  $p = 4.8 \text{ cm}$     $q = 4.5 \text{ cm}$     $r = 7.5 \text{ cm}$
5.  $e = 10 \text{ cm}$     $f = 2\frac{2}{3} \text{ cm}$
6. a)  $10 \text{ cm}^2$     b) 1.6    c)  $25.6 \text{ cm}^2$
7. a) 10 cm    b) 2.5    c)  $150 \text{ cm}^2$
8. a)  $33\frac{1}{3} \text{ cm}^2$     b)  $6\frac{2}{3} \text{ cm}$
9. 9.6 cm
10. No, as the corresponding angles may not be the same.
11. No, as, despite the corresponding angles being the same, the slanting side lengths may not be in the same ratio as the horizontal sides.

**Exercise 22.2** page 234

1.  $50 \text{ cm}^2$
2.  $10 \text{ cm}^2$
3. a) i)  $456 \text{ cm}^2$  (3 s.f.)   ii)  $90 \text{ cm}^2$    iii)  $40 \text{ cm}^2$   
b) Triangle I
4.  $43.56 \text{ cm}^2$
5.  $56.25 \text{ cm}^2$
6.  $18.1 \text{ cm}^2$  (3 s.f.)

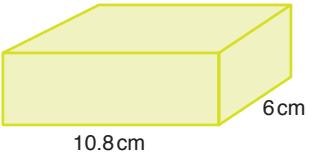
**Exercise 22.3** page 235

1. a) i) 8 m    ii) 4.8 m  
b)  $2\sqrt{2} \text{ m}$   
c)  $25\sqrt{2} \text{ cm}^2$
2. a)  $220 \text{ cm}^2$     b)  $1375 \text{ cm}^2$     c)  $200 \text{ cm}^3$   
d)  $3125 \text{ cm}^3$
3. a)  $54 \text{ cm}^2$     b) 3    c)  $729 \text{ cm}^3$
4. a)  $1 : n^2$     b)  $1 : n^3$
5.  $112 \text{ cm}^3$
6. 0.64 litres

**Exercise 22.4** page 236

1. 20 cm
2. a) 1 : 8    b) 1 : 7
3.  $16 \text{ cm}^3$
4. a) Not similar. Student's own reasons  
b) 1 : 3
5. a)  $16 \text{ cm}^2$     b)  $64 \text{ cm}^2$     c)  $144 \text{ cm}^2$
6. a)  $30 \text{ km}^2$     b)  $6 \text{ cm}^2$
7. a)  $10 \text{ cm} \times 20 \text{ cm} \times 30 \text{ cm}$     b) 100 g

**Student assessment 1** page 237

1. A and C
2.  $1 : \left(\frac{H}{h}\right)^2$
3. a) Yes. Student's own explanation  
b) 5 cm    c) 8 cm    d) 6 cm
4. 15 m
5. a)
 
- b)  $233.28 \text{ cm}^3$     c)  $250.56 \text{ cm}^2$
6. a)  $12.8 \text{ cm}^3$     b)  $880 \text{ cm}^2$     c)  $35.2 \text{ cm}^2$
7.  $1250 \text{ cm}^2$
8.  $27\ 000 \text{ cm}^3$

**Student assessment 2** page 239

1. a) 5                  b)  $x = 4.5$      $y = 7.5$
2. a)  $1 : \left(\frac{H}{h}\right)^2$       b)  $1 : \left(\frac{H}{h}\right)^3$
3.  $x = \sqrt{41}$  cm     $y = \frac{3\sqrt{41}}{5}$  cm     $z = 6.4$  cm
4.  $156 \text{ cm}^2$  (3 s.f.)
5. a)  $1000 \text{ cm}^3$                   b)  $600 \text{ cm}^2$
6.  $18.75 \text{ cm}^3$
7. a) 4 m by 3 m                  b)  $12 \text{ m}^2$
8.  $3200 \text{ cm}^3$

**23 Symmetry****Exercise 23.1** page 241

1. a) i) Student's planes ii) 3  
b) i) Student's planes ii) 2  
c) i) Student's planes ii) 4  
d) i) Student's planes ii) 4  
e) i) Student's planes ii) Infinite  
f) i) Student's planes ii) Infinite  
g) i) Student's planes ii) Infinite  
h) i) Student's planes ii) 9
2. a) 2                  b) 2                  c) 3  
d) 4                  e) Infinite                  f) Infinite  
g) Infinite                  h) 4

**Exercise 23.2** page 242

1. a) Isosceles                  b) Perpendicular bisector  
c)  $50^\circ$                   d)  $50^\circ$   
e)  $3.58 \text{ cm}$  (3 s.f.)    f)  $9.33 \text{ cm}$  (3 s.f.)
2. a) True                  b) True                  c) False                  d) True
3. a) False                  b) True

**Exercise 23.3** page 243

1. a)  $70^\circ$                   b)  $72^\circ$                   c)  $21^\circ$
2. a)  $10.9 \text{ cm}$  (3 s.f.)  
b)  $9.33 \text{ cm}$  (3 s.f.)  
c)  $3.48 \text{ cm}$  (3 s.f.)

**Student assessment 1** page 243

1. a) b) c) Student's own diagrams
2. a) b) Student's own diagrams
3. Proof
4.  $50^\circ$
5.  $11.8 \text{ mm}$  (3 s.f.)

**Student assessment 2** page 244

1. a) b) c) Student's own diagrams
2. a) b) c) Student's own diagrams
3. Proof
4. a)  $24^\circ$                   b)  $9.14 \text{ cm}$  (3 s.f.)
5.  $88.0 \text{ cm}$  (3 s.f.)

**24 Angle properties****Exercise 24.1** page 247

1.  $p = 54^\circ$                    $q = 63^\circ$
2.  $a = 55^\circ$                    $b = 80^\circ$                    $c = 100^\circ$
3.  $v = 120^\circ$                    $w = 60^\circ$                    $x = 120^\circ$                    $y = 60^\circ$   
 $z = 60^\circ$
4.  $a = 50^\circ$                    $b = 130^\circ$                    $c = 45^\circ$                    $d = 135^\circ$
5.  $p = 45^\circ$                    $q = 135^\circ$                    $r = 45^\circ$                    $s = 45^\circ$   
 $t = 135^\circ$
6.  $d = 70^\circ$                    $e = 30^\circ$
7.  $a = 37^\circ$
8.  $a = 36^\circ$

**Exercise 24.2** page 248

1. a)  $70^\circ$                   b)  $55^\circ$                   c)  $60^\circ$                   d)  $73^\circ$   
e)  $45^\circ$                   f)  $110^\circ$
2. a)  $a = 30^\circ$                   b)  $b = 45^\circ$   
b)  $x = 50^\circ$                   y)  $y = 80^\circ$                   z)  $z = 70^\circ$   
c)  $p = 130^\circ$                   q)  $q = 15^\circ$                   r)  $r = 60^\circ$   
d)  $d = 35^\circ$                   e)  $e = 55^\circ$                   f)  $f = 55^\circ$   
e)  $a = 27.5^\circ$                   b)  $b = 27.5^\circ$                   c)  $c = 55^\circ$   
d)  $d = 27.5^\circ$                   e)  $e = 97.5^\circ$   
f)  $p = 45^\circ$                   q)  $q = 45^\circ$                   r)  $r = 67.5^\circ$   
s)  $s = 112.5^\circ$

**Exercise 24.3** page 250

1.  $a = 115^\circ$
2.  $x = 40^\circ \quad y = 140^\circ \quad z = 140^\circ$
3.  $m = 75^\circ \quad n = 75^\circ$
4.  $s = 65^\circ \quad t = 115^\circ \quad u = 115^\circ$
5.  $h = 120^\circ \quad i = 60^\circ \quad j = 120^\circ \quad k = 60^\circ$
6.  $a = 80^\circ \quad b = 20^\circ \quad c = 20^\circ \quad d = 20^\circ$   
 $e = 140^\circ$
7.  $p = 40^\circ \quad q = 130^\circ \quad r = 50^\circ$
8.  $p = 75^\circ \quad q = 30^\circ \quad r = 50^\circ \quad s = 80^\circ$   
 $t = 70^\circ \quad u = 70^\circ \quad v = 40^\circ$

**Exercise 24.4** page 253

1. a)  $720^\circ$    b)  $1260^\circ$    c)  $900^\circ$
2. a)  $135^\circ$    b)  $90^\circ$    c)  $144^\circ$    d)  $150^\circ$
3. a)  $72^\circ$    b)  $30^\circ$    c)  $51.4^\circ$  (1 d.p.)
4. a) 18   b) 10   c) 36   d) 8  
e) 20   f) 120
5. a) 5   b) 12   c) 20   d) 15  
e) 40   f) 360
6. 12

**Exercise 24.5** page 254

1.  $60^\circ$
2.  $135^\circ$
3.  $20^\circ$
4.  $32^\circ$
5.  $110^\circ$
6.  $22.5^\circ$

**Exercise 24.6** page 255

1.  $35^\circ$
2.  $60^\circ$
3.  $40^\circ$
4.  $45^\circ$
5.  $24^\circ$
6.  $26^\circ$
7. 13 cm
8. 8 cm
9. 17.7 cm (1 d.p.)

**Exercise 24.7** page 256

1. a)  $x = 54^\circ$    b)  $54^\circ, 108^\circ, 162^\circ, 54^\circ, 162^\circ$
2.  $125^\circ, 145^\circ$
3.  $64^\circ$
4.  $a = 135^\circ, b = 125^\circ, c = 130^\circ, d = 110^\circ, e = 85^\circ$

**Exercise 24.8** page 257

1.  $55^\circ$
2.  $80^\circ$
3.  $90^\circ$
4.  $100^\circ$
5.  $80^\circ$
6.  $20^\circ$
7.  $x = 54^\circ, y = 18^\circ$
8.  $x = 50^\circ, y = 25^\circ$

**Exercise 24.9** page 258

1.  $a = 72^\circ$
2.  $b = 33^\circ, c = 66^\circ$
3.  $d = 48^\circ, e = 32^\circ$
4.  $f = 30^\circ, g = 120^\circ, h = 120^\circ, i = 30^\circ, j = 30^\circ$
5.  $k = 55^\circ, l = 55^\circ, m = 55^\circ, n = 55^\circ$
6.  $p = 65^\circ, q = 40^\circ$

**Exercise 24.10** page 259

1.  $a = 80^\circ, b = 65^\circ$
2.  $c = 110^\circ, d = 98^\circ, e = 70^\circ$
3.  $f = 115^\circ, g = 75^\circ$
4.  $i = 98^\circ, j = 90^\circ, k = 90^\circ$
5.  $l = 95^\circ, m = 55^\circ, n = 85^\circ, p = 95^\circ, q = 55^\circ$
6.  $r = 70^\circ, s = 120^\circ, t = 60^\circ, u = 110^\circ$

**Student assessment I** page 259

1. a)  $p = 135^\circ \quad q = 135^\circ \quad r = 45^\circ$   
b)  $a = 120^\circ \quad b = 60^\circ \quad c = 60^\circ \quad d = 60^\circ$
2. a)  $m = 50^\circ \quad n = 90^\circ \quad p = 40^\circ \quad q = 140^\circ$   
b)  $w = 55^\circ \quad x = 70^\circ \quad y = 55^\circ \quad z = 55^\circ$   
c)  $a = 70^\circ \quad b = 110^\circ \quad c = 110^\circ \quad d = 70^\circ$   
 $e = 30^\circ$
3.  $162^\circ$
4.  $1260^\circ$
5.  $360^\circ$
6.  $72^\circ$
7. a)  $90^\circ$   
b) 6.5 cm
8.  $58^\circ$

9.  $30^\circ$   
10.  $25^\circ$   
11.  $152^\circ$

### Student assessment 2 page 261

1. a)  $p = 130^\circ$   $q = 130^\circ$   $r = 50^\circ$   
b)  $a = 50^\circ$   $b = 50^\circ$   $c = 50^\circ$   $d = 50^\circ$
2. a)  $m = 50^\circ$   $n = 70^\circ$   $p = 70^\circ$   $q = 50^\circ$   
b)  $w = 85^\circ$   $x = 50^\circ$   $y = 50^\circ$   $z = 45^\circ$   
c)  $a = 130^\circ$   $b = 25^\circ$   $c = 25^\circ$   $d = 50^\circ$   
d)  $a = 40^\circ$   $b = 100^\circ$   $c = 40^\circ$   $d = 70^\circ$   
 $e = 70^\circ$
3.  $165^\circ$
4.  $1800^\circ$
5.  $30^\circ$
6. a)  $90^\circ$   
b) 13 cm
7.  $28^\circ$
8.  $125^\circ$
9.  $45^\circ$
10.  $42^\circ$
11.  $38^\circ$

### Student assessment 3 page 262

1. a) ii)  $\angle OBA$   $\angle OBC$   
b) i)  $\angle DAB + \angle DCB$   $\angle ADC + \angle CBA$   
c) iii)  $\angle DAC = \angle DBC$   $\angle ADB = \angle ACB$   
d) ii)  $\angle CAB$  iii)  $\angle ACB = \angle ABC$
2. a)  $42^\circ$  b)  $21^\circ$
3.  $\angle DAB = 117^\circ$   $\angle ABC = 92^\circ$
4.  $\angle BDC = 25^\circ$   $\angle DAB = 115^\circ$
5.  $\angle OQR = 15^\circ$   $\angle ORQ = \angle OPQ = 90^\circ$   
 $\angle RPQ = \angle PRQ = 75^\circ$   
 $\angle OPR = \angle ORP = 15^\circ$   $\angle ROP = 150^\circ$
6.  $35^\circ, 54^\circ, 91^\circ$  respectively
7.  $95^\circ, 85^\circ, 85^\circ, 92^\circ$  respectively

### Student assessment 4 page 264

1. a) i)  $\angle DAB + \angle DCB$   $\angle CDA + \angle CBA$   
b) i)  $\angle AOC + \angle CBA$   $\angle OCB + \angle OAB$   
ii)  $\angle OAB, \angle OCB$   
iii)  $\angle ABO = \angle CBO$   $\angle AOB = \angle COB$

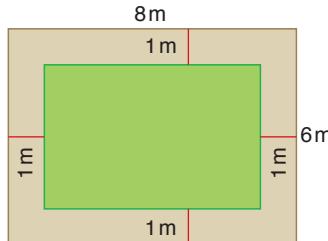
- c) iii)  $\angle TPS = \angle TQS = \angle TRS$   
 $\angle PTR = \angle PSR$   $\angle PTQ = \angle PSQ$   
 $\angle QTR = \angle QSR$   
d) ii)  $\angle OAX, \angle OCY$   
iii)  $\angle DCB = \angle BAD$   $\angle CDA = \angle CBA$

2.  $36^\circ$
3.  $\angle ABC = 50^\circ$   $\angle OAB = 25^\circ$   $\angle CAO = 40^\circ$
4.  $\angle BCD = 40^\circ = \angle BAD$   
 $\angle ABC = 65^\circ = \angle ADC$
5.  $28^\circ$  and  $56^\circ$  respectively
6.  $67.5^\circ$

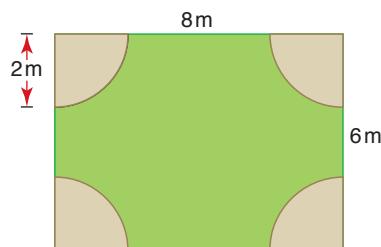
## 25 Loci

### Exercise 25.1 page 266

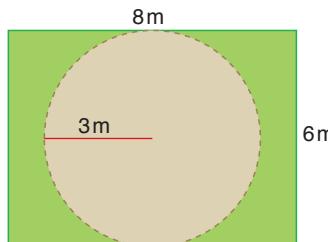
1.



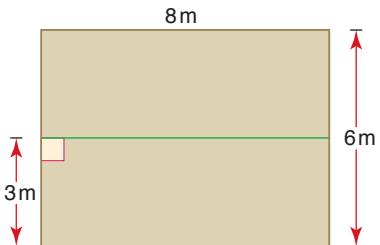
2.



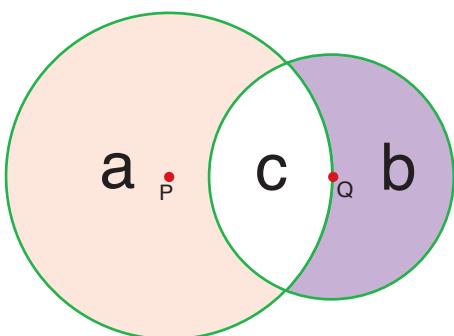
3.



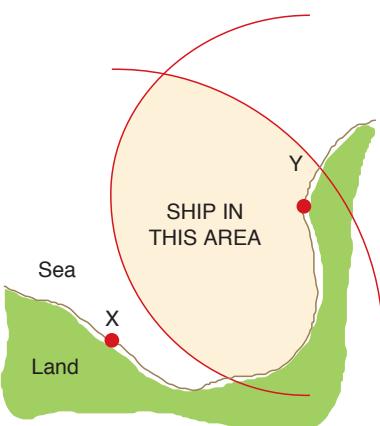
4.



5. a) b) c) d)

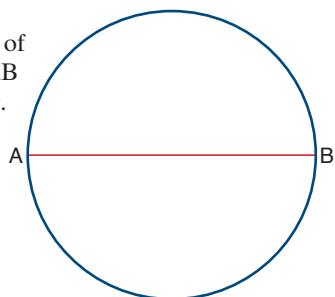


6.



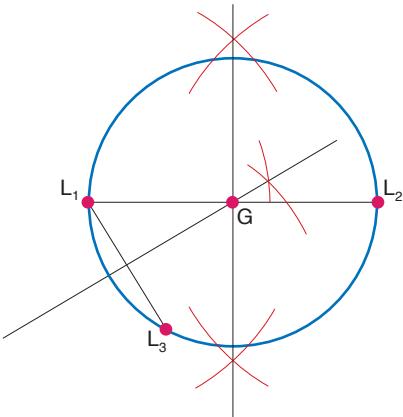
7. a) Student's own diagrams. L, M and N will all lie on the circumference of a circle, the centre of the circle being the point equidistant from L, M and N.  
 b) There would be no point equidistant from all three (except in the infinite!).

8. C is on the circumference of a circle with AB as its diameter.



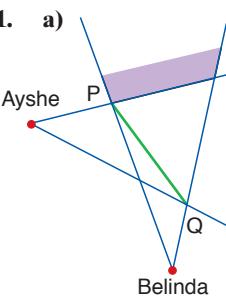
9. Student's own construction

10.

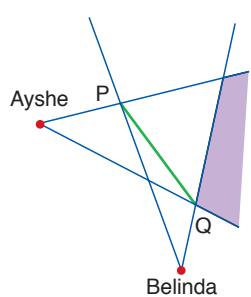


### Exercise 25.2 page 267

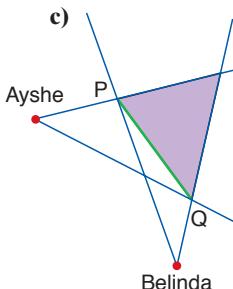
1.



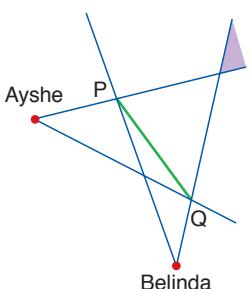
b)



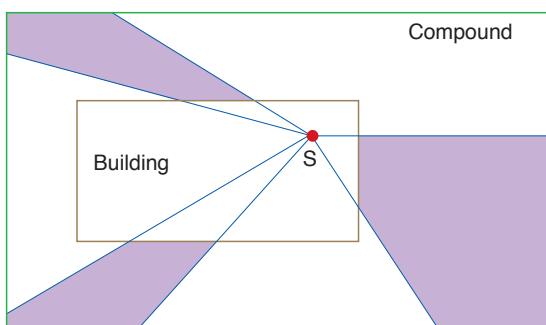
c)



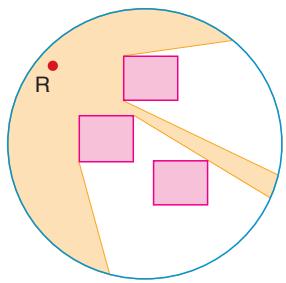
d)



2.



3.

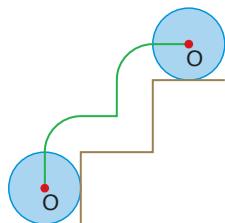


### Exercise 25.3 page 268

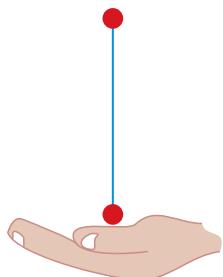
1.



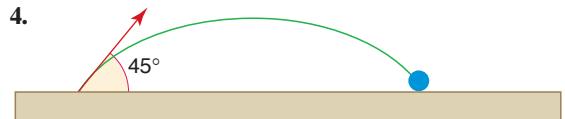
2.



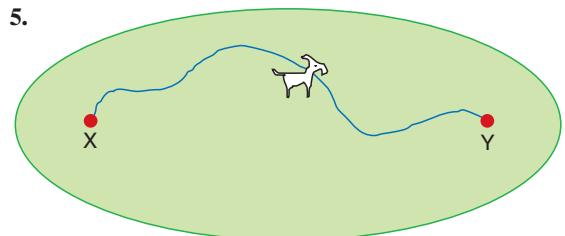
3.



4.

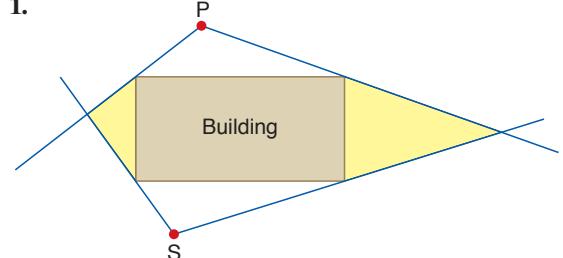


5.

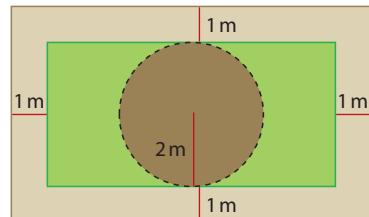


### Student assessment I page 269

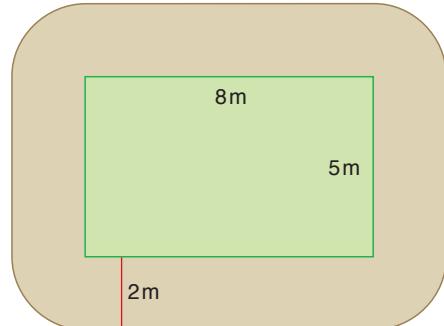
1.



2. a) b)

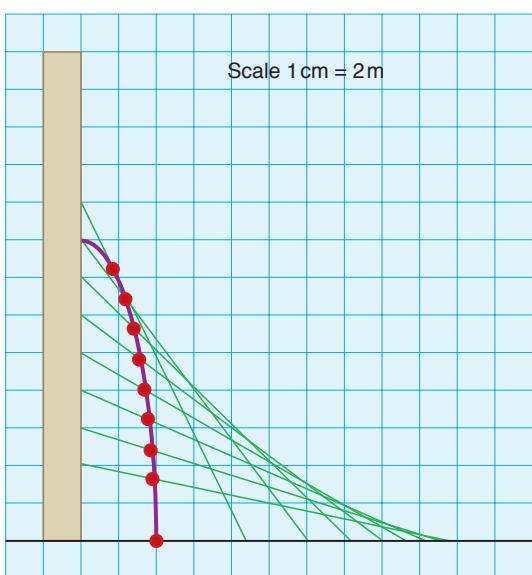


3.

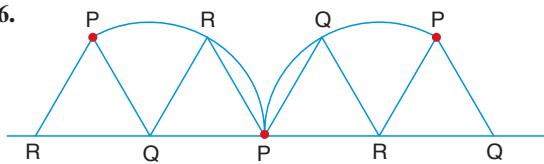


4. Ship's path is perpendicular bisector of AB.

5.

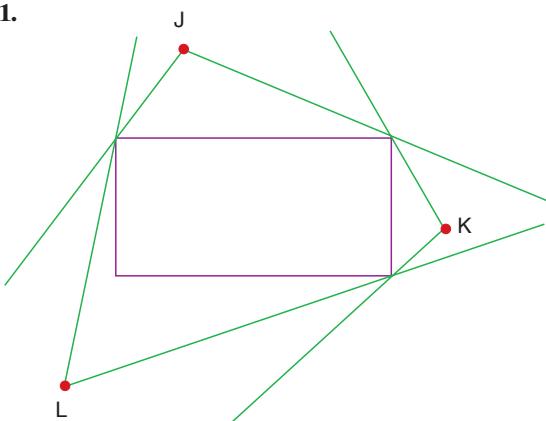


6.



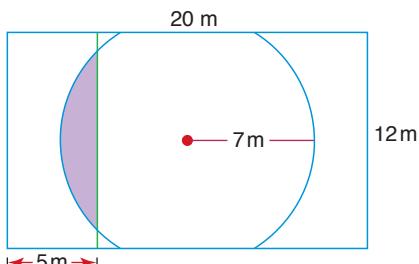
### **Student assessment 2** page 270

1.

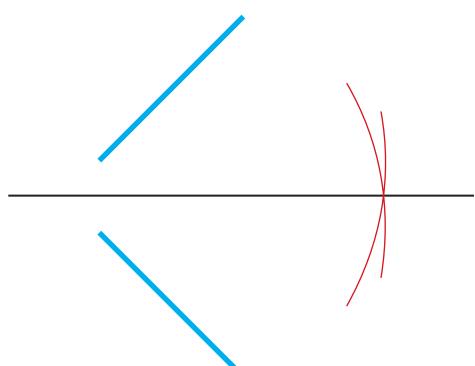


None of the friends can see each other, as shown above.

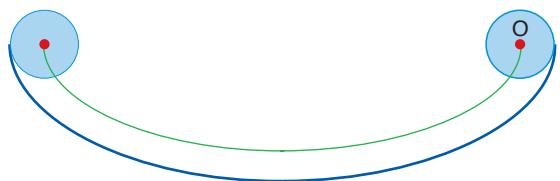
2.



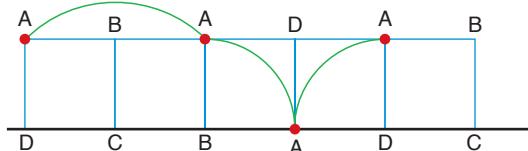
3.



4.



5.

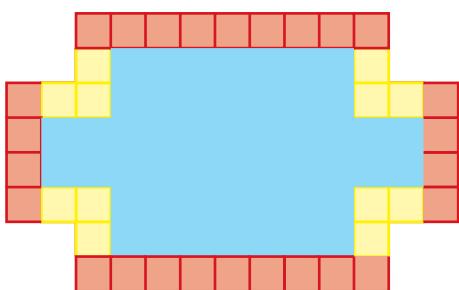


### **Topic 3 Mathematical investigations and ICT**

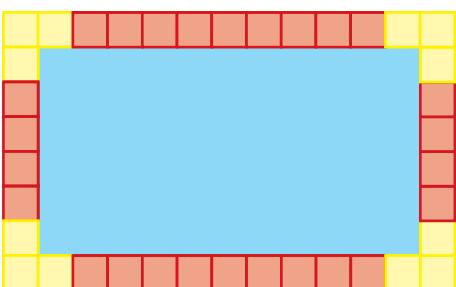
#### **Fountain borders** page 271

1. Student's results
2.  $T = 2(m + n + 2)$
3. There are many ways to prove the algebraic rule, for example:

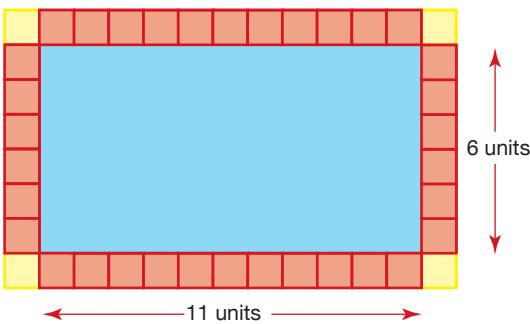
The original pool considered:



has the same number of tiles as a rectangular pool of dimensions  $11 \times 6$  units:



In the diagram below it can be seen that the number of tiles along the length and width of the pool is twice the length and width. This leaves the four tiles needed for the corners.



Hence  $T = 2m + 2n + 4$  which factorises to  $T = 2(m + n + 2)$ .

### **Tiled walls** page 272

1. Student's diagrams
2. Student's ordered table of results
3.  $c = (l - 1)(w - 1)$
4.  $t = 2(l - 1) + 2(w - 1)$

### **ICT activity 1** page 272

2. The ratios are the same.
3. a) The ratios remain the same.  
b) Ratios are still equal to each other (but probably of a different value from Q.1 (d)).
4. The ratios change as ED no longer parallel to AB.

### **ICT activity 2** page 273

Student's own demonstrations

## 26 Measures

### **Exercise 26.1** page 276

1. a) 100      b) 1000      c)  $\frac{1}{1000}$       d)  $\frac{1}{10000}$   
e) Millilitre
2. a) m, cm      b) cm      c) g      d) ml  
e) cm, m      f) tonne      g) litres      h) km  
i) tonne      j) litres

### **Exercise 26.2** page 277

1. a) mm      b) m      c) mm      d) m      e) m
2. a) 85      b) 230      c) 830      d) 50      e) 4
3. a) 5.6      b) 6400      c) 0.96      d) 4  
e) 0.012
4. a) 1.15      b) 250      c) 0.5      d) 0.07  
e) 0.008

### **Exercise 26.3** page 278

1. a) 3800      b) 28.5      c) 4280      d) 0.32  
e) 500

### **Exercise 26.4** page 278

1. a) 4500 ml      b) 1530 ml      c) 7050 ml  
d) 1000 ml
2. a) 1.2 litres      b) 1.34 litres      c) 1.4 litres  
d) 1.4 litres

### **Exercise 26.5** page 279

1. a)  $100\ 000\ \text{cm}^2$       b)  $2\ 000\ 000\ \text{mm}^2$   
c)  $5\ 000\ 000\ \text{m}^2$       d)  $3\ 200\ 000\ \text{m}^2$   
e)  $830\ \text{mm}^2$

2. a)  $0.05 \text{ m}^2$       b)  $150 \text{ cm}^2$   
 c)  $0.001 \text{ km}^2$       d)  $0.04 \text{ m}^2$   
 e)  $0.00025 \text{ km}^2$
3. a)  $2\,500\,000 \text{ cm}^3$       b)  $3400 \text{ mm}^3$   
 c)  $2\,000\,000\,000 \text{ m}^3$       d)  $200\,000 \text{ cm}^3$   
 e)  $30\,000\,000 \text{ mm}^3$
4. a)  $0.15 \text{ m}^3$       b)  $24 \text{ cm}^3$   
 c)  $0.00085 \text{ km}^3$       d)  $0.3 \text{ cm}^3$   
 e)  $0.000015 \text{ m}^3$

### Student assessment 1 page 280

1. a) 26      b) 88      c) 6.8      d) 875
2. a) 4200      b) 3.94      c) 4100      d) 720
3. a) 1.8      b) 3200      c) 83      d) 250
4. a)  $5600 \text{ mm}^2$   
 b)  $2\,050\,000 \text{ cm}^3$
5. a)  $0.00867 \text{ m}^3$   
 b)  $0.444 \text{ km}^3$

### Student assessment 2 page 280

1. a) 310      b) 6400      c) 4      d) 46
2. a) 0.0036      b) 0.55      c) 6.5      d) 1.51
3. a) 3.4      b) 6700      c) 730      d) 300
4. a)  $30\,000 \text{ mm}^2$   
 b)  $5000 \text{ m}^2$
5. a)  $0.1004 \text{ m}^3$   
 b)  $0.000005005 \text{ km}^3$

## 27 Perimeter, area and volume

### Exercise 27.1 page 282

1. a)  $6 \text{ cm}^2$       b)  $32.5 \text{ cm}^2$       c)  $20 \text{ cm}^2$   
 d)  $60 \text{ cm}^2$       e)  $108 \text{ cm}^2$       f)  $55 \text{ cm}^2$
2. a)  $64 \text{ cm}^2$       b)  $1168 \text{ mm}^2$       c)  $300 \text{ cm}^2$   
 d)  $937.5 \text{ mm}^2$

### Exercise 27.2 page 284

1.  $58.5 \text{ cm}^2$
2.  $84 \text{ cm}^2$
3.  $118.7 \text{ cm}^2$
4.  $157.5 \text{ cm}^2$

### Exercise 27.3 page 285

1. 4
2. 3
3.  $23.5 \text{ m}^2$
4. a)  $16 \text{ m}^2, 24 \text{ m}^2$       b)  $100 \text{ m}^2$       c) 15

### Exercise 27.4 page 287

1. a)  $25.1 \text{ cm}$       b)  $22.0 \text{ cm}$       c)  $28.9 \text{ cm}$   
 d)  $1.57 \text{ m}$
2. a)  $50.3 \text{ cm}^2$       b)  $38.5 \text{ cm}^2$       c)  $66.5 \text{ cm}^2$   
 d)  $0.196 \text{ m}^2$
3. a)  $2.39 \text{ cm}$  (3 s.f.)      b)  $0.5 \text{ cm}$   
 c)  $0.637 \text{ m}$  (3 s.f.)      d)  $1.27 \text{ mm}$  (3 s.f.)
4. a)  $4.51 \text{ cm}$  (3 s.f.)      b)  $6 \text{ cm}$   
 c)  $3.23 \text{ m}$  (3 s.f.)      d)  $4.31 \text{ mm}$  (3 s.f.)

### Exercise 27.5 page 287

1. a)  $1.57 \text{ m}$  (2 d.p.)      b) 637 times (3 s.f.)
2.  $188 \text{ m}$  (3 s.f.)
3.  $264 \text{ mm}^2$  (3 s.f.)
4. a)  $144 \text{ cm}^2$       b)  $28.3 \text{ cm}^2$  (3 s.f.)  
 c)  $30.9 \text{ cm}^2$  (3 s.f.)
5. a)  $57.1 \text{ m}$  (3 s.f.)      b)  $178.3 \text{ m}^2$  (3 s.f.)

### Exercise 27.6 page 289

1. a)  $460 \text{ cm}^2$       b)  $208 \text{ cm}^2$       c)  $147.78 \text{ cm}^2$   
 d)  $33.52 \text{ cm}^2$
2. a) 2 cm      b) 4 cm      c) 6 cm      d) 5 cm
3. a)  $101 \text{ cm}^2$  (3 s.f.)      b)  $276 \text{ cm}^2$  (3 s.f.)  
 c)  $279 \text{ cm}^2$  (3 s.f.)      d)  $25.6 \text{ cm}^2$  (3 s.f.)
4. a) 1.2 cm      b) 0.5 cm      c) 1.7 cm  
 d) 7.0 cm

### Exercise 27.7 page 289

1. a)  $24 \text{ cm}^2$       b) 2 cm
2. a)  $216 \text{ cm}^2$       b)  $15.2 \text{ cm}$  (3 s.f.)
3. a)  $94.2 \text{ cm}^2$  (3 s.f.)      b) 14 cm
4. 4.4 cm

### Exercise 27.8 page 290

1. a)  $24 \text{ cm}^3$       b)  $18 \text{ cm}^3$       c)  $27.6 \text{ cm}^3$   
 d)  $8.82 \text{ cm}^3$

2. a)  $452 \text{ cm}^3$  (3 s.f.) b)  $277 \text{ cm}^3$  (3 s.f.)  
c)  $196 \text{ cm}^3$  (3 s.f.) d)  $0.481 \text{ cm}^3$  (3 s.f.)
3. a)  $108 \text{ cm}^3$  b)  $140 \text{ cm}^3$  c)  $42 \text{ cm}^3$   
d)  $6.2 \text{ cm}^3$
4. a)  $70 \text{ cm}^3$  b)  $96 \text{ cm}^3$  c)  $380 \text{ cm}^3$   
d)  $137.5 \text{ cm}^3$

**Exercise 27.9** page 291

1. a)  $16 \text{ cm}$  b)  $4096 \text{ cm}^3$  c)  $3217 \text{ cm}^3$   
d)  $21.5\%$  (3 s.f.)
2. a)  $42 \text{ cm}^2$  b)  $840 \text{ cm}^3$
3.  $6.3 \text{ cm}$
4.  $2.90 \text{ m}^3$  (3 s.f.)

**Exercise 27.10** page 293

1. a)  $6.28 \text{ cm}$  b)  $2.09 \text{ cm}$  c)  $11.5 \text{ cm}$   
d)  $23.6 \text{ cm}$
2. a)  $32.7^\circ$  (1 d.p.) b)  $229.2^\circ$  (1 d.p.)  
c)  $57.3^\circ$  (1 d.p.) d)  $114.6^\circ$  (1 d.p.)
3. a)  $12.2 \text{ cm}$  (3 s.f.) b)  $4.58 \text{ cm}$  (3 s.f.)  
c)  $18.6 \text{ cm}$  (3 s.f.) d)  $4.01 \text{ cm}$  (3 s.f.)

**Exercise 27.11** page 293

1. a)  $48.8 \text{ cm}$  (3 s.f.) b)  $105 \text{ cm}$  (3 s.f.)
2. a)  $3.67 \text{ cm}$  (3 s.f.) b)  $49.7 \text{ cm}$  (3 s.f.)  
c)  $68.8^\circ$  (1 d.p.)
3. a)  $12 \text{ cm}$  b)  $54 \text{ cm}$  c)  $47.7^\circ$  (1 d.p.)

**Exercise 27.12** page 294

1. a)  $33.5 \text{ cm}^2$  (3 s.f.) b)  $205 \text{ cm}^2$  (3 s.f.)  
c)  $5.65 \text{ cm}^2$  (3 s.f.) d)  $44.7 \text{ cm}^2$  (3 s.f.)
2. a)  $18.5 \text{ cm}$  (3 s.f.) b)  $20.0 \text{ cm}$  (3 s.f.)  
c)  $1.75 \text{ cm}$  (3 s.f.) d)  $12.4 \text{ cm}$  (3 s.f.)
3. a)  $48^\circ$  b)  $34^\circ$   
c)  $20^\circ$  d)  $127^\circ$

**Exercise 27.13** page 295

1.  $79.2 \text{ m}^2$  (3 s.f.)
2. a)  $118 \text{ cm}^2$  (3 s.f.) b)  $39.3 \text{ cm}^2$  (3 s.f.)  
c)  $8.66 \text{ cm}$  (3 s.f.)
3. a)  $4.19 \text{ cm}$  (3 s.f.) b)  $114 \text{ cm}^2$  (3 s.f.)  
c)  $62.8 \text{ cm}^3$  (3 s.f.)
4. a)  $9.40 \text{ cm}$  (3 s.f.) b)  $0.60 \text{ cm}$  (2 s.f.)

- c)  $34.9 \text{ cm}^2$  (3 s.f.)  
d) Length =  $17.1 \text{ cm}$  (3 s.f.)  
Width =  $10.6 \text{ cm}$  (3 s.f.)  
e)  $41.7 \text{ cm}^2$  (3 s.f.)

5. a)  $20^\circ$  b)  $0.64 \text{ cm}$  (2 s.f.)  
c) Length =  $13.7 \text{ cm}$  (3 s.f.)  
Width =  $11.3 \text{ cm}$  (3 s.f.)  
d)  $5.43 \text{ cm}^2$  (3 s.f.)

**Exercise 27.14** page 296

1. a)  $905 \text{ cm}^3$  (3 s.f.) b)  $3590 \text{ cm}^3$  (3 s.f.)  
c)  $2310 \text{ cm}^3$  (3 s.f.) d)  $1.44 \text{ cm}^3$  (3 s.f.)
2. a)  $3.1 \text{ cm}$  b)  $5.6 \text{ cm}$   
c)  $36.3 \text{ cm}$  d)  $0.6 \text{ cm}$

**Exercise 27.15** page 297

1.  $6.3 \text{ cm}$
2.  $86.7 \text{ cm}^3$  (3 s.f.)
3.  $11.9 \text{ cm}$  (1 d.p.)
4. a)  $4190 \text{ cm}^3$  (3 s.f.) b)  $8000 \text{ cm}^3$  c)  $48\%$
5.  $10.0 \text{ cm}$
6. A =  $4.1 \text{ cm}$ , B =  $3.6 \text{ cm}$ , C =  $3.1 \text{ cm}$
7.  $3 : 2$

**Exercise 27.16** page 297

1. a)  $452 \text{ cm}^2$  (3 s.f.) b)  $254 \text{ cm}^2$  (3 s.f.)  
c)  $1890 \text{ cm}^2$  (3 s.f.) d)  $4 \text{ cm}^2$
2. a)  $1.99 \text{ cm}$  (3 s.f.) b)  $1.15 \text{ cm}$  (3 s.f.)  
c)  $3.09 \text{ mm}$  (3 s.f.) d)  $0.5 \text{ cm}$
3.  $1 : 4$
4. a)  $157 \text{ cm}^2$  (3 s.f.) b)  $15 \text{ cm}$   
c)  $707 \text{ cm}^2$  (3 s.f.)
5. a)  $804.2 \text{ cm}^2$  b)  $5.9 \text{ cm}$  (1 d.p.)

**Exercise 27.17** page 299

1.  $40 \text{ cm}^3$
2.  $133 \text{ cm}^3$  (3 s.f.)
3.  $64 \text{ cm}^3$
4.  $70 \text{ cm}^3$

**Exercise 27.18** page 299

1. 7 cm
2. 5 cm
3. a) 8 cm    b)  $384 \text{ cm}^3$     c)  $378 \text{ cm}^3$
4. a) 3.6 cm    b)  $21.7 \text{ cm}^3$  (3 s.f.)  
c)  $88.7 \text{ cm}^3$  (3 s.f.)

**Exercise 27.19** page 300

1.  $6.93 \text{ cm}^2$  (3 s.f.)
2.  $189 \text{ cm}^2$  (3 s.f.)
3.  $73.3 \text{ cm}^2$  (3 s.f.)
4.  $1120 \text{ cm}^2$  (3 s.f.)
5. a)  $693 \text{ cm}^2$  (3 s.f.)    b)  $137 \text{ cm}^2$  (3 s.f.)  
c) 23.6 cm (3 s.f.)

**Exercise 27.20** page 303

1. a)  $56.5 \text{ cm}^3$  (3 s.f.)    b)  $264 \text{ cm}^3$  (3 s.f.)  
c)  $1.34 \text{ cm}^3$  (3 s.f.)    d)  $166 \text{ cm}^3$  (3 s.f.)
2. a) 6.91 cm (3 s.f.)    b) 10.9 cm (3 s.f.)  
c) 0.818 cm (3 s.f.)    d) 51.3 cm (3 s.f.)
3. a) i) 7.96 cm    ii) 12.7 cm    iii)  $843 \text{ cm}^3$   
b) i) 15.9 cm    ii) 8.41 cm    iii)  $2230 \text{ cm}^3$   
c) i) 6.37 cm    ii) 3.97 cm    iii)  $168 \text{ cm}^3$   
d) i) 3.82 cm    ii) 4.63 cm    iii)  $70.7 \text{ cm}^3$

**Exercise 27.21** page 303

1. 3.88 cm (3 s.f.)
2. a) 33.0 cm (3 s.f.)    b) 5.25 cm (3 s.f.)  
c) 7.31 cm (3 s.f.)    d)  $211 \text{ cm}^3$  (3 s.f.)
3. a)  $2304 \text{ cm}^3$     b)  $603 \text{ cm}^3$  (3 s.f.)  
c)  $1700 \text{ cm}^3$  (3 s.f.)
4. a)  $81.6 \text{ cm}^3$  (3 s.f.)    b)  $275 \text{ cm}^3$  (3 s.f.)  
c) 8 : 27

**Exercise 27.22** page 304

1.  $81.8 \text{ cm}^3$  (3 s.f.)
2.  $771 \text{ cm}^3$  (3 s.f.)
3.  $3170 \text{ cm}^3$  (3 s.f.)
4. a)  $654 \text{ cm}^3$     b) 12.5 cm    c)  $2950 \text{ cm}^3$

**Exercise 27.23** page 305

1. a)  $415 \text{ cm}^2$  (3 s.f.)    b)  $1650 \text{ cm}^2$  (3 s.f.)
2.  $1130 \text{ cm}^2$  (3 s.f.)

**Student assessment 1** page 306

1.  $90 \text{ cm}^2$
2. a) Circumference = 34.6 cm  
Area =  $95.0 \text{ cm}^2$   
b) Circumference = 50.3 mm  
Area =  $201 \text{ mm}^2$
3.  $9.86 \text{ cm}^2$
4. a)  $39.3 \text{ cm}^2$     b)  $34 \text{ cm}^2$     c)  $101.3 \text{ cm}^2$
5. a)  $10.2 \text{ cm}^2$     b)  $283 \text{ cm}^2$     c)  $633 \text{ cm}^2$
6. a)  $339 \text{ mm}^3$     b)  $9.82 \text{ cm}^3$

**Student assessment 2** page 307

1.  $104 \text{ cm}^2$
2. a) Circumference = 27.0 cm  
Area =  $58.1 \text{ cm}^2$   
b) Circumference = 47.1 mm  
Area =  $177 \text{ mm}^2$
3.  $326 \text{ cm}^2$
4. a)  $56.5 \text{ cm}^2$     b)  $108 \text{ cm}^2$     c)  $254.5 \text{ cm}^2$
5.  $418 \text{ cm}^3$
6. a)  $1012 \text{ cm}^2$     b)  $523 \text{ cm}^2$

**Student assessment 3** page 308

1. a) 11.8 cm (3 s.f.)    b) 35.3 cm (3 s.f.)
2. a)  $272.2^\circ$  (1 d.p.)    b)  $5.7^\circ$  (1 d.p.)
3.  $232 \text{ cm}^2$  (3 s.f.)
4. a)  $531 \text{ cm}^2$     b)  $1150 \text{ cm}^3$
5. a)  $1210 \text{ cm}^2$  (3 s.f.)    b)  $2592 \text{ cm}^3$

**Student assessment 4** page 309

1. a) 178 cm (3 s.f.)    b) 68.3 mm (3 s.f.)
2. a)  $143.2^\circ$  (1 d.p.)    b)  $2.9^\circ$  (1 d.p.)
3.  $95.5 \text{ cm}^2$  (3 s.f.)
4. a)  $603.2 \text{ cm}^2$     b)  $1072.3 \text{ cm}^3$
5. a) 22.5 cm    b)  $126 \text{ cm}^3$     c)  $3270 \text{ cm}^3$

**Student assessment 5** page 309

1. a) 22.9 cm (3 s.f.) b)  $229 \text{ cm}^2$  (3 s.f.)  
c)  $985 \text{ cm}^2$  (3 s.f.) d)  $1830 \text{ cm}^3$  (3 s.f.)
2. a)  $905 \text{ cm}^3$  (3 s.f.) b) 12 cm  
c)  $13.4 \text{ cm}$  (3 s.f.) d)  $958.2 \text{ cm}^2$
3. a) 10 cm b)  $82.1 \text{ cm}^3$  (3 s.f.)  
c)  $71.8 \text{ cm}^3$  (3 s.f.) d)  $30.8 \text{ cm}^3$  (3 s.f.)  
e)  $41.1 \text{ cm}^3$  (3 s.f.)

**Student assessment 6** page 310

1. a)  $3620 \text{ cm}^3$  (3 s.f.) b)  $3620 \text{ cm}^3$  (3 s.f.)  
c)  $905 \text{ cm}^2$  (3 s.f.) d)  $1920 \text{ cm}^2$  (3 s.f.)
2. a)  $43.3 \text{ cm}^2$  (3 s.f.) b)  $173 \text{ cm}^2$  (3 s.f.)
3. a)  $314 \text{ cm}^2$  (3 s.f.) b) 26.9 cm

**Topic 4 Mathematical investigations and ICT****Metal trays** page 311

1. a) length = 38 cm  
width = 28 cm  
height = 1 cm  
b)  $1064 \text{ cm}^3$
2. a) length = 36 cm  
width = 26 cm  
height = 2 cm  
b)  $1872 \text{ cm}^3$
3. Student's investigation and ordered table of results similar to this one.

| Square length (cm) | Tray dimensions (cm) |       |        | Volume |
|--------------------|----------------------|-------|--------|--------|
|                    | Length               | Width | Height |        |
| 1                  | 38                   | 28    | 1      | 1064   |
| 2                  | 36                   | 26    | 2      | 1872   |
| 3                  | 34                   | 24    | 3      | 2448   |
| 4                  | 32                   | 22    | 4      | 2816   |
| 5                  | 30                   | 20    | 5      | 3000   |
| 6                  | 28                   | 18    | 6      | 3024   |
| 7                  | 26                   | 16    | 7      | 2912   |
| 8                  | 24                   | 14    | 8      | 2688   |
| 9                  | 22                   | 12    | 9      | 2376   |
| 10                 | 20                   | 10    | 10     | 2000   |
| 11                 | 18                   | 8     | 11     | 1584   |
| 12                 | 16                   | 6     | 12     | 1152   |
| 13                 | 14                   | 4     | 13     | 728    |
| 14                 | 12                   | 2     | 14     | 336    |
| 15                 | 10                   | 0     | 15     | 0      |

4.  $x = 5.7 \text{ cm}$
5. Maximum volume =  $3032 \text{ cm}^3$

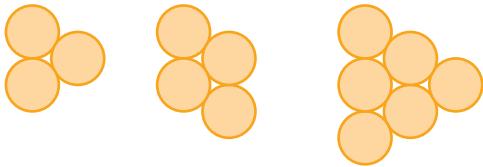
**Tennis balls** page 312

1. Cuboids of the following dimensions should be considered. Note each unit represents the diameter of one tennis ball and only different combinations are considered.  
 $1 \times 1 \times 12$     $1 \times 2 \times 6$     $1 \times 3 \times 4$     $2 \times 2 \times 3$
2. Total surface area of a cuboid is given by the formula:  $A = 2(lw + lh + wh)$   
Total surface area of the four options are as shown (to nearest whole number):

| Dimensions (units)     | Length (cm) | Width (cm) | Height (cm) | Surface area (cm <sup>2</sup> ) |
|------------------------|-------------|------------|-------------|---------------------------------|
| $1 \times 1 \times 12$ | 6.6         | 6.6        | 79.2        | 2178                            |
| $1 \times 2 \times 6$  | 6.6         | 13.2       | 39.6        | 1742                            |
| $1 \times 3 \times 4$  | 6.6         | 19.8       | 26.4        | 1655                            |
| $2 \times 2 \times 3$  | 13.2        | 13.2       | 19.8        | 1394                            |

The optimum dimensions of the box are 13.2 cm × 13.2 cm × 19.8 cm.

3. Cross-sections of possible designs are shown below:



4. Student's investigations  
5. Student's conclusion based on their calculations

### **ICT activity** page 312

1. Possible formulae are given:  
In cell B2: =A2/360\*2\*PI()\*10  
C2: =B2  
D2:=C2/(2\*PI())  
E2: =SQRT((100-D2^2))  
F2: =1/3\*PI()\*D2^2\*E2

## 28 Straight-line graphs

### **Exercise 28.1** page 319

1. a) 1      b)  $\frac{3}{2}$       c) -2  
d)  $-\frac{1}{4}$       e) 0      f) infinite  
2. A horizontal line has a zero gradient.  
3. A vertical line has an infinite gradient.  
4. Gradient of A = 2  
Gradient of B = 0  
Gradient of C = -3  
Gradient of D =  $-\frac{1}{2}$   
Gradient of E =  $\frac{1}{2}$   
Gradient of F is infinite.

### **Exercise 28.2** page 321

1. a)  $y = 7$       b)  $y = 2$       c)  $x = 7$   
d)  $x = 3$       e)  $y = x$       f)  $y = \frac{1}{2}x$   
g)  $y = -x$       h)  $y = -2x$

### **Exercise 28.3** page 322

1. a)  $y = x + 1$       b)  $y = x + 3$       c)  $y = x - 2$   
d)  $y = 2x + 2$       e)  $y = \frac{1}{2}x + 5$       f)  $y = \frac{1}{2}x - 1$   
2. a)  $y = -x + 4$       b)  $y = -x - 2$   
c)  $y = -2x - 2$       d)  $y = -\frac{1}{2}x + 3$   
e)  $y = -\frac{3}{2}x + 2$       f)  $y = -4x + 1$   
3. a) 1      b) 1      c) 1  
d) 2      e)  $\frac{1}{2}$       f)  $\frac{1}{2}$   
2. a) -1      b) -1      c) -2  
d)  $-\frac{1}{2}$       e)  $-\frac{3}{2}$       f) -4  
b) The gradient is equal to the coefficient of  $x$ .  
c) The constant being added/subtracted indicates where the line intersects the  $y$ -axis.  
4. Only the intercept  $c$  is different.  
5. The lines are parallel.

### **Exercise 28.4** page 325

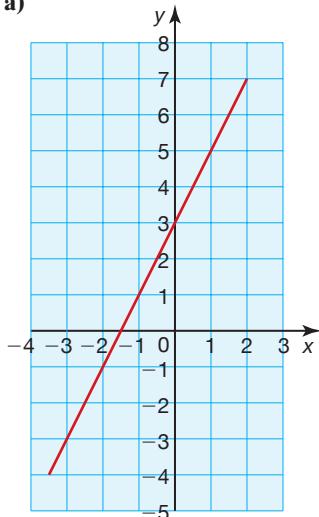
1. a)  $m = 2$       c)  $m = 1$       b)  $m = 3$       c)  $m = 5$   
c)  $m = 1$       c)  $m = -2$       d)  $m = \frac{1}{2}$       c)  $m = 4$   
e)  $m = -3$       c)  $m = 6$       f)  $m = -\frac{2}{3}$       c)  $m = 1$   
g)  $m = -1$       c)  $m = 0$       h)  $m = -1$       c)  $m = -2$   
i)  $m = -2$       c)  $m = 2$   
2. a)  $m = 3$       c)  $m = 1$       b)  $m = -\frac{1}{2}$       c)  $m = 2$   
c)  $m = -2$       c)  $m = -3$       d)  $m = -2$       c)  $m = -4$   
e)  $m = \frac{1}{4}$       c)  $m = 6$       f)  $m = 3$       c)  $m = 2$   
g)  $m = 1$       c)  $m = -2$       h)  $m = -8$       c)  $m = 6$   
i)  $m = 3$       c)  $m = 1$   
3. a)  $m = 2$       c)  $m = -3$       b)  $m = \frac{1}{2}$       c)  $m = 4$   
c)  $m = 2$       c)  $m = -4$       d)  $m = -8$       c)  $m = 12$   
e)  $m = 2$       c)  $m = 0$       f)  $m = -3$       c)  $m = 3$   
g)  $m = 2$       c)  $m = 1$       h)  $m = -\frac{1}{2}$       c)  $m = 2$   
i)  $m = 2$       c)  $m = -\frac{1}{2}$   
4. a)  $m = 2$       c)  $m = -4$       b)  $m = 1$       c)  $m = 6$   
c)  $m = -3$       c)  $m = -1$       d)  $m = -1$       c)  $m = 4$   
e)  $m = 10$       c)  $m = -2$       f)  $m = -3$       c)  $m = \frac{3}{2}$   
g)  $m = -9$       c)  $m = 2$       h)  $m = 6$       c)  $m = -14$   
i)  $m = 2$       c)  $m = -\frac{3}{2}$   
5. a)  $m = 2$       c)  $m = -2$       b)  $m = 2$       c)  $m = 3$   
c)  $m = 1$       c)  $m = 0$       d)  $m = \frac{3}{2}$       c)  $m = 6$   
e)  $m = -1$       c)  $m = \frac{2}{3}$       f)  $m = -4$       c)  $m = 2$   
g)  $m = 3$       c)  $m = -12$       h)  $m = 0$       c)  $m = 0$   
i)  $m = -3$       c)  $m = 0$   
6. a)  $m = 1$       c)  $m = 0$       b)  $m = -\frac{1}{2}$       c)  $m = -2$   
c)  $m = -3$       c)  $m = 0$       d)  $m = 1$       c)  $m = 0$   
e)  $m = -2$       c)  $m = -\frac{3}{2}$       f)  $m = \frac{2}{3}$       c)  $m = -4$   
7. a)  $m = -\frac{2}{5}$       c)  $m = 0$       b)  $m = \frac{1}{3}$       c)  $m = -\frac{5}{6}$   
c)  $m = 3$       c)  $m = 0$       d)  $m = -1$       c)  $m = -4$

**Exercise 28.5** page 327

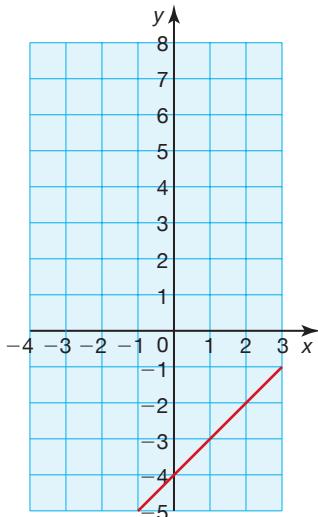
1. Any line with a gradient of 1
2. a, b and d are parallel
3.  $y = 4x$
4. a)  $y = -3x + 4$       b)  $y = -3x - 2$   
c)  $y = -3x - \frac{7}{2}$
5. a)  $y = \frac{1}{2}x + 3$       b)  $y = \frac{1}{2}x - \frac{1}{4}$

**Exercise 28.6** page 328

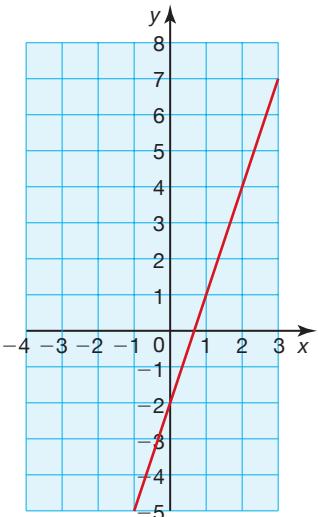
1. a)



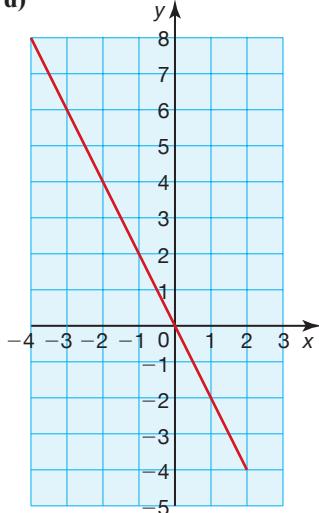
b)



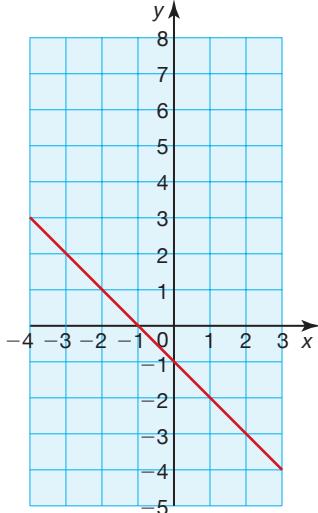
c)



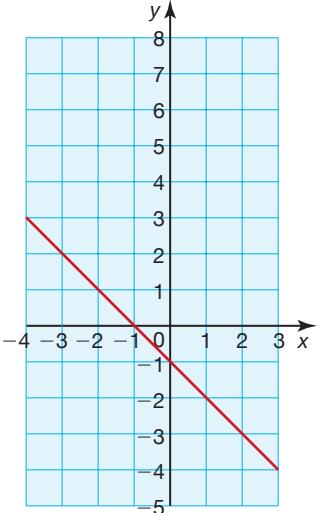
d)

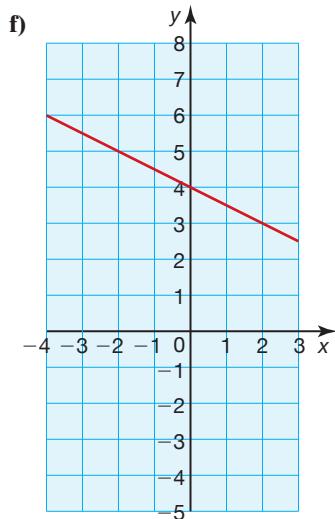
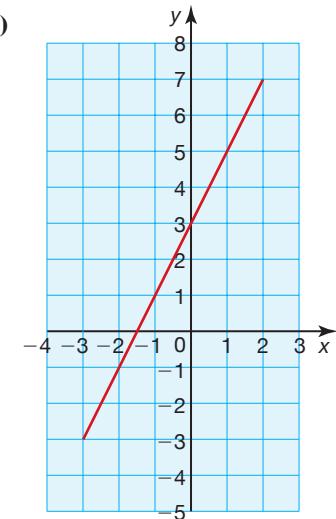
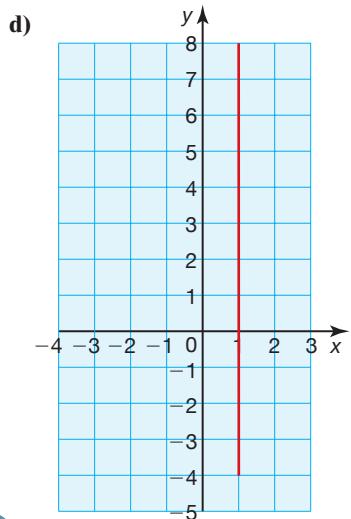
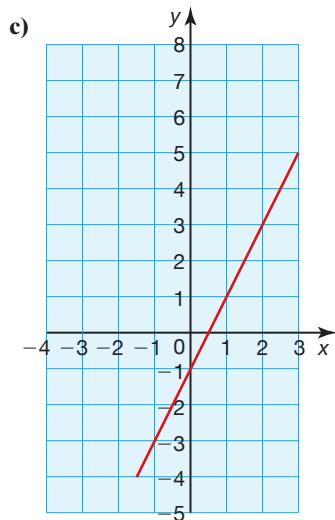
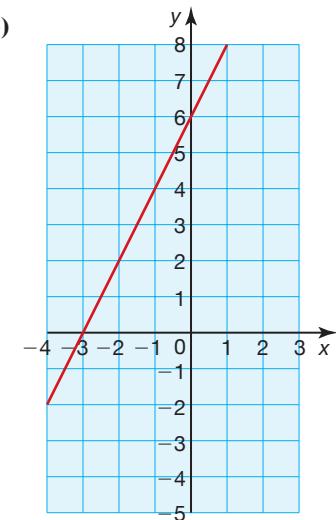
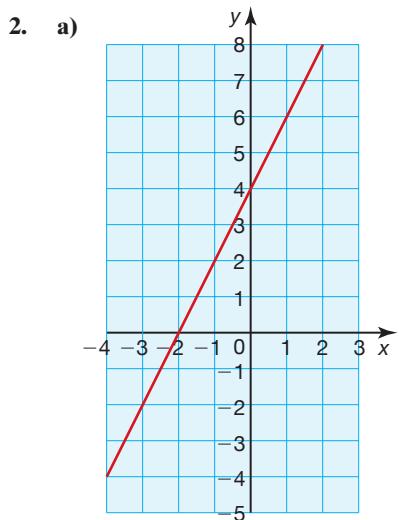
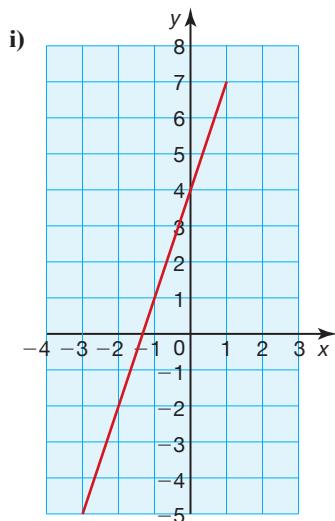
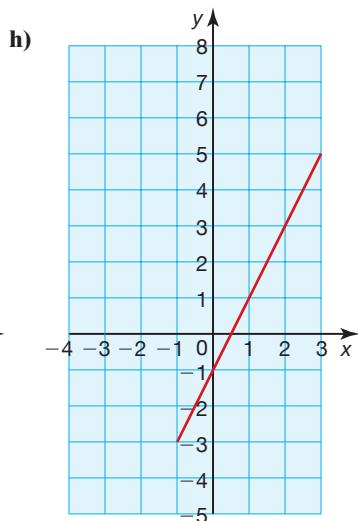
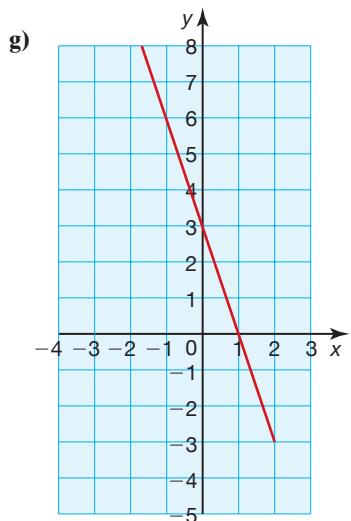


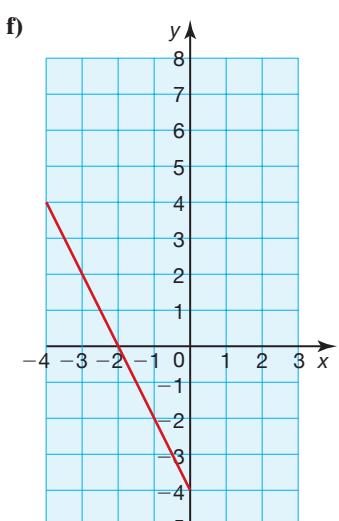
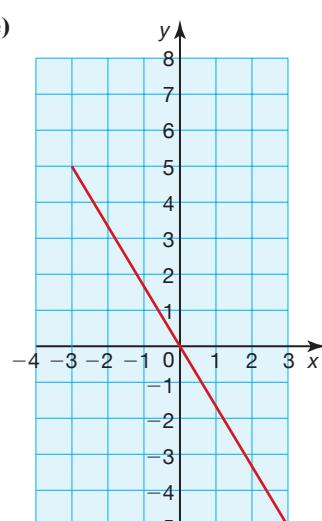
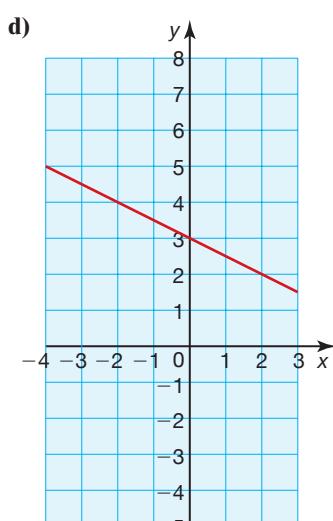
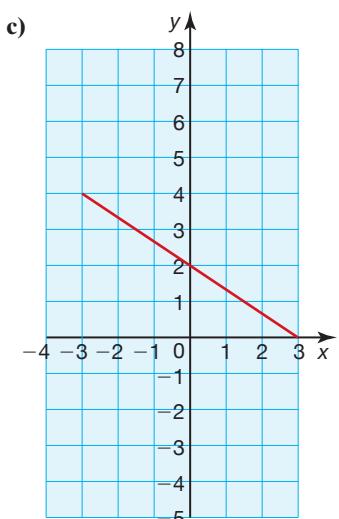
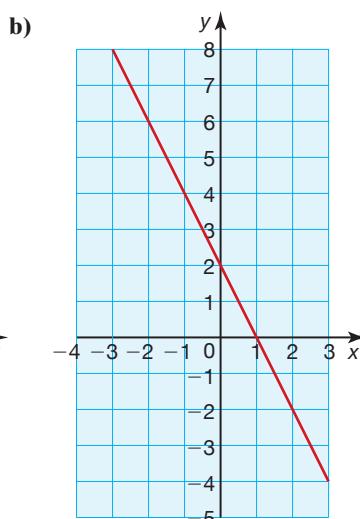
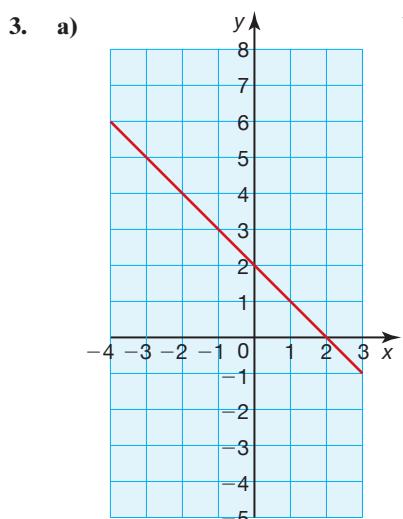
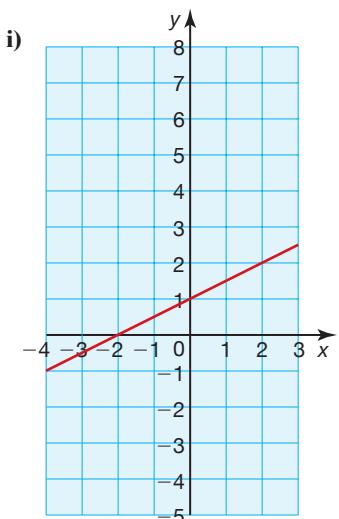
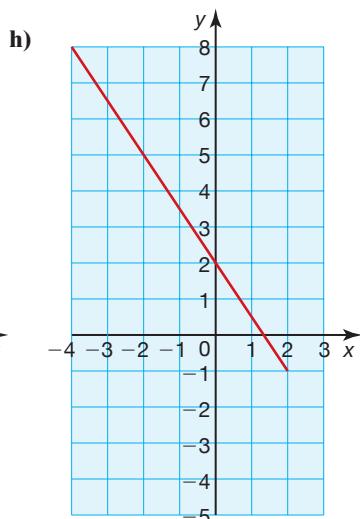
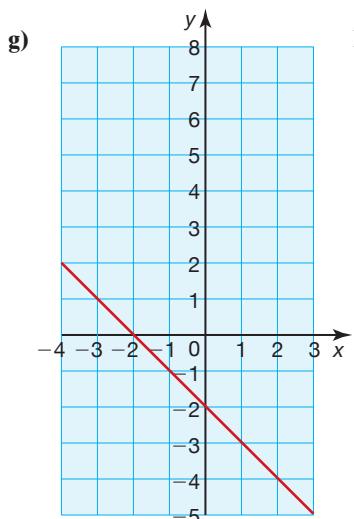
e)

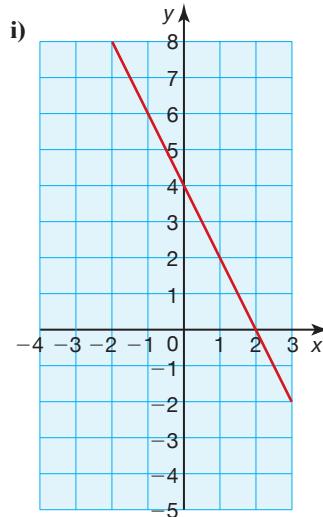
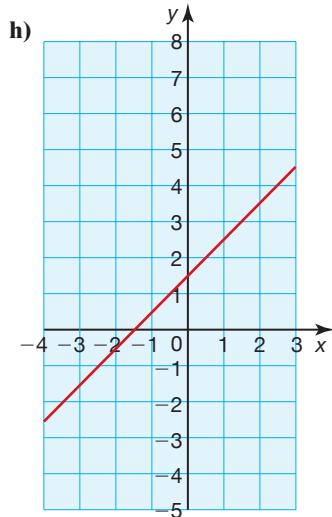
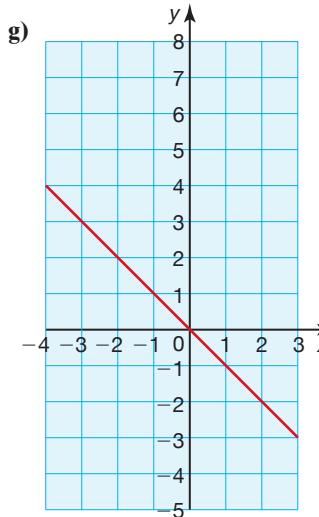


f)









**Exercise 28.7** page 330

1. a) (3, 2)      b) (5, 2)      c) (2, 1)  
d) (2, 1)      e) (-4, 1)      f) (4, -2)
2. a) (3, -2)      b) (-1, -1)      c) (-2, 3)  
d) (-3, -3)      e) Infinite solutions  
f) No solution

**Exercise 28.8** page 331

1. a) ii) 5.66 units (3 s.f.) iii) (3, 4)  
b) ii) 4.24 units (3 s.f.) iii) (4.5, 2.5)  
c) ii) 5.66 units (3 s.f.) iii) (3, 6)  
d) ii) 8.94 units (3 s.f.) iii) (2, 4)  
e) ii) 6.32 units (3 s.f.) iii) (3, 4)  
f) ii) 6.71 units (3 s.f.) iii) (-1.5, 4)  
g) ii) 8.25 units (3 s.f.) iii) (-2, 1)  
h) ii) 8.94 units (3 s.f.) iii) (0, 0)  
i) ii) 7 units                                    iii) (0.5, 5)  
j) ii) 6 units                                    iii) (2, 3)  
k) ii) 8.25 units (3 s.f.) iii) (0, 4)  
l) ii) 10.8 units (3 s.f.) iii) (0, 1.5)

2. a) i) 4.24 units (3 s.f.) ii) (2.5, 2.5)  
b) i) 5.66 units (3 s.f.) ii) (5, 4)  
c) i) 8.94 units (3 s.f.) ii) (4, 2)  
d) i) 8.94 units (3 s.f.) ii) (5, 0)  
e) i) 4.24 units (3 s.f.) ii) (-1.5, 4.5)  
f) i) 4.47 units (3 s.f.) ii) (-4, -3)  
g) i) 7.21 units (3 s.f.) ii) (0, 3)  
h) i) 7.21 units (3 s.f.) ii) (5, -1)  
i) i) 12.4 units (3 s.f.) ii) (0, 2.5)  
j) i) 8.49 units (3 s.f.) ii) (1, -1)  
k) i) 11 units                                    ii) (0.5, -3)  
l) i) 8.25 units (3 s.f.) ii) (4, 2)

**Exercise 28.9** page 333

1. a)  $y = 2x - 1$       b)  $y = 3x + 1$   
c)  $y = 2x + 3$       d)  $y = x - 4$   
e)  $y = 4x + 2$       f)  $y = -x + 4$   
g)  $y = -2x + 2$       h)  $y = -3x - 1$   
i)  $y = \frac{1}{2}x$
2. a)  $y = \frac{1}{7}x + \frac{26}{7}$       b)  $y = \frac{6}{7}x + \frac{4}{7}$   
c)  $y = \frac{3}{2}x + \frac{15}{2}$       d)  $y = 9x - 13$   
e)  $y = -\frac{1}{2}x + \frac{5}{2}$       f)  $y = -\frac{3}{13}x + \frac{20}{13}$   
g)  $y = 2$       h)  $y = -3x$   
i)  $x = 6$

**Exercise 28.10** page 335

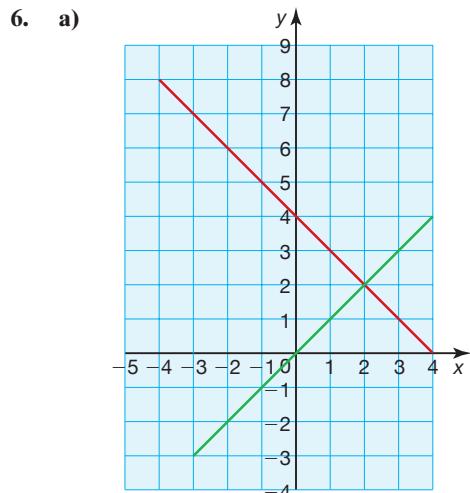
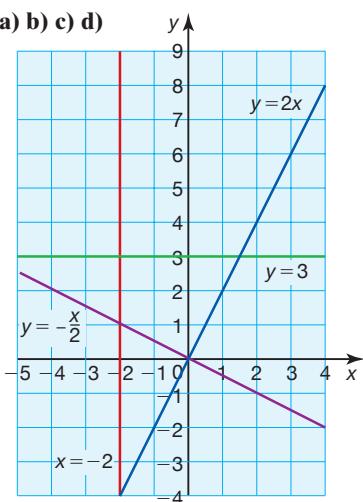
1. a) i) -1      ii) 1      iii)  $y = x - 3$   
b) i) -1      ii) 1      iii)  $y = x - 5$   
c) i) -2      ii)  $\frac{1}{2}$       iii)  $y = \frac{1}{2}x - 5$   
d) i)  $-\frac{1}{2}$       ii) 2      iii)  $y = 2x - 20$   
e) i) -1      ii) 1      iii)  $y = x + 9$   
f) i) -2      ii)  $\frac{1}{2}$       iii)  $y = \frac{1}{2}x + \frac{3}{2}$   
g) i)  $-\frac{3}{2}$       ii)  $\frac{2}{3}$       iii)  $y = \frac{2}{3}x - \frac{4}{3}$   
h) i)  $\frac{2}{3}$       ii)  $-\frac{3}{2}$       iii)  $y = -\frac{3}{2}x + 13$   
i) i)  $-\frac{1}{4}$       ii) 4      iii)  $y = 4x + 28$   
j) i) -1      ii) 1      iii)  $y = x - 8$   
k) i) 0      ii) Infinite      iii)  $x = 6$   
l) i) -4      ii)  $\frac{1}{4}$       iii)  $y = \frac{1}{4}x - \frac{13}{4}$

2. a)  $\frac{1}{3}$       b)  $y = \frac{1}{3}x + \frac{5}{3}$   
 c) -3      d)  $y = -3x + 15$   
 e)  $y = -3x + 35$       f) (8, 11)  
 g) (2, 9)      h)  $y = \frac{1}{3}x + \frac{25}{3}$   
 i) 6.3 units      j) (6, 7)
3. a)  $y = \frac{2}{5}x - \frac{8}{5}$   
 b)  $y = -\frac{5}{2}x - \frac{9}{2}$   
 c) 15.2 units  
 d) Midpoint AB = (4, 0)  
 Midpoint AC = (-3, 3)  
 Midpoint BC = (2, 5)

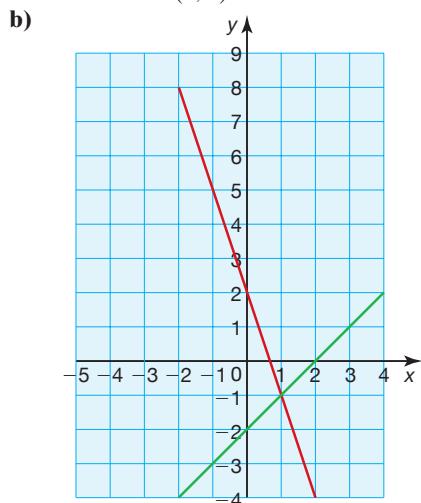
**Student assessment I** page 337

1. a) 1      b) -3  
 2. a)  $y = 2x + 4$       b)  $y = \frac{5}{2}x + 4$   
 3. a)  $m = -3$   $c = 4$       b)  $m = 3$   $c = 6$   
 c)  $m = -\frac{1}{2}$   $c = \frac{3}{2}$   
 4.  $y = -\frac{2}{3}x + 6$

5. a) b) c) d)

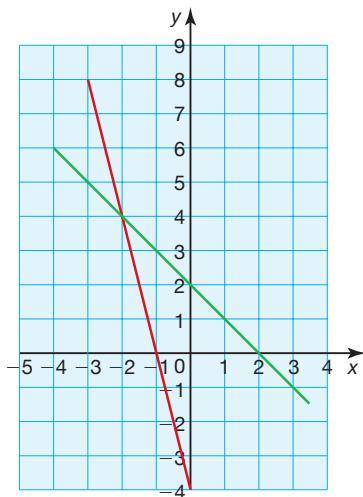


Solution is (2, 2)

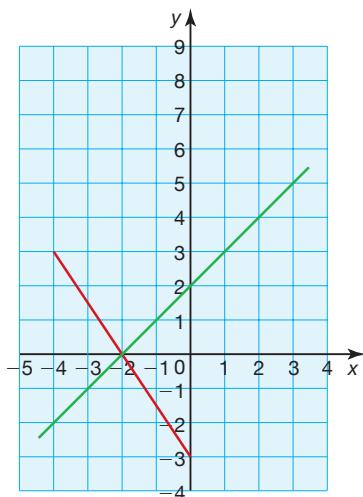


Solution is (1, -1)

c)

Solution is  $(-2, 4)$ 

d)

Solution is  $(-2, 0)$ 

7. a) i) 13 units      ii)  $(0, 1.5)$   
 b) i) 10 units      ii)  $(4, 6)$
8. a)  $y = 3x - 4$       b)  $y = -2x + 7$
9. a)  $y = -\frac{2}{7}x + \frac{31}{7}$       b)  $y = \frac{7}{2}x + 12$
10. a) i)  $(5, 6)$   
 ii)  $y = 3x - 9$   
 iii)  $y = -\frac{1}{3}x + 6$   
 b) The diagonals are perpendicular as the product of their gradients is  $-1$ .

**Student assessment 2** page 339

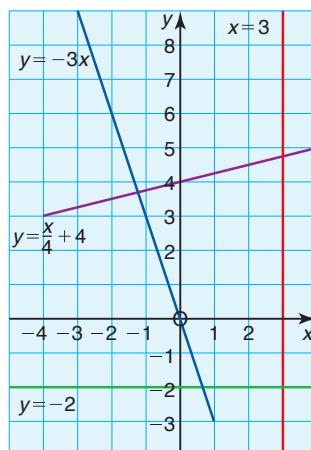
1. a) 2  
 b)  $-1$

2. a)  $y = 2x - 3$   
 b)  $y = \frac{3}{2}x + \frac{5}{2}$

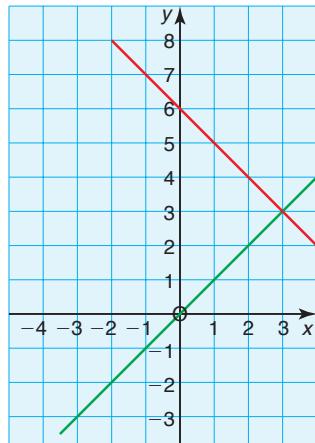
3. a)  $m = \frac{1}{2}$        $c = 0$   
 b)  $m = 4$        $c = 6$   
 c)  $m = -\frac{3}{2}$        $c = \frac{5}{2}$

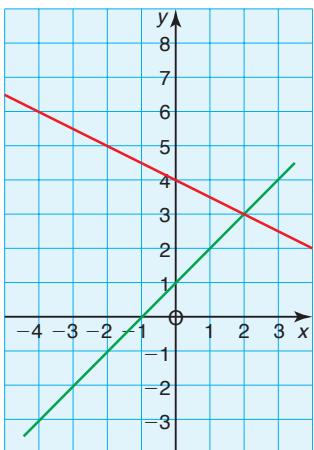
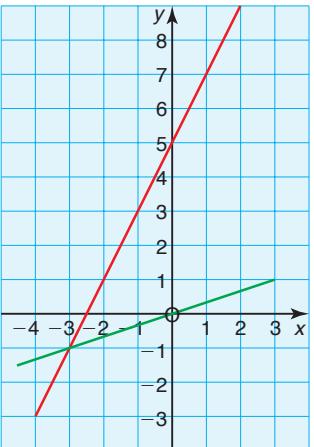
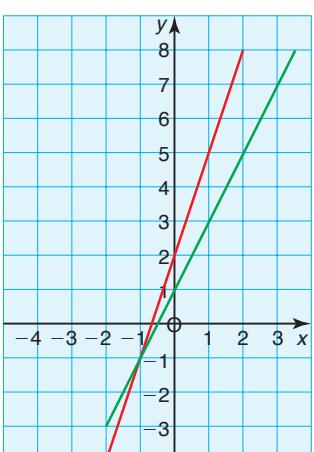
4.  $y = 5x$

5. a) b) c) d)



6. a)

Solution is  $(3, 3)$

**b)**Solution is  $(2, 3)$ **c)**Solution is  $(-3, -1)$ **d)**Solution is  $(-1, -1)$ 

- 7.** **a)** i) 5 units      ii)  $(0, 4.5)$   
**b)** i) 26 units      ii)  $(-5, 2)$
- 8.** **a)**  $y = 2x - 5$       **b)**  $y = -4x + 3$
- 9.** **a)**  $y = \frac{2}{7}x + \frac{55}{7}$       **b)**  $y = -\frac{2}{7}x - \frac{19}{7}$
- 10.** **a)**  $(1, 6)$   
**b)**  $y = \frac{3}{4}x + \frac{21}{4}$   
**c)** Substitute  $y = 10\frac{1}{2}$  into the equation  
 $y = \frac{3}{4}x + \frac{21}{4}$  and rearrange to find  $x = 7$ .  
**d)** 7.5 units

## Topic 5 Mathematical investigations and ICT

### Plane trails

page 341

1. Student's investigation
2. Student's ordered table similar to the one shown

| Number of planes ( $p$ ) | Maximum number of crossing points ( $n$ ) |
|--------------------------|---|
| 1                        | 0   |
| 2                        | 1   |
| 3                        | 3   |
| 4                        | 6   |
| 5                        | 10  |
| ...                      | ...                                       |

3. The sequence of the number of crossing points is the sequence of triangular numbers.

$$n = \frac{1}{2}p(p - 1)$$

**Hidden treasure** page 342

- 1–2.** The results for up to 20 contestants are given in the table below:

| Number of contestants (n) | Winning chest (x) |
|---------------------------|-------------------|
| 1                         | 1                 |
| 2                         | 2                 |
| 3                         | 2                 |
| 4                         | 4                 |
| 5                         | 2                 |
| 6                         | 4                 |
| 7                         | 6                 |
| 8                         | 8                 |
| 9                         | 2                 |
| 10                        | 4                 |
| 11                        | 6                 |
| 12                        | 8                 |
| 13                        | 10                |
| 14                        | 12                |
| 15                        | 14                |
| 16                        | 16                |
| 17                        | 2                 |
| 18                        | 4                 |
| 19                        | 6                 |
| 20                        | 8                 |

- 3.** Student's observed pattern: key pattern is that  $x = n$  when  $n$  is a power of 2.
- 4.** 31 contestants, winning chest is 30.  
32 contestants, winning chest is 32.  
33 contestants, winning chest is 2.
- 5.**  $x = 2(n - T)$ , where  $x$  = the winning chest,  
 $n$  = number of contestants and  $T$  = the nearest power of 2 below  $n$ .

**ICT activity** page 343

Student's own investigation

**29 Bearings****Exercise 29.1** page 347

1. Student's own diagrams
2. Student's own diagrams leading to:  
 a)  $343^\circ$       b)  $034^\circ$
3. Student's own diagrams leading to:  
 a)  $120^\circ$       b)  $102^\circ$

**Student assessment 1** page 348

1. Student's own diagram
2. Student's own diagram
3. Student's own diagram

**30 Trigonometry****Exercise 30.1** page 350

- |       |              |    |              |    |              |
|-------|--------------|----|--------------|----|--------------|
| 1. a) | 1.82 cm      | b) | 4.04 cm      | c) | 19.2 cm      |
| d)    | 4.87 cm      | e) | 37.3 cm      | f) | 13.9 cm      |
| 2. a) | 14.3 cm      | b) | 8.96 cm      | c) | 9.33 cm      |
| d)    | 4.10 cm      | e) | 13.9 cm      | f) | 6.21 cm      |
| 3. a) | $49.4^\circ$ | b) | $51.1^\circ$ | c) | $51.3^\circ$ |
| d)    | $63.4^\circ$ | e) | $50.4^\circ$ | f) | $71.6^\circ$ |

**Exercise 30.2** page 352

- |       |              |    |              |    |              |
|-------|--------------|----|--------------|----|--------------|
| 1. a) | 2.44 cm      | b) | 18.5 cm      | c) | 6.19 cm      |
| d)    | 2.44 cm      | e) | 43.8 cm      | f) | 31.8 cm      |
| 2. a) | $38.7^\circ$ | b) | $48.6^\circ$ | c) | $38.1^\circ$ |
| d)    | $49.8^\circ$ | e) | $32.6^\circ$ | f) | $14.5^\circ$ |

**Exercise 30.3** page 353

- |       |              |    |         |    |         |
|-------|--------------|----|---------|----|---------|
| 1. a) | 36.0 cm      | b) | 15.1 cm | c) | 48.2°   |
| d)    | $81.1^\circ$ | e) | 6.7 cm  | f) | 16.8 cm |
| g)    | $70.5^\circ$ | h) | 2.1 cm  |    |         |

**Exercise 30.4** page 354

- |       |                  |    |                  |
|-------|------------------|----|------------------|
| 1. a) | 5 cm             | b) | 11.4 mm (3 s.f.) |
| c)    | 12 cm            | d) | 13.2 cm (3 s.f.) |
| 2. a) | 11.0 cm (3 s.f.) | b) | 14.8 cm (3 s.f.) |
| c)    | 7.86 cm (3 s.f.) | d) | 7.35 cm (3 s.f.) |
| e)    | 3 cm             | f) | 13.9 cm (3 s.f.) |
| 3.    | 71.6 km          |    |                  |

4. 66.9 km  
 5. a)  $225^\circ - 135^\circ = 90^\circ$  b) 73.8 km

6. 57 009 m  
 7. a) 8.5 km b) 15.5 km (3 s.f.)  
 8. a) 13.3 m (3 s.f.) b) 15.0 m (3 s.f.)

### **Exercise 30.5** page 356

1. a)  $43.6^\circ$  b) 19.5 cm  
 c) 16.7 cm d)  $42.5^\circ$   
 2. a) 20.8 km (3 s.f.) b)  $215.2^\circ$  (1 d.p.)  
 3. a) 228 km (3 s.f.) b) 102 km (3 s.f.)  
 c) 103 km (3 s.f.) d) 147 km (3 s.f.)  
 e) 415 km (3 s.f.) f)  $217^\circ$  (3 s.f.)  
 4. a) 6.71 m (3 s.f.) b) 19.6 m (3 s.f.)  
 c) 15.3 m (3 s.f.)  
 5. a)  $48.2^\circ$  (3 s.f.) b)  $41.8^\circ$  (3 s.f.)  
 c) 8 cm d) 8.94 cm (3 s.f.)  
 e)  $76.0 \text{ cm}^2$  (3 s.f.)

### **Exercise 30.6** page 357

1. a) 12.2 km (3 s.f.) b)  $9.5^\circ$  (1 d.p.)  
 2. a) 10.1 km (3 s.f.) b) 1.23 km (3 s.f.)  
 3. a)  $22.6^\circ$  (1 d.p.) b) 130 m  
 4. a) 0.342 km (3 s.f.) b) 0.940 km (3 s.f.)  
 5. a) 64.0 m (3 s.f.) b) 30.2 m (3 s.f.)  
 6. 6.93 km (3 s.f.)  
 7. a) 7.46 km (3 s.f.) b) 3.18 km (3 s.f.)  
 8. a) 2.9 km (1 d.p.) b) 6.9 km (1 d.p.)  
 c)  $11.4^\circ$  (1 d.p.) d) 20.4 km (1 d.p.)  
 9. a) 2.68 km (3 s.f.) b) 1.02 km (3 s.f.)  
 b)  $3.5^\circ$  (1 d.p.) d) 16.83 km (2 d.p.)  
 10. a) 225 m b)  $48.4^\circ$  (1 d.p.)

### **Exercise 30.7** page 360

1. a)  $\sin 120^\circ$  b)  $\sin 100^\circ$  c)  $\sin 65^\circ$   
 d)  $\sin 40^\circ$  e)  $\sin 52^\circ$  f)  $\sin 13^\circ$   
 2. a)  $\sin 145^\circ$  b)  $\sin 130^\circ$  c)  $\sin 150^\circ$   
 d)  $\sin 132^\circ$  e)  $\sin 76^\circ$  f)  $\sin 53^\circ$   
 3. a)  $19^\circ, 161^\circ$  b)  $82^\circ, 98^\circ$  c)  $5^\circ, 175^\circ$   
 d)  $72^\circ, 108^\circ$  e)  $13^\circ, 167^\circ$  f)  $28^\circ, 152^\circ$

4. a)  $70^\circ, 110^\circ$  b)  $9^\circ, 171^\circ$  c)  $53^\circ, 127^\circ$   
 d)  $34^\circ, 146^\circ$  e)  $16^\circ, 164^\circ$  f)  $19^\circ, 161^\circ$

### **Exercise 30.8** page 361

1. a)  $-\cos 160^\circ$  b)  $-\cos 95^\circ$  c)  $-\cos 148^\circ$   
 d)  $-\cos 85^\circ$  e)  $-\cos 33^\circ$  f)  $-\cos 74^\circ$   
 2. a)  $-\cos 82^\circ$  b)  $-\cos 36^\circ$  c)  $-\cos 20^\circ$   
 d)  $-\cos 37^\circ$  e)  $-\cos 9^\circ$  f)  $-\cos 57^\circ$   
 3. a)  $\cos 80^\circ$  b)  $-\cos 90^\circ$  c)  $\cos 70^\circ$   
 d)  $\cos 135^\circ$  e)  $\cos 58^\circ$  f)  $\cos 155^\circ$   
 4. a)  $-\cos 55^\circ$  b)  $-\cos 73^\circ$  c)  $\cos 60^\circ$   
 d)  $\cos 82^\circ$  e)  $\cos 88^\circ$  f)  $\cos 70^\circ$

### **Student assessment 1** page 362

1. a) 4 cm b) 43.9 cm c) 20.8 cm  
 d) 3.91 cm  
 2. a)  $36.9^\circ$  b)  $56.3^\circ$  c)  $31.0^\circ$   
 d)  $33.8^\circ$   
 3. a) 5 cm b) 6.63 cm c) 9.29 cm  
 d) 28.5 cm

### **Student assessment 2** page 363

1. a) 160.8 km b) 177.5 km  
 2. a)  $\tan \theta = \frac{5}{x}$  b)  $\tan \theta = \frac{7.5}{(x + 16)}$   
 $c) \frac{5}{x} = \frac{7.5}{(x + 16)}$  d) 32 m  
 e)  $8.9^\circ$  (1 d.p.)  
 3. a) 285 m (3 s.f.) b)  $117^\circ$  (3 s.f.)  
 c)  $297^\circ$  (3 s.f.)  
 4. a) 1.96 km (3 s.f.) b) 3.42 km (3 s.f.)  
 c) 3.57 km (3 s.f.)

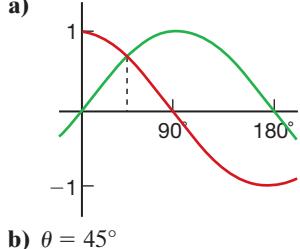
### **Student assessment 3** page 364

1. a) 4003 m b)  $2.35^\circ$  (3 s.f.)  
 2. Student's graph  
 3. a)  $\sin 130^\circ$  b)  $\sin 30^\circ$  c)  $-\cos 135^\circ$   
 d)  $-\cos 60^\circ$   
 4. a)  $38^\circ$  b)  $106^\circ$   
 5. a)  $24.6^\circ$  (1 d.p.) b)  $32.6^\circ$  (1 d.p.)  
 c) 5.94 km (3 s.f.) d) 1641

**Student assessment 4** page 364

1. Student's graph
2. a)  $-\cos 52^\circ$       b)  $\cos 100^\circ$
3. a) 678 m (3 s.f.)      b)  $11.6^\circ$  (1 d.p.)
- c) 718 m (3 s.f.)
4. a)  $21.8^\circ$  (1 d.p.)      b)  $8.5^\circ$  (1 d.p.)
- c) 2.2 km      d)  $10.5^\circ$  (1 d.p.)
- e)  $15.3^\circ$  (1 d.p.)      f) 1.76 km (3 s.f.)

5. a)

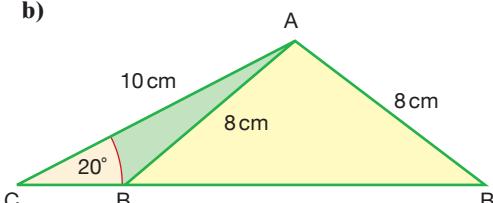


b)  $\theta = 45^\circ$

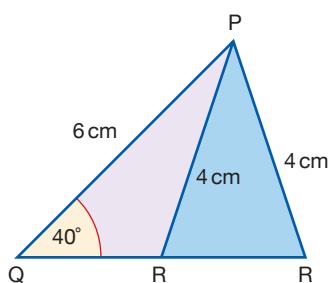
## 31 Further trigonometry

**Exercise 31.1** page 367

1. a) 8.91 cm      b) 8.93 cm      c) 5.96 mm
- d) 8.64 cm
2. a)  $33.2^\circ$       b)  $52.7^\circ$       c)  $77.0^\circ$
- d)  $44.0^\circ$
3. a)  $25^\circ, 155^\circ$  (nearest degree)
- b)



4. a)  $75^\circ, 105^\circ$  (nearest degree)
- b)

**Exercise 31.2** page 368

1. a) 4.71 m      b) 12.1 cm      c) 9.15 cm
- d) 3.06 cm      e) 10.7 cm
2. a)  $125.1^\circ$       b)  $108.2^\circ$       c)  $33.6^\circ$
- d)  $37.0^\circ$       e)  $122.9^\circ$

**Exercise 31.3** page 369

1. a) 42.9 m (3 s.f.)      b)  $116.9^\circ$  (1 d.p.)
- c)  $24.6^\circ$  (1 d.p.)      d)  $33.4^\circ$  (1 d.p.)
- e) 35.0 m (3 s.f.)
2. 370 m
3. 73.9 m (3 s.f.)

**Exercise 31.4** page 370

1. a)  $70.0 \text{ cm}^2$       b)  $70.9 \text{ mm}^2$       c)  $122 \text{ cm}^2$
- d)  $17.0 \text{ cm}^2$
2. a)  $24.6^\circ$       b) 13.0 cm      c) 23.1 cm
- d)  $63.2^\circ$
3.  $16\ 800 \text{ m}^2$
4. a)  $3.90 \text{ m}^2$  (3 s.f.)      b)  $222 \text{ m}^3$  (3 s.f.)

**Exercise 31.5** page 372

1. a) 5.66 cm (3 s.f.)      b) 6.93 cm (3 s.f.)
- c)  $54.7^\circ$  (1 d.p.)
2. a) 5.83 cm (3 s.f.)      b) 6.16 cm (3 s.f.)
- c)  $18.9^\circ$  (1 d.p.)
3. a) 6.40 cm (3 s.f.)      b) 13.6 cm (3 s.f.)
- c)  $61.9^\circ$  (1 d.p.)
4. a)  $75.3^\circ$  (1 d.p.)      b)  $56.3^\circ$  (1 d.p.)
5. a) i) 7.21 cm (3 s.f.) ii)  $21.1^\circ$  (1 d.p.)
- b) i)  $33.7^\circ$  (1 d.p.) ii)  $68.9^\circ$  (1 d.p.)
6. a) i) 8.54 cm (3 s.f.) ii)  $28.3^\circ$  (1 d.p.)
- b) i)  $20.6^\circ$  (1 d.p.) ii)  $61.7^\circ$  (1 d.p.)
7. a) 6.5 cm      b) 11.3 cm (3 s.f.)
- c) 70.7 cm (1 d.p.)
8. a) 11.7 cm      b) 7.55 cm (3 s.f.)
9. a)  $TU = TQ = 10 \text{ cm}$   
 $QU = 8.49$  (3 s.f.)
- b)  $90^\circ, 36.9^\circ, 53.1^\circ$       c)  $24 \text{ cm}^2$

**Exercise 31.6** page 375

- |                          |                          |                 |
|--------------------------|--------------------------|-----------------|
| 1. a) RW                 | b) TQ                    | c) SQ           |
| d) WU                    | e) QV                    | f) SV           |
| 2. a) JM                 | b) KN                    | c) HM           |
| d) HO                    | e) JO                    | f) MO           |
| 3. a) $\angle$ TPS       | b) $\angle$ UPQ          | c) $\angle$ VSW |
| d) $\angle$ RTV          | e) $\angle$ SUR          | f) $\angle$ VPW |
| 4. a) 5.83 cm (3 s.f.)   | b) $31.0^\circ$ (1 d.p.) |                 |
| 5. a) 10.2 cm (3 s.f.)   | b) $29.2^\circ$ (1 d.p.) |                 |
| c) $51.3^\circ$ (1 d.p.) |                          |                 |
| 6. a) 6.71 cm (3 s.f.)   | b) $61.4^\circ$ (1 d.p.) |                 |
| 7. a) 7.81 cm (3 s.f.)   | b) 11.3 cm (3 s.f.)      |                 |
| c) $12.4^\circ$ (1 d.p.) |                          |                 |
| 8. a) 14.1 cm (3 s.f.)   | b) 8.49 cm (3 s.f.)      |                 |
| c) 7.48 cm (3 s.f.)      | d) $69.3^\circ$ (1 d.p.) |                 |
| 9. a) 17.0 cm (3 s.f.)   | b) 5.66 cm (3 s.f.)      |                 |
| c) 7 cm                  | d) $51.1^\circ$ (1 d.p.) |                 |

**Student assessment 1** page 377

- $134^\circ$  (3 s.f.)
- a) 11.7 cm (3 s.f.)  
b) 12.3 cm (3 s.f.)  
c)  $29.1^\circ$  (1 d.p.)
- a) 18.0 m (3 s.f.)  
b)  $26.5^\circ$  (1 d.p.)  
c) 28.8 m (3 s.f.)  
d)  $278 \text{ m}^2$  (3 s.f.)
- a) 12.7 cm (3 s.f.)  
b)  $66.6^\circ$  (1 d.p.)  
c)  $93.4 \text{ cm}^2$  (3 s.f.)  
d) 14.7 cm (1 d.p.)

**Student assessment 2** page 377

- a) 10.8 cm (3 s.f.)  
b) 11.9 cm (3 s.f.)  
c)  $30.2^\circ$  (1 d.p.)  
d)  $49.0^\circ$  (1 d.p.)
- a) 9.81 cm (3 s.f.)  
b)  $30^\circ$   
c) 19.6 cm (3 s.f.)
- a) 5.83 cm (3 s.f.)  
b) 6.71 cm (3 s.f.)  
c) 7.81 cm (3 s.f.)  
d)  $46.6^\circ$  (1 d.p.)  
e)  $19.0 \text{ cm}^2$  (3 s.f.)  
f)  $36.7^\circ$  (1 d.p.)

**Topic 6 Mathematical investigations and ICT****Numbered balls** page 378

- If a ball is odd ( $n$ ), the next ball is  $n + 1$ .  
If the ball is even ( $n$ ), the next ball is  $\frac{n}{2}$ .
- 65, 66, 33, 34, 17, 18, 9, 10, 5, 6, 3, 4, 2, 1
- The first ball must be odd. Start at 1 and work backwards.
- 513, 514, 257, 258, 129, 130, 65, 66, 33, 34, 17, 18, 9, 10, 5, 6, 3, 4, 2, 1

**Towers of Hanoi** page 378

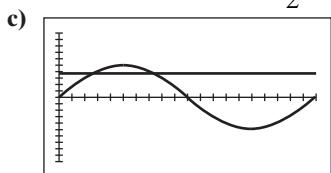
- 3
- 15
- Student's investigation
- The results up to 8 discs are given below:

| Number of discs | Smallest number of moves |
|-----------------|--------------------------|
| 1               | 1                        |
| 2               | 3                        |
| 3               | 7                        |
| 4               | 15                       |
| 5               | 31                       |
| 6               | 63                       |
| 7               | 127                      |
| 8               | 255                      |

- The number of moves are 1 less than the powers of 2.
- 1023
- Number of moves =  $2^n - 1$ , where  $n$  = number of discs.
- Time taken to move 64 discs is  $2^{64} - 1$  seconds  
This equates to  $5.85 \times 10^{11}$  years, i.e.  
585 billion years.  
Therefore according to the legend we needn't be too worried!

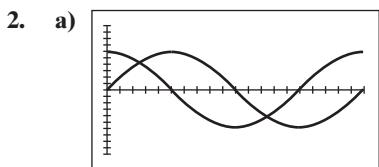
**ICT activity** page 379

1. b) i) 0.940 (3 d.p.)  
 ii) 0.819 (3 d.p.)  
 iii)  $-0.866$  (3 d.p.) or  $-\frac{\sqrt{3}}{2}$

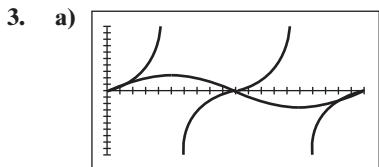


The graph of  $y = \sin x$  intersects the line  $y = 0.7$  in two places as shown.

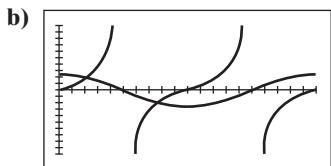
- d)  $30^\circ$  and  $150^\circ$



- b) Two solutions  
 c)  $225^\circ$



Solutions are  $0^\circ$ ,  $180^\circ$  and  $360^\circ$

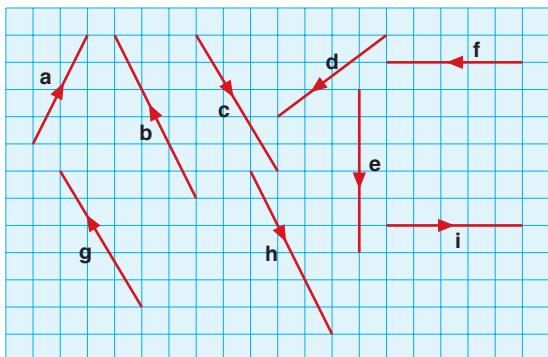


Solutions are  $38.2^\circ$  and  $141.8^\circ$  (1 d.p.)

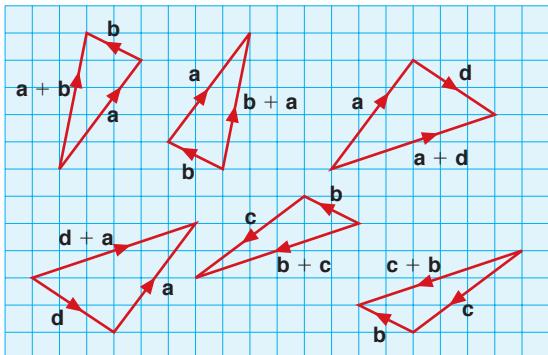
**32 Vectors****Exercise 32.1** page 383

1. a)  $\begin{pmatrix} 2 \\ 4 \end{pmatrix}$       b)  $\begin{pmatrix} 3 \\ 1 \end{pmatrix}$       c)  $\begin{pmatrix} -2 \\ -4 \end{pmatrix}$   
 d)  $\begin{pmatrix} 3 \\ -2 \end{pmatrix}$       e)  $\begin{pmatrix} -6 \\ 1 \end{pmatrix}$       f)  $\begin{pmatrix} 6 \\ -1 \end{pmatrix}$   
 g)  $\begin{pmatrix} -3 \\ -1 \end{pmatrix}$       h)  $\begin{pmatrix} -5 \\ -5 \end{pmatrix}$       i)  $\begin{pmatrix} -1 \\ 3 \end{pmatrix}$
2. a)  $\begin{pmatrix} 4 \\ 4 \end{pmatrix}$       b)  $\begin{pmatrix} 0 \\ 4 \end{pmatrix}$       c)  $\begin{pmatrix} -3 \\ 0 \end{pmatrix}$   
 d)  $\begin{pmatrix} -2 \\ 6 \end{pmatrix}$       e)  $\begin{pmatrix} -4 \\ -2 \end{pmatrix}$       f)  $\begin{pmatrix} 0 \\ -4 \end{pmatrix}$   
 g)  $\begin{pmatrix} 3 \\ 0 \end{pmatrix}$       h)  $\begin{pmatrix} 2 \\ -6 \end{pmatrix}$       i)  $\begin{pmatrix} -4 \\ -4 \end{pmatrix}$

3.

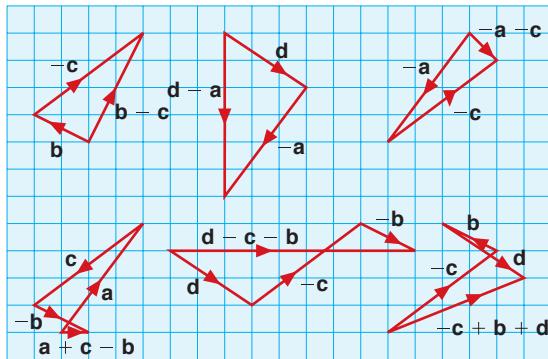
**Exercise 32.2** page 384

1. a) b) c) d) e) f)



2.  $\mathbf{a} + \mathbf{b} = \mathbf{b} + \mathbf{a}$ ,  $\mathbf{a} + \mathbf{d} = \mathbf{d} + \mathbf{a}$ ,  $\mathbf{b} + \mathbf{c} = \mathbf{c} + \mathbf{b}$

3. a) b) c) d) e) f)



4. a)  $\begin{pmatrix} 2 \\ 4 \end{pmatrix}$       b)  $\begin{pmatrix} 0 \\ -6 \end{pmatrix}$       c)  $\begin{pmatrix} 1 \\ -1 \end{pmatrix}$   
 d)  $\begin{pmatrix} 1 \\ 0 \end{pmatrix}$       e)  $\begin{pmatrix} 9 \\ 0 \end{pmatrix}$       f)  $\begin{pmatrix} 5 \\ 2 \end{pmatrix}$

### Exercise 32.3 page 385

1.  $\mathbf{d} = -\mathbf{c}$      $\mathbf{e} = -\mathbf{a}$      $\mathbf{f} = 2\mathbf{a}$      $\mathbf{g} = \frac{1}{2}\mathbf{c}$      $\mathbf{h} = \frac{1}{2}\mathbf{b}$   
 $\mathbf{i} = -\frac{1}{2}\mathbf{b}$      $\mathbf{j} = \frac{3}{2}\mathbf{b}$      $\mathbf{k} = -\frac{3}{2}\mathbf{a}$

2. a)  $\begin{pmatrix} 4 \\ 6 \end{pmatrix}$       b)  $\begin{pmatrix} -12 \\ -3 \end{pmatrix}$       c)  $\begin{pmatrix} 2 \\ -4 \end{pmatrix}$   
 d)  $\begin{pmatrix} -2 \\ 2 \end{pmatrix}$       e)  $\begin{pmatrix} -2 \\ -5 \end{pmatrix}$       f)  $\begin{pmatrix} -8 \\ 9 \end{pmatrix}$   
 g)  $\begin{pmatrix} -10 \\ -5 \end{pmatrix}$       h)  $\begin{pmatrix} 3 \\ 2 \end{pmatrix}$       i)  $\begin{pmatrix} 10 \\ -6 \end{pmatrix}$

3. a)  $2\mathbf{a}$       b)  $-\mathbf{b}$       c)  $\mathbf{b} + \mathbf{c}$   
 d)  $\mathbf{a} - \mathbf{b}$       e)  $2\mathbf{c}$       f)  $2\mathbf{c} - \mathbf{a}$

### Exercise 32.4 page 386

1.  $|\mathbf{a}| = 5.0$  units     $|\mathbf{b}| = 4.1$  units     $|\mathbf{c}| = 4.5$  units  
 $|\mathbf{d}| = 7.0$  units     $|\mathbf{e}| = 7.3$  units     $|\mathbf{f}| = 6.4$  units

2. a)  $|\mathbf{AB}| = 4.0$  units      b)  $|\mathbf{BC}| = 5.4$  units  
 c)  $|\mathbf{CD}| = 7.2$  units      d)  $|\mathbf{DE}| = 13.0$  units  
 e)  $|\mathbf{2AB}| = 8.0$  units      f)  $|\mathbf{-CD}| = 7.2$  units

3. a) 4.1 units      b) 18.4 units      c) 15.5 units  
 d) 17.7 units      e) 31.8 units      f) 19.6 units

### Exercise 32.5 page 387

1.  $\mathbf{A} = \begin{pmatrix} 3 \\ 3 \end{pmatrix}$        $\mathbf{B} = \begin{pmatrix} 1 \\ 2 \end{pmatrix}$        $\mathbf{C} = \begin{pmatrix} -3 \\ 2 \end{pmatrix}$   
 $\mathbf{D} = \begin{pmatrix} -3 \\ 0 \end{pmatrix}$        $\mathbf{E} = \begin{pmatrix} 4 \\ -2 \end{pmatrix}$        $\mathbf{F} = \begin{pmatrix} 2 \\ -4 \end{pmatrix}$   
 $\mathbf{G} = \begin{pmatrix} -1 \\ -1 \end{pmatrix}$        $\mathbf{H} = \begin{pmatrix} 0 \\ -3 \end{pmatrix}$

### Exercise 32.6 page 388

|  |   |                               |
|--|---|-------------------------------|
| 1. a) $\mathbf{a}$                           | b) $\mathbf{a}$                               | c) $\mathbf{b}$               |
| d) $-\mathbf{b}$                             | e) $2\mathbf{b}$                              | f) $-2\mathbf{a}$             |
| g) $\mathbf{a} + \mathbf{b}$                 | h) $\mathbf{b} - \mathbf{a}$                  | i) $\mathbf{b} - 2\mathbf{a}$ |
| 2. a) $2\mathbf{a}$                          | b) $\mathbf{b}$                               | c) $\mathbf{b} - \mathbf{a}$  |
| d) $\mathbf{b} - \mathbf{a}$                 | e) $-\mathbf{a}$                              | f) $\mathbf{a} - 2\mathbf{b}$ |
| 3. a) $-2\mathbf{a}$                         | b) $-\mathbf{a}$                              | c) $\mathbf{b}$               |
| d) $\mathbf{b} - \mathbf{a}$                 | e) $2(\mathbf{b} - \mathbf{a})$               | f) $2\mathbf{b} - \mathbf{a}$ |
| g) $-2\mathbf{b}$                            | h) $\mathbf{b} - 2\mathbf{a}$                 | i) $-\mathbf{a} - \mathbf{b}$ |
| 4. a) $5\mathbf{a}$                          | b) $\frac{8}{3}\mathbf{b}$                    |                               |
| c) $\frac{1}{3}(8\mathbf{b} - 15\mathbf{a})$ | d) $\frac{1}{15}(8\mathbf{b} - 15\mathbf{a})$ |                               |
| e) $\mathbf{b} - 2\mathbf{a}$                | f) $5\mathbf{a} - 2\mathbf{b}$                |                               |
| g) $\frac{8}{5}\mathbf{b}$                   | h) $\frac{1}{5}(10\mathbf{a} + 8\mathbf{b})$  |                               |
| i) $\frac{1}{5}(8\mathbf{b} - 5\mathbf{a})$  |   |                               |

### Exercise 32.7 page 389

1. a) i)  $2\mathbf{a}$       ii)  $2\mathbf{a} - \mathbf{b}$       iii)  $\frac{1}{4}(2\mathbf{a} + 3\mathbf{b})$   
 b) Proof

2. a) b) Proofs

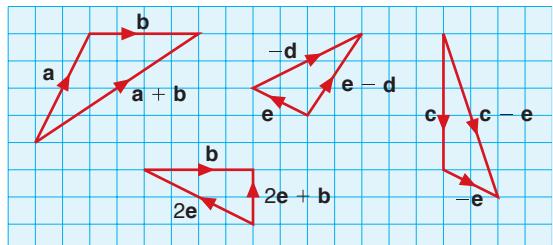
3. a) i)  $4\mathbf{a}$       ii)  $2\mathbf{a}$       iii)  $2(\mathbf{a} + \mathbf{b})$       iv)  $\frac{3}{2}\mathbf{a}$   
 b) Proof

4. a) i)  $\frac{1}{2}(2\mathbf{q} - \mathbf{p})$       ii)  $\frac{2}{7}(\mathbf{p} - \mathbf{q})$       b) Proof

### Student assessment I page 390

1. a)  $\begin{pmatrix} -2 \\ 3 \end{pmatrix}$       b)  $\begin{pmatrix} 7 \\ 2 \end{pmatrix}$       c)  $\begin{pmatrix} 6 \\ -2 \end{pmatrix}$   
 2.  $\mathbf{a} = \begin{pmatrix} 2 \\ 4 \end{pmatrix}$        $\mathbf{b} = \begin{pmatrix} 4 \\ 0 \end{pmatrix}$        $\mathbf{c} = \begin{pmatrix} 0 \\ -5 \end{pmatrix}$   
 $\mathbf{d} = \begin{pmatrix} -4 \\ -2 \end{pmatrix}$        $\mathbf{e} = \begin{pmatrix} -2 \\ 1 \end{pmatrix}$

3.



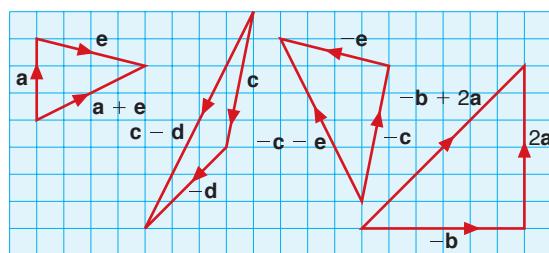
4. a)  $\begin{pmatrix} -1 \\ 5 \end{pmatrix}$       b)  $\begin{pmatrix} 1 \\ 5 \end{pmatrix}$       c)  $\begin{pmatrix} 1 \\ 11 \end{pmatrix}$       d)  $\begin{pmatrix} 0 \\ 14 \end{pmatrix}$

**Student assessment 2** page 390

1. a)  $\begin{pmatrix} -2 \\ 7 \end{pmatrix}$       b)  $\begin{pmatrix} -5 \\ -4 \end{pmatrix}$       c)  $\begin{pmatrix} -1 \\ -3 \end{pmatrix}$

2. a)  $\begin{pmatrix} 0 \\ 3 \end{pmatrix}$       b)  $\begin{pmatrix} -6 \\ 0 \end{pmatrix}$       c)  $\begin{pmatrix} -1 \\ -5 \end{pmatrix}$   
 d)  $\begin{pmatrix} 3 \\ 3 \end{pmatrix}$       e)  $\begin{pmatrix} 4 \\ -1 \end{pmatrix}$

3.



4. a)  $\begin{pmatrix} 7 \\ -11 \end{pmatrix}$     b)  $\begin{pmatrix} -3 \\ 9 \end{pmatrix}$     c)  $\begin{pmatrix} 6 \\ -6 \end{pmatrix}$     d)  $\begin{pmatrix} -18 \\ 28 \end{pmatrix}$

**Student assessment 3** page 391

1. a)  $\overrightarrow{|AB|} = 7.21$  units  
 b)  $|\mathbf{a}| = 9.22$  units     $|\mathbf{b}| = 8.06$  units  
 $|\mathbf{c}| = 13$  units

2. a) 17.5 units      b) 2.69 units

3.  $A = \begin{pmatrix} 2 \\ 4 \end{pmatrix}$        $B = \begin{pmatrix} -1 \\ 2 \end{pmatrix}$        $C = \begin{pmatrix} -3 \\ -1 \end{pmatrix}$   
 $D = \begin{pmatrix} 0 \\ -3 \end{pmatrix}$        $E = \begin{pmatrix} 1 \\ -4 \end{pmatrix}$

4. a) Student's own vector  
 b)  $\overrightarrow{DF} = \frac{1}{2}\overrightarrow{BC}$   
 c)  $\overrightarrow{CF} = -\overrightarrow{DE}$

**Student assessment 4** page 392

1. a)  $\overrightarrow{|FG|} = 5$  units  
 b)  $|\mathbf{a}| = 6.1$  units     $|\mathbf{b}| = 12.4$  units  
 $|\mathbf{c}| = 14.1$  units

2. a) 29.7 units      b) 11.4 units

3. a)  $2\mathbf{a}$       b)  $-\mathbf{b}$       c)  $\mathbf{b} - \mathbf{a}$

**Student assessment 5** page 392

1. a) i)  $\frac{1}{4}\mathbf{b}$       ii)  $\frac{1}{4}(4\mathbf{a} - \mathbf{b})$       iii)  $\frac{2}{5}(\mathbf{b} - \mathbf{a})$   
 b) Proof

2. a) Proof      b) Proof

3. a) i)  $\mathbf{b} - \mathbf{a}$     ii)  $\mathbf{a}$     iii)  $\mathbf{a} + \mathbf{b}$   
 b) i)  $4 : 25$     ii)  $20 : 25$

**Student assessment 6** page 393

1. a)  $\mathbf{a}$       b)  $-\mathbf{b}$       c)  $(1 + \sqrt{2})\mathbf{b}$

2. a)  $5\mathbf{b}$       b)  $5\mathbf{b} - \mathbf{a}$       c)  $\frac{1}{2}(\mathbf{a} + 3\mathbf{b})$

3. a) i)  $\frac{1}{2}\mathbf{a}$     ii)  $\mathbf{b} - \mathbf{a}$       b)  $2 : 3$

**33 Matrices****Exercise 33.1** page 394

1. a)  $\mathbf{P} = 2 \times 3$     b)  $\mathbf{Q} = 2 \times 4$     c)  $\mathbf{R} = 4 \times 2$   
 d)  $\mathbf{S} = 4 \times 5$     e)  $\mathbf{T} = 5 \times 1$     f)  $\mathbf{F} = 1 \times 5$

2. Student's own matrices

3.  $\begin{pmatrix} 6500 & 900 \\ 7200 & 1100 \\ 7300 & 1040 \end{pmatrix}$

4.  $\begin{pmatrix} 3 & 4 & 2 & 1 \\ 0 & 6 & 2 & 0 \\ 1 & 3 & 0 & 2 \end{pmatrix}$

5.  $\begin{pmatrix} 8 & 6 & 9 & 3 \\ 37 & 49 \\ 74 & 58 \\ 76 & 62 \\ 89 & 56 \end{pmatrix}$

7.  $\begin{pmatrix} 20 & 35 & 15 \\ 45 & 25 & 40 \\ 30 & 30 & 10 \\ 0 & 0 & 25 \\ 5 & 10 & 10 \end{pmatrix}$

8.  $\begin{pmatrix} 8000 & 3000 & 5000 \\ 8000 & 6000 & 10000 \\ 5000 & 11000 & 9000 \\ 9000 & 13000 & 6000 \end{pmatrix}$

9.  $\begin{pmatrix} 6 & 12 & 43 & 18 & 6 & 9 & 6 \\ 9 & 15 & 28 & 18 & 12 & 12 & 6 \\ 12 & 19 & 30 & 12 & 9 & 9 & 9 \end{pmatrix}$

10. Student's own matrix

**Exercise 33.2** page 398

1. a)  $\begin{pmatrix} 14 & 8 \\ 7 & 16 \end{pmatrix}$

b)  $\begin{pmatrix} 9 & 3 & 24 \\ 19 & 35 & 5 \end{pmatrix}$

c)  $\begin{pmatrix} 24 \\ 3 \\ 18 \end{pmatrix}$

d)  $\begin{pmatrix} -10 & 13 & 17 \\ 2 & -13 & 18 \\ 5 & 10 & 11 \end{pmatrix}$

e)  $(-3 \ 1 \ -1)$

f)  $\begin{pmatrix} 14 & -9 \\ 15 & -5 \\ -5 & 10 \end{pmatrix}$

2. a)  $\begin{pmatrix} 5 & 4 \\ 1 & 0 \end{pmatrix}$

b)  $\begin{pmatrix} 2 & 2 & 2 \\ 2 & 2 & 2 \end{pmatrix}$

c)  $\begin{pmatrix} -5 \\ 0 \\ 4 \end{pmatrix}$

d)  $\begin{pmatrix} 4 & -14 & -1 \\ 2 & 0 & 4 \\ -9 & -1 & -5 \end{pmatrix}$

e)  $\begin{pmatrix} -3 & 18 \\ -1 & -12 \end{pmatrix}$

f)  $\begin{pmatrix} -3 & -4 \\ -21 & 13 \\ -3 & 2 \end{pmatrix}$

3. a)  $\begin{pmatrix} 9 & 11 \\ 15 & 5 \\ 9 & 8 \end{pmatrix}$

b)  $\begin{pmatrix} 9 & 11 \\ 15 & 5 \\ 9 & 8 \end{pmatrix}$

**Exercise 33.4** page 402

1. a)  $\begin{pmatrix} 18 & 78 \\ 14 & 54 \end{pmatrix}$

b)  $\begin{pmatrix} 12 & 72 \\ 0 & 24 \end{pmatrix}$

2. a)  $\begin{pmatrix} 52 & 12 & 18 \\ 44 & 22 & 12 \end{pmatrix}$

b)  $\begin{pmatrix} 18 & 18 \\ 8 & 8 \\ 6 & 6 \end{pmatrix}$

3. a)  $\begin{pmatrix} 28 & 4 & -8 \\ -31 & 19 & 40 \end{pmatrix}$

b)  $(27 \ -17)$

4. a)  $\begin{pmatrix} 6 & 4 & -2 \\ -3 & -2 & 1 \\ -12 & -8 & 4 \\ 18 & 12 & -6 \end{pmatrix}$

b)  $\begin{pmatrix} 30 & 22 & 38 \\ 20 & 13 & 2 \\ 9 & 7 & 17 \\ 24 & 19 & 50 \end{pmatrix}$

**Exercise 33.5** page 402

1.  $\mathbf{VW} = \begin{pmatrix} 0 & 7 \\ 24 & 8 \end{pmatrix}$   $\mathbf{WV} = \begin{pmatrix} -12 & 4 \\ -18 & 20 \end{pmatrix}$

2.  $\mathbf{VW} = \begin{pmatrix} -10 & -9 \\ -20 & -18 \end{pmatrix}$

$\mathbf{WV} = \begin{pmatrix} 11 & 14 & -1 \\ -25 & -30 & 5 \\ 39 & 46 & -9 \end{pmatrix}$

3.  $\mathbf{VW} = (-11)$

$\mathbf{WV} = \begin{pmatrix} 4 & -10 & 18 & 4 \\ 0 & 0 & 0 & 0 \\ -6 & 15 & -27 & -6 \\ 12 & -30 & 54 & 12 \end{pmatrix}$

4.  $\mathbf{VW} = \begin{pmatrix} 7 & 7 & 9 \\ -6 & -4 & -14 \end{pmatrix}$   $\mathbf{WV}$  is not possible

5.  $\mathbf{VW} = \begin{pmatrix} -33 & 41 & -10 \\ 17 & -11 & -8 \end{pmatrix}$   $\mathbf{WV}$  is not possible

**Exercise 33.6** page 403

1.  $\mathbf{AI} = \begin{pmatrix} 2 & 1 \\ 3 & 2 \end{pmatrix}$   $\mathbf{IA} = \begin{pmatrix} 2 & 1 \\ 3 & 2 \end{pmatrix}$

2.  $\mathbf{AI} = \begin{pmatrix} -2 & -4 \\ 3 & 6 \end{pmatrix}$   $\mathbf{IA} = \begin{pmatrix} -2 & -4 \\ 3 & 6 \end{pmatrix}$

3.  $\mathbf{AI} = \begin{pmatrix} 4 & 8 \\ -2 & 4 \end{pmatrix}$   $\mathbf{IA} = \begin{pmatrix} 4 & 8 \\ -2 & 4 \end{pmatrix}$

4.  $\mathbf{AI} = \begin{pmatrix} 3 & 2 \\ 1 & 6 \\ -2 & 5 \end{pmatrix}$   $\mathbf{IA}$  is not possible

5.  $\mathbf{AI} = (-5 \ -6)$   $\mathbf{IA}$  is not possible

5. a) 444

b)  $\begin{pmatrix} 265 & 312 \\ 140 & 132 \end{pmatrix} - \begin{pmatrix} 189 & 204 \\ 121 & 68 \end{pmatrix} = \begin{pmatrix} 76 & 108 \\ 19 & 64 \end{pmatrix}$

c) 267

**Exercise 33.3** page 400

1. a)  $\begin{pmatrix} 8 & 12 \\ 14 & 6 \end{pmatrix}$

b)  $\begin{pmatrix} 21 & 6 \\ 3 & 0 \end{pmatrix}$

c)  $\begin{pmatrix} 9 & 3 \\ 0 & 6 \end{pmatrix}$

d)  $\begin{pmatrix} 10 & 5 \\ 0 & 20 \end{pmatrix}$

e)  $\begin{pmatrix} 28 & 20 \\ 16 & 32 \end{pmatrix}$

f)  $\begin{pmatrix} 21 & 42 \\ 14 & 7 \end{pmatrix}$

2. a)  $\begin{pmatrix} 4 & 1 \\ 0 & 2 \end{pmatrix}$

b)  $\begin{pmatrix} 4 & 3 \\ 2 & 1 \end{pmatrix}$

c)  $\begin{pmatrix} 3 & 6 \\ 0.75 & 1.5 \end{pmatrix}$

d)  $\begin{pmatrix} 6 & 4 \\ 0.8 & 2 \end{pmatrix}$

e)  $\begin{pmatrix} 2.5 & 7.5 \\ 7.5 & 10 \end{pmatrix}$

f)  $\begin{pmatrix} 12 & 3 \\ 3 & 6 \end{pmatrix}$

6.  $\begin{pmatrix} 4 & -3 \\ 5 & -6 \\ 3 & 2 \\ 1 & 4 \end{pmatrix}$  **IA** is not possible

7. When **AI** exists, it is equal to **A**.

8. For a  $2 \times 2$  matrix  $\mathbf{AI} = \mathbf{IA} = \mathbf{A}$ .

### **Exercise 33.7** page 404

- |          |                        |        |         |
|----------|------------------------|--------|---------|
| 1. a) 3  | b) 3                   | c) 4   | d) 2    |
| 2. a) -4 | b) -10                 | c) -10 | d) -1   |
| 3. a) 18 | b) 14                  | c) -54 | d) 4    |
| 4.       | Student's own matrices |        |         |
| 5.       | Student's own matrices |        |         |
| 6.       | Student's own matrices |        |         |
| 7. a) 16 | b) 131                 | c) 18  | d) 936  |
| e) -104  | f) -576                | g) 254 | h) -576 |
| i) 147   |                        |        |         |

### **Exercise 33.8** page 406

- |   |   |   |
|---|---|---|
| 1. a) $\begin{pmatrix} 4 & -5 \\ -7 & 9 \end{pmatrix}$                            | b) $\begin{pmatrix} 5 & -7 \\ -7 & 10 \end{pmatrix}$  | c) $\begin{pmatrix} 1 & -1 \\ -0.8 & 1 \end{pmatrix}$                   |
| d) $\begin{pmatrix} -\frac{1}{3} & 3 \\ -1 & 2 \end{pmatrix}$                     | e) $\begin{pmatrix} -1.8 & -0.8 \\ 2 & 1 \end{pmatrix}$   |   |
| f) Not possible   |   |   |
| 2.  | See answers for Q.1.  |   |
| 3.  | It has no inverse as the determinant = 0.   |   |
| 4.  | A, B, D have no inverse.  |   |
| 5. a) $\begin{pmatrix} -9 & 4 \\ 7 & -3 \end{pmatrix}$                            | b) $\begin{pmatrix} -\frac{5}{4} & -\frac{3}{4} \\ 2 & 1 \end{pmatrix}$                         | c) $\begin{pmatrix} 6 & -\frac{11}{4} \\ -11 & 5 \end{pmatrix}$         |
| d) $\begin{pmatrix} -\frac{1}{2} & 0 \\ \frac{1}{2} & \frac{1}{11} \end{pmatrix}$ | e) $\begin{pmatrix} \frac{9}{2} & \frac{5}{2} \\ -\frac{31}{12} & -\frac{17}{12} \end{pmatrix}$ | f) $\begin{pmatrix} -\frac{3}{4} & \frac{1}{2} \\ 2 & -1 \end{pmatrix}$ |

### **Student assessment 1** page 406

- |  |  |
|--|--|
| 1. a) $\begin{pmatrix} 4 & -1 \\ -7 & 8 \end{pmatrix}$         | b) $\begin{pmatrix} 6 & 11 \\ -1 & -12 \\ 10 & -5 \end{pmatrix}$ |
| c) $\begin{pmatrix} -9 & -6 \\ -1 & 1 \end{pmatrix}$           | d) $\begin{pmatrix} 5 & -4 \\ 1 & 5 \\ 1 & 5 \end{pmatrix}$      |
| e) $\begin{pmatrix} 6 & 16 & -8 \\ 2 & -12 & 14 \end{pmatrix}$ | f) $\begin{pmatrix} 1 & -2 \\ 0 & -1.5 \end{pmatrix}$            |

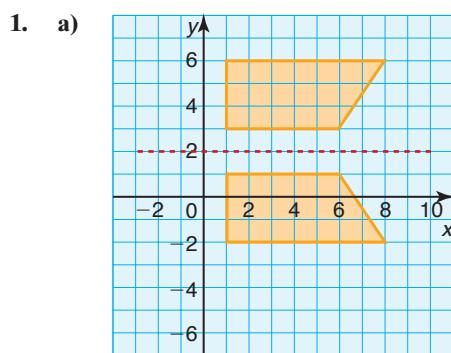
- |   |  |       |       |
|---|--|-------|-------|
| 2. a) $\begin{pmatrix} 18 & -17 \\ 45 & 0 \\ 30 & 15 \end{pmatrix}$                           | b) (-83 -14)   |       |       |
| 3. a) 1   | b) 6   | c) -6 | d) -4 |
| 4. a) $\begin{pmatrix} 1 & -2 \\ -\frac{3}{2} & \frac{7}{2} \end{pmatrix}$                    | b) $\begin{pmatrix} 8 & -7 \\ -9 & 8 \end{pmatrix}$  |       |       |
| c) $\begin{pmatrix} \frac{5}{3} & -\frac{11}{18} \\ -\frac{2}{3} & \frac{5}{6} \end{pmatrix}$ | d) $\begin{pmatrix} -\frac{1}{2} & \frac{1}{4} \\ \frac{1}{2} & -\frac{1}{12} \end{pmatrix}$ |       |       |

### **Student assessment 2** page 407

- |  |   |   |       |
|--|---|---|-------|
| 1. a) $\begin{pmatrix} 3 & -1 \\ -8 & 2 \end{pmatrix}$               | b) $\begin{pmatrix} 11 & 7 \\ 6 & -12 \\ 8 & -5 \end{pmatrix}$          |   |       |
| c) $\begin{pmatrix} -10 & -7 \\ -4 & 1 \end{pmatrix}$                | d) $\begin{pmatrix} 3 & 1 \\ -4 & 1 \\ 6 & -3 \end{pmatrix}$            |   |       |
| e) $\begin{pmatrix} 3 & 12 & -3 \\ 6 & -12 & 15 \end{pmatrix}$       | f) $\begin{pmatrix} 1 & -2 \\ 0 & -4 \end{pmatrix}$                     |   |       |
| 2. a) $\begin{pmatrix} 3 & -15 \\ 42 & 10 \\ -36 & 26 \end{pmatrix}$ | b) (-19 -32)  |   |       |
| 3. a) 1  | b) 66   | c) 66   | d) 18 |
| 4. a) $\begin{pmatrix} 9 & -8 \\ -10 & 9 \end{pmatrix}$              | b) $\begin{pmatrix} \frac{7}{2} & -3 \\ -\frac{9}{2} & 4 \end{pmatrix}$ |   |       |
| c) Not possible  |   | d) $\begin{pmatrix} 67.5 & -59 \\ -75.5 & 66 \end{pmatrix}$ |       |

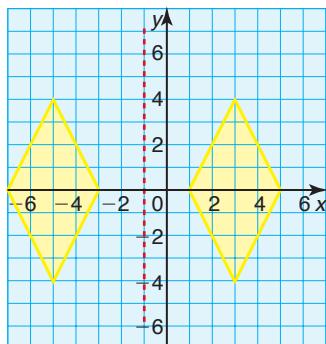
## 34 Transformations

### **Exercise 34.1** page 409



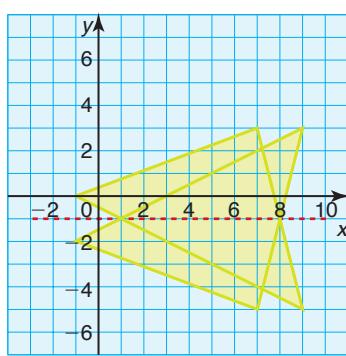
b)  $y = 2$

2. a)



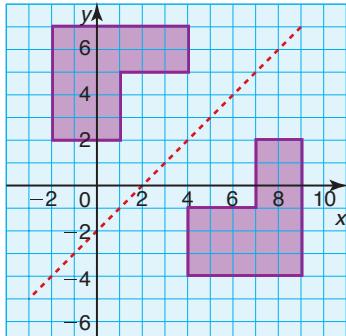
b)  $x = -1$

3. a)



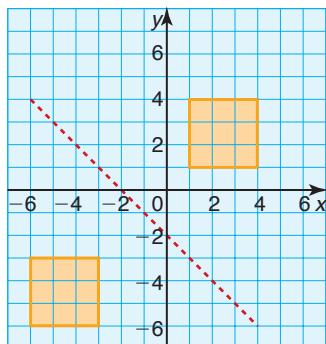
b)  $y = -1$

4. a)



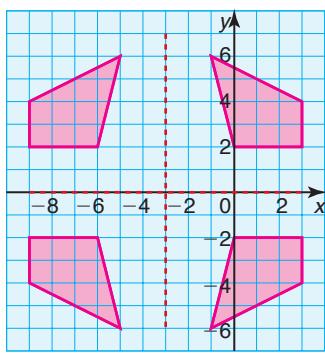
b)  $y = x - 2$

5. a)



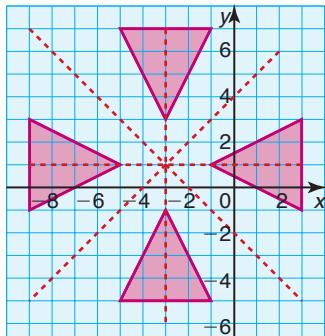
b)  $y = -x - 2$

6. a)



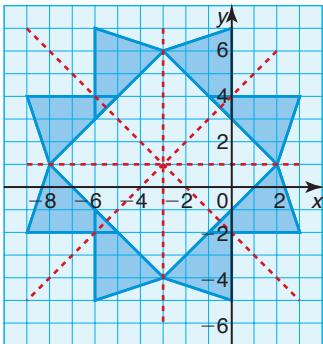
b)  $y = 0, x = -3$

7. a)



b)  $y = 1, x = -3, y = x + 4, y = -x - 2$

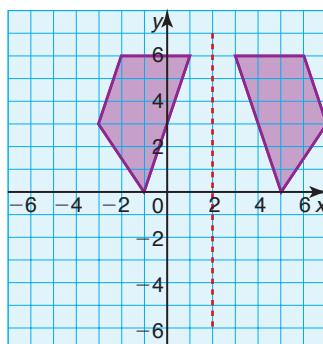
8. a)



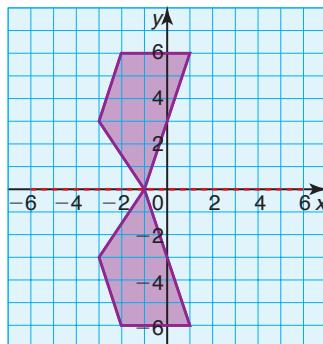
b)  $y = 1, x = -3, y = x + 4, y = -x - 2$

**Exercise 34.2** page 410

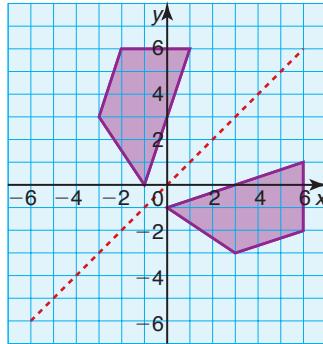
1. a)



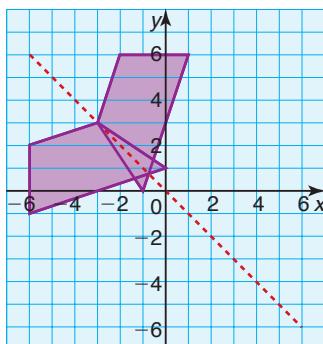
b)



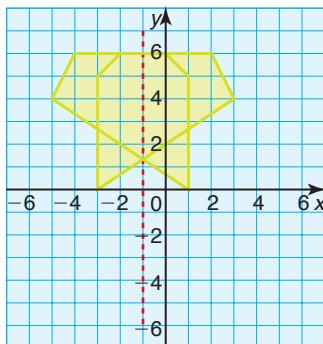
c)



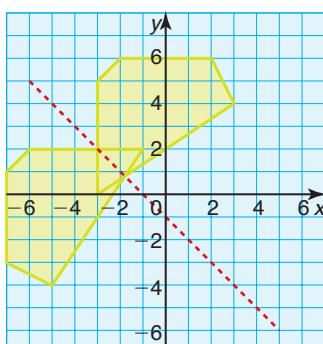
d)



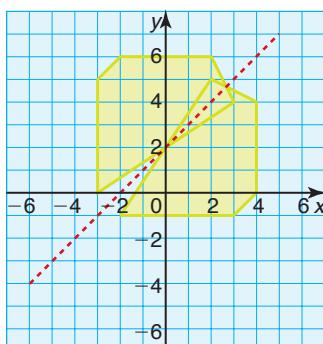
2. a)



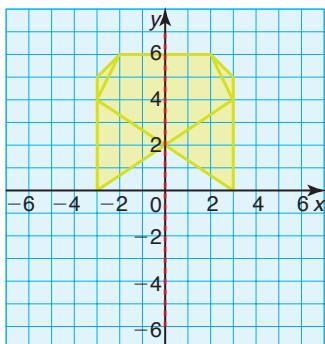
b)



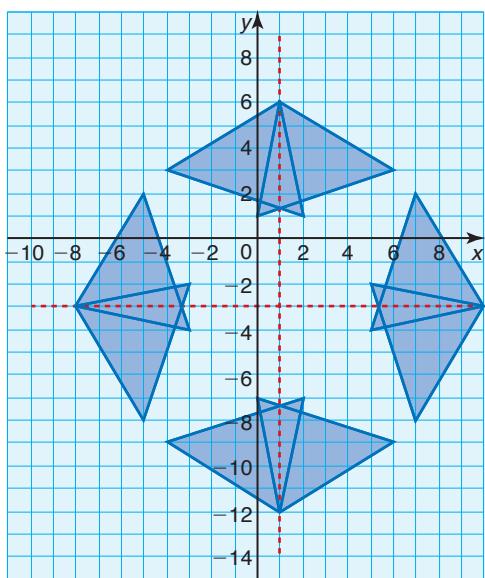
c)



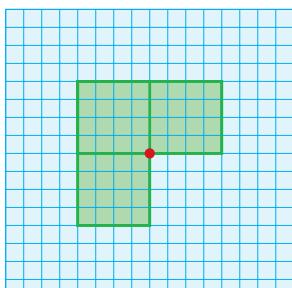
d)



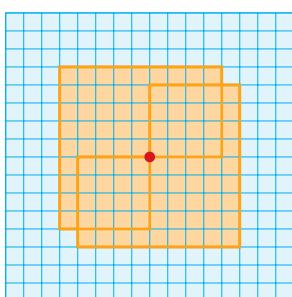
3.



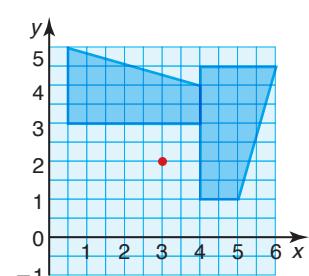
2.



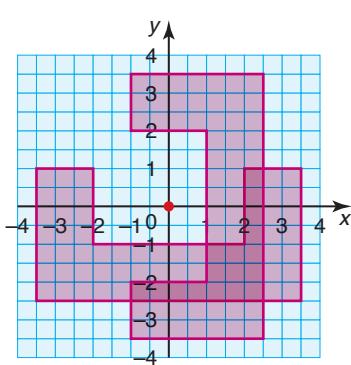
3.



4.

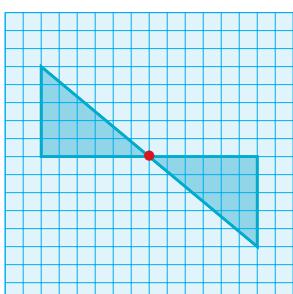


5.

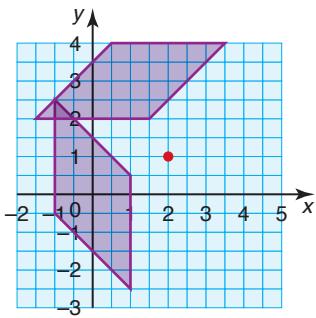


### Exercise 34.3 page 411

1.

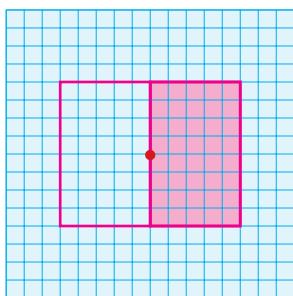


6.



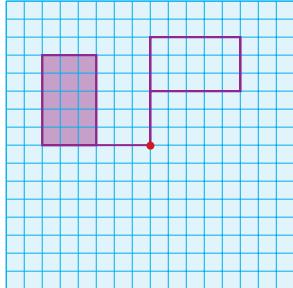
**Exercise 34.4** page 411

1. a)



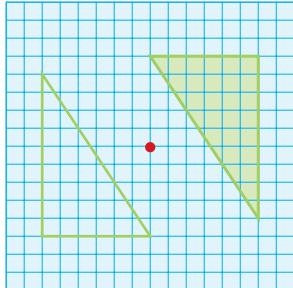
b)  $180^\circ$  clockwise/anti-clockwise

2. a)



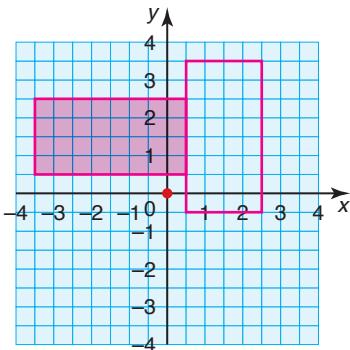
b)  $90^\circ$  anti-clockwise

3. a)



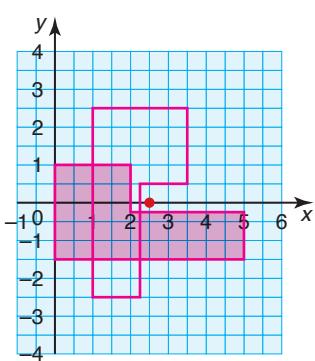
b)  $180^\circ$  clockwise/anti-clockwise

4. a)



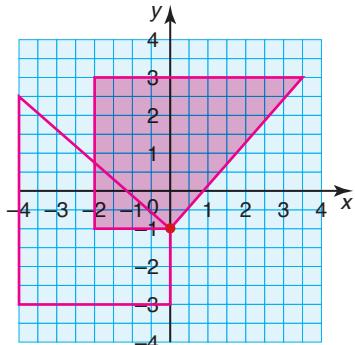
b)  $90^\circ$  anti-clockwise about  $(0, 0)$

5. a)



b)  $90^\circ$  anti-clockwise about  $(2.5, 0)$

6. a)



b)  $90^\circ$  clockwise about  $(0, -1)$

**Exercise 34.5** page 413

Student's own diagrams.

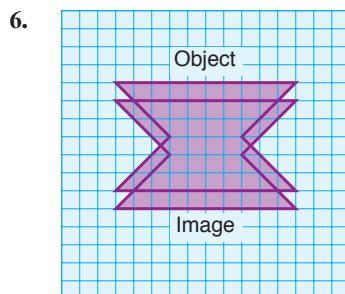
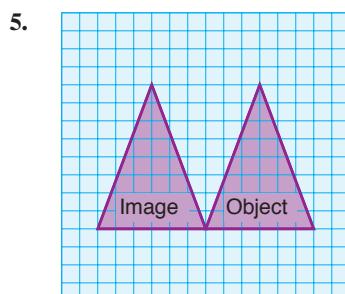
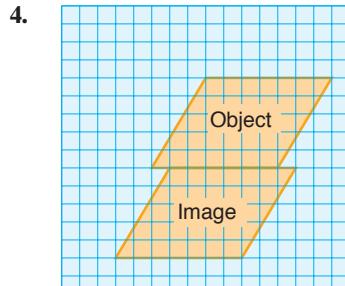
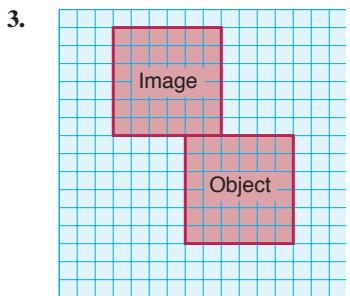
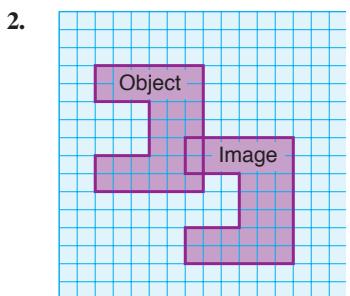
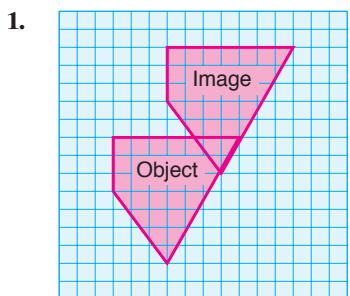
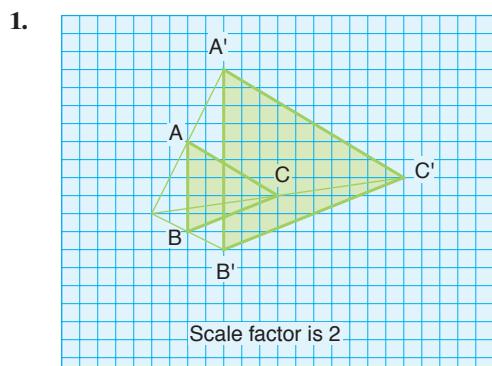
**Exercise 34.6** page 414

1.  $A \rightarrow B = \begin{pmatrix} -6 \\ 0 \end{pmatrix}$     $A \rightarrow C = \begin{pmatrix} 3 \\ 6 \end{pmatrix}$

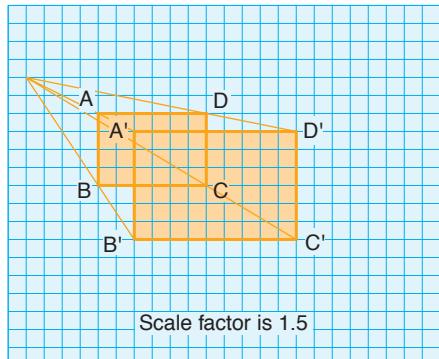
2.  $A \rightarrow B = \begin{pmatrix} 0 \\ -7 \end{pmatrix}$     $A \rightarrow C = \begin{pmatrix} -6 \\ 1 \end{pmatrix}$

3.  $A \rightarrow B = \begin{pmatrix} 0 \\ 6 \end{pmatrix}$     $A \rightarrow C = \begin{pmatrix} 6 \\ -3 \end{pmatrix}$

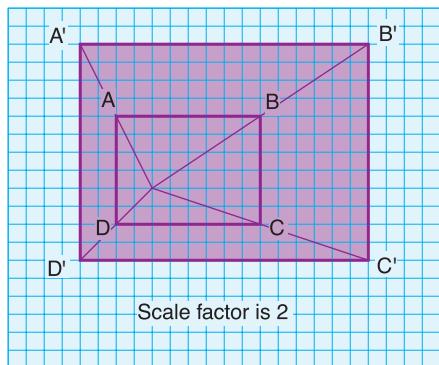
4.  $A \rightarrow B = \begin{pmatrix} 5 \\ 0 \end{pmatrix}$     $A \rightarrow C = \begin{pmatrix} -3 \\ -6 \end{pmatrix}$

**Exercise 34.7** page 415**Exercise 34.8** page 418

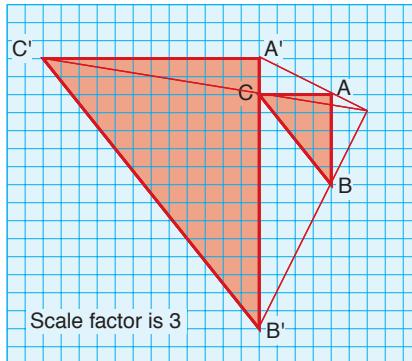
2.



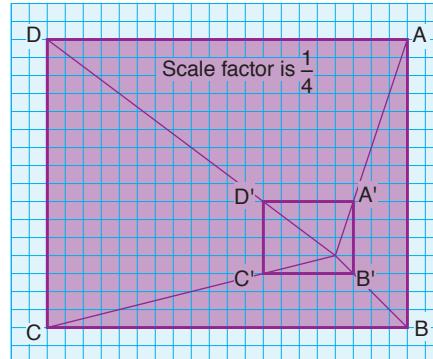
3.



4.

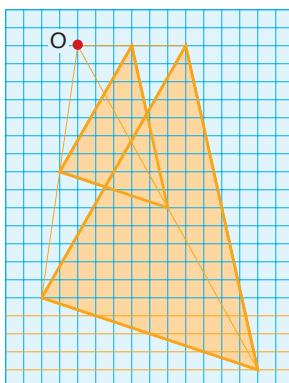


5.

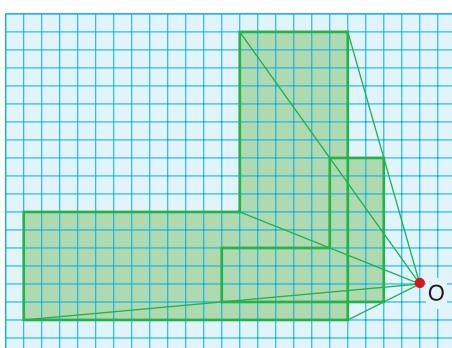


### Exercise 34.9 page 419

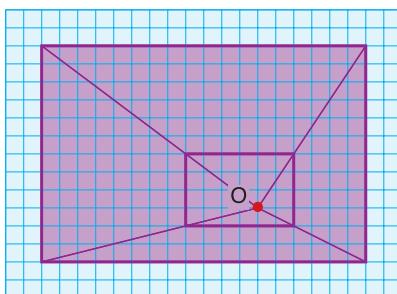
1.



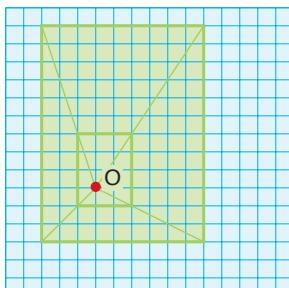
2.



3.

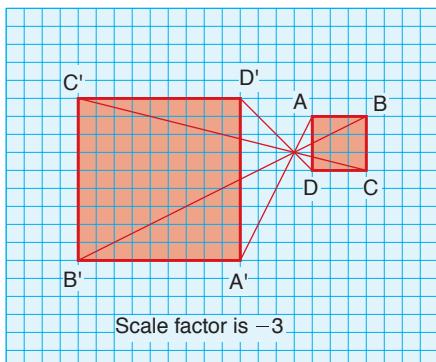


4.

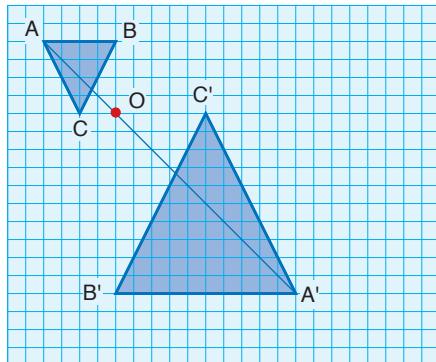


**Exercise 34.10** page 420

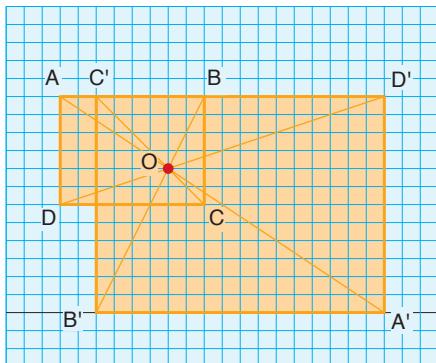
1.



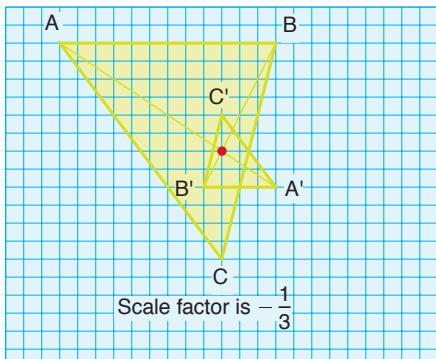
2.



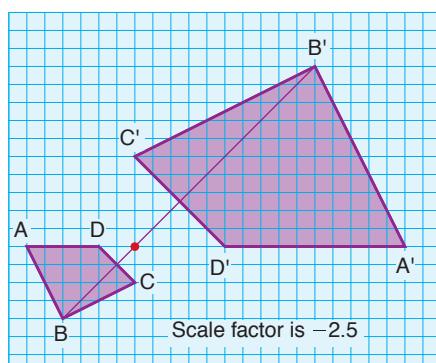
3.



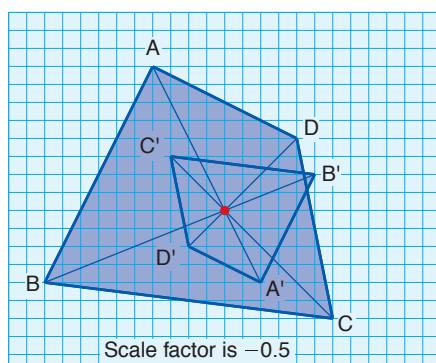
4.



5.

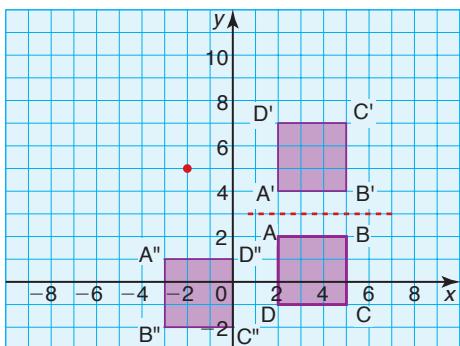


6.

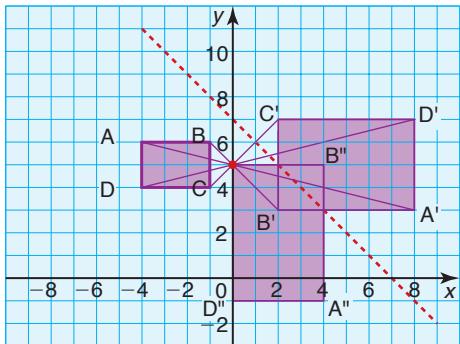


**Exercise 34.11** page 422

1.

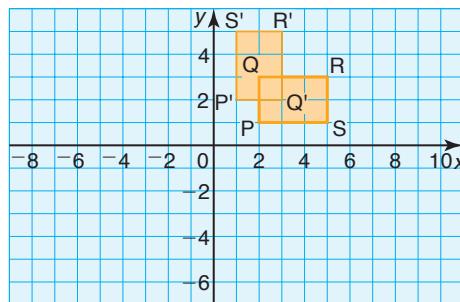


2.

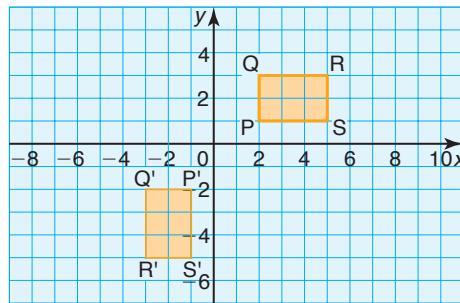


**Exercise 34.12** page 424

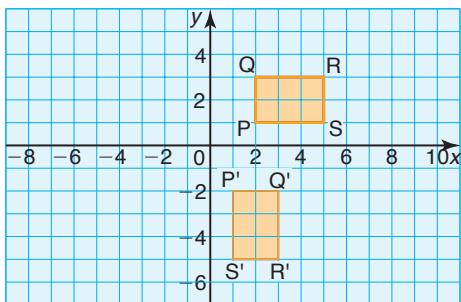
1.



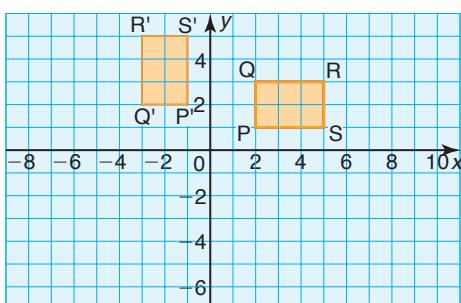
2.



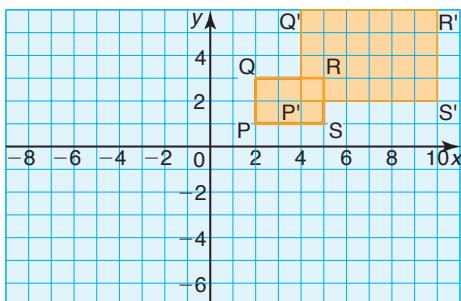
3.



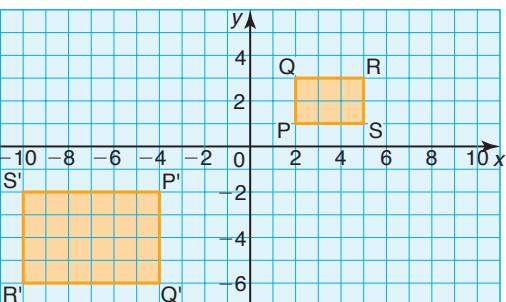
4.



5.

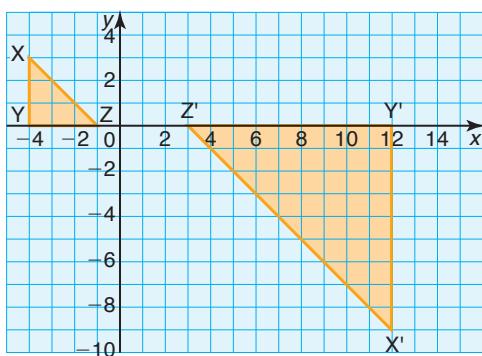


6.



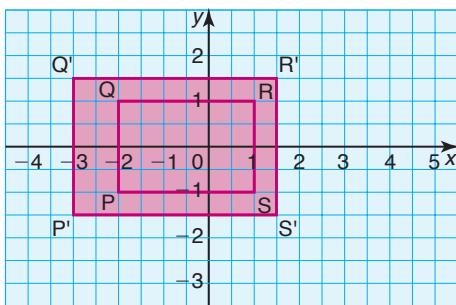
7. Q.1 represents a reflection in the line  $y = x$ .  
 Q.2 represents a reflection in the line  $y = -x$ .  
 Q.3 represents a clockwise rotation of  $90^\circ$  about the origin.  
 Q.4 represents an anti-clockwise rotation of  $90^\circ$  about the origin.  
 Q.5 represents an enlargement of scale factor 2 with its centre at the origin.  
 Q.6 represents an enlargement of scale factor  $-2$  with its centre at the origin.

8. a)



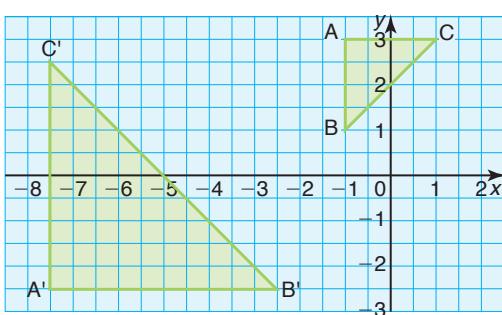
- b) 4.5 units<sup>2</sup> c) 40.5 units<sup>2</sup> d) 9 e) 9

9. a)



- b) 6 units<sup>2</sup> c) 13.5 units<sup>2</sup> d) 2.25 e) 2.25

10. a)



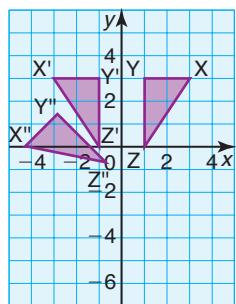
- b) 2 units<sup>2</sup> c) 12.5 units<sup>2</sup> d) 6.25 e) 6.25

### Exercise 34.13 page 426

1. a) Student's own diagram  
 b) Student's diagram should show a reflection in  $y = -x$  followed by enlargement from the origin  $\times 2$   
 c)  $\begin{pmatrix} 0 & -0.5 \\ -0.5 & 0 \end{pmatrix}$
2. a) Student's own diagram  
 b) Student's diagram should show a rotation  $180^\circ$  about the origin  
 c)  $\begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix}$
3. a) Student's own diagram  
 b) Student's diagram should show a rotation  $90^\circ$  clockwise about the origin followed by enlargement from the origin  $\times 1.5$   
 c)  $\begin{pmatrix} 0 & -\frac{2}{3} \\ \frac{2}{3} & 0 \end{pmatrix}$
4. a) Student's own diagram  
 b) Student's diagram should show an enlargement from the origin  $\times 0.5$  followed by reflection in the  $y$ -axis  
 c)  $\begin{pmatrix} -2 & 0 \\ 0 & 2 \end{pmatrix}$
5. a) Student's own diagram  
 b) Student's diagram should show an enlargement from the origin  $\times 2.5$  followed by reflection in the  $x$ -axis  
 c)  $\begin{pmatrix} \frac{2}{5} & 0 \\ 0 & -\frac{2}{5} \end{pmatrix}$
6. a) Student's own diagram  
 b) Student's diagram should show a rotation about the origin  $60^\circ$  anti-clockwise followed by an enlargement from origin  $\times (-2)$   
 c)  $\begin{pmatrix} -\frac{1}{4} & -\frac{\sqrt{3}}{4} \\ \frac{\sqrt{3}}{4} & -\frac{1}{4} \end{pmatrix}$

**Exercise 34.14** page 429

1. a) c)

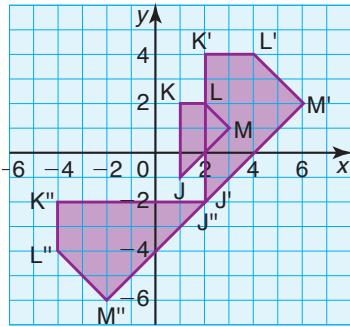


b) Reflection in the  $y$ -axis

d) Rotation  $45^\circ$  anti-clockwise about the origin

$$\text{e) } \begin{pmatrix} -\frac{\sqrt{2}}{2} & -\frac{\sqrt{2}}{2} \\ -\frac{\sqrt{2}}{2} & \frac{\sqrt{2}}{2} \end{pmatrix} \quad \text{f) } \begin{pmatrix} -\frac{\sqrt{2}}{2} & -\frac{\sqrt{2}}{2} \\ -\frac{\sqrt{2}}{2} & \frac{\sqrt{2}}{2} \end{pmatrix}$$

2. a) c)



b) Enlargement scale factor 2, with centre at the origin

d) Reflection in the line  $y = -x$

$$\text{e) } \begin{pmatrix} 0 & -2 \\ -2 & 0 \end{pmatrix} \quad \text{f) } \begin{pmatrix} 0 & -\frac{1}{2} \\ -\frac{1}{2} & 0 \end{pmatrix}$$

3. a)  $\begin{pmatrix} 0 & -\frac{3}{2} \\ \frac{3}{2} & 0 \end{pmatrix}$

$$\text{b) } \begin{pmatrix} 0 & \frac{2}{3} \\ -\frac{2}{3} & 0 \end{pmatrix}$$

4. a)  $\begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix}$

$$\text{b) } \begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix}$$

$$\text{c) } \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$$

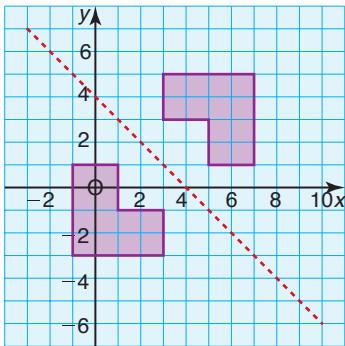
d) Rotation  $180^\circ$  about the origin

e) Reflection in the line  $y = -x$

f) Reflection in the line  $y = x$

**Student assessment 1** page 431

1. a)



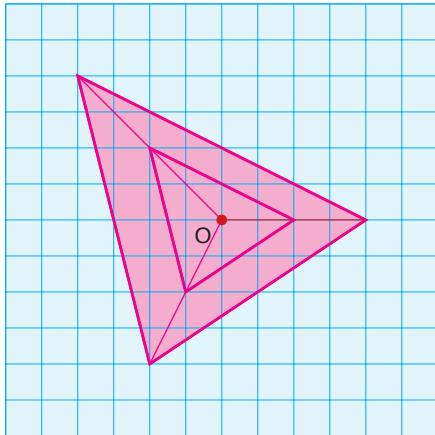
$y = x - 2$  is also a mirror line

$$\text{b) } y = -x + 4$$

2. a)  $(3, 2)$  b)  $90^\circ$  clockwise

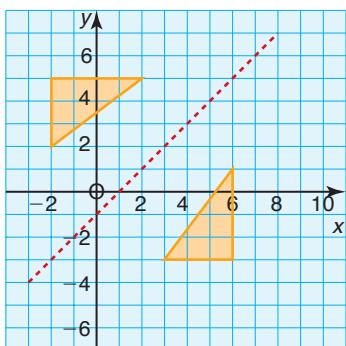
3. a)  $\begin{pmatrix} 6 \\ 0 \end{pmatrix}$  b)  $\begin{pmatrix} -3 \\ -5 \end{pmatrix}$

4.



**Student assessment 2** page 432

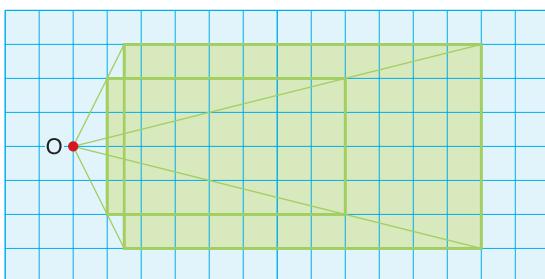
1.



2. a) Student's own construction  
b)  $180^\circ$  clockwise/anti-clockwise

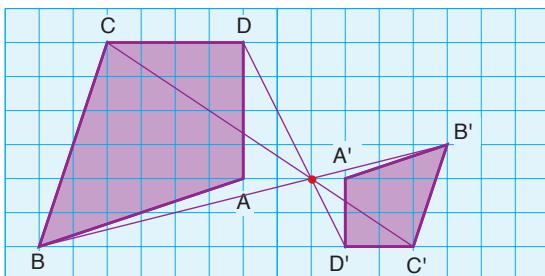
3. a)  $\begin{pmatrix} 0 \\ -3 \end{pmatrix}$       b)  $\begin{pmatrix} -8 \\ 2 \end{pmatrix}$

4.



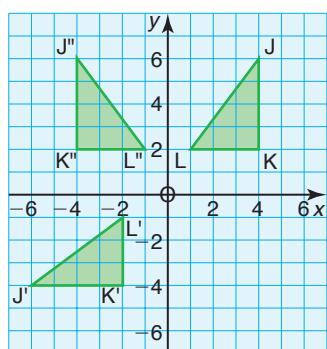
### **Student assessment 3** page 433

1. a)



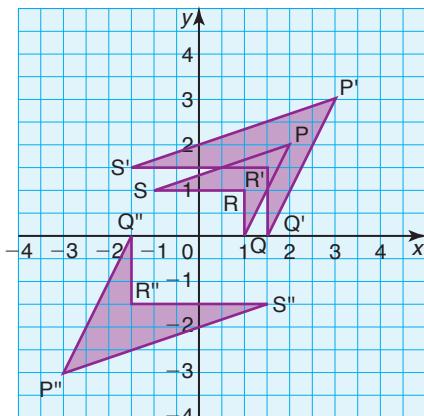
- b) The scale factor of enlargement is  $-0.5$ .  
2. a) An enlargement of scale factor 2. Centre of enlargement  $(3, 3)$   
b) A reflection about the line  $y = -x - 1$   
3. a) A reflection in the line  $x = 0$   
b) An enlargement by scale factor  $-0.5$ . Centre of enlargement  $(0, -1)$

4. a) b)



c)  $\begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}$

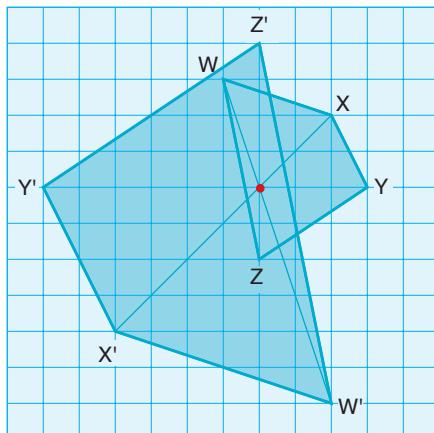
5. a) b)



c)  $\begin{pmatrix} -1.5 & 0 \\ 0 & -1.5 \end{pmatrix}$       d)  $\begin{pmatrix} -\frac{2}{3} & 0 \\ 0 & -\frac{2}{3} \end{pmatrix}$

### **Student assessment 4** page 435

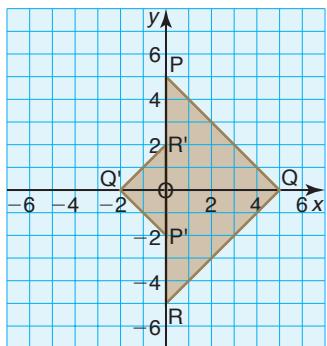
1. a)



- b) The scale factor of enlargement is  $-2$ .

2. a) A translation of vector  $\begin{pmatrix} 6 \\ 0 \end{pmatrix}$   
b) An enlargement of scale factor 2. Centre of enlargement  $(6, 8)$

3. a)



b)  $\frac{4}{25} = 0.16$

c)  $\frac{4}{25}$  or 0.16

## Topic 7 Mathematical investigations and ICT

### A painted cube

page 436

1. a) 8      b) 12      c) 6      d) 1
2. A: 8, B: 24, C: 24, D: 8
3. A: 8, B: 96, C: 384, D: 512
4. When  $(n-2) \geq 0$ , A: 8, B:  $12(n-2)$ , C:  $6(n-2)^2$ , D:  $(n-2)^3$
5. When  $(l-2) \geq 0$ ,  $(w-2) \geq 0$  and  $(h-2) \geq 0$ ,  
A: 8,  
B:  $4(l-2) + 4(w-2) + 4(h-2)$ ,  
C:  $2(l-2)(w-2) + 2(l-2)(h-2) + 2(w-2)(h-2)$ ,  
D:  $(l-2)(w-2)(h-2)$

### Triangle count

page 437

1. 9

2. Student's investigation and ordered table

| Number of horizontal lines | Number of triangles |
|----------------------------|---------------------|
| 0                          | 3                   |
| 1                          | 6                   |
| 2                          | 9                   |
| 3                          | 12                  |
| ...                        | ...                 |

3.  $n = 3(h+1)$

4. 12

5. Student's investigation and ordered table

| Number of horizontal lines | Number of triangles |
|----------------------------|---------------------|
| 0                          | 6                   |
| 1                          | 12                  |
| 2                          | 18                  |
| 3                          | 24                  |
| ...                        | ...                 |

6.  $n = 6(h+1)$

### ICT activity 1

page 438

Student's help sheet

### ICT activity 2

page 439

3. Reflection in  $y = x$
4. a) Reflection in  $y = -x$   
b) Clockwise rotation about the origin of  $90^\circ$   
c) Anti-clockwise rotation about the origin of  $90^\circ$   
d) Enlargement of scale factor 2, centred at the origin.  
e) Enlargement of scale factor -2, centred at the origin

## 35 Probability

### Exercise 35.1

page 443

1. Student's own drawing
2. Student's own answers

### Exercise 35.2

page 444

1. a)  $\frac{1}{6}$       b)  $\frac{5}{6}$       c)  $\frac{1}{2}$       d)  $\frac{5}{6}$       e) 0      f) 1
2. a) i)  $\frac{1}{7}$       ii)  $\frac{6}{7}$       b) Total = 1
3. a)  $\frac{1}{250}$       b)  $\frac{1}{2}$       c)  $\frac{151}{250}$       d) 1
4. a)  $\frac{5}{8}$       b)  $\frac{3}{8}$
5. a)  $\frac{1}{13}$       b)  $\frac{5}{26}$       c)  $\frac{21}{26}$       d)  $\frac{3}{26}$
6.  $\frac{1}{6}$
7. a) i)  $\frac{1}{10}$       ii)  $\frac{1}{4}$       b) i)  $\frac{1}{19}$       ii)  $\frac{3}{19}$
8. a)  $\frac{1}{37}$       b)  $\frac{36}{37}$       c)  $\frac{18}{37}$       d)  $\frac{1}{37}$   
e)  $\frac{21}{37}$       f)  $\frac{12}{37}$       g)  $\frac{17}{37}$       h)  $\frac{11}{37}$
9. a) RCA RAC CRA CAR ARC ACR  
b)  $\frac{1}{6}$       c)  $\frac{1}{3}$       d)  $\frac{1}{2}$       e)  $\frac{1}{24}$

10. a)  $\frac{1}{4}$       b)  $\frac{3}{4}$       c)  $\frac{1}{13}$       d)  $\frac{1}{26}$   
 e)  $\frac{3}{13}$       f)  $\frac{1}{52}$       g)  $\frac{5}{13}$       h)  $\frac{4}{13}$

**Exercise 35.3** page 445

1. a) 140  
 b) i)  $\frac{1}{5}$       ii)  $\frac{3}{70}$       iii)  $\frac{6}{7}$   
 2. a) 32  
 b) i)  $\frac{9}{16}$       ii)  $\frac{5}{32}$       iii)  $\frac{3}{8}$       iv)  $\frac{5}{8}$   
 3. a) 70  
 b) i)  $\frac{11}{35}$       ii)  $\frac{2}{7}$       iii)  $\frac{5}{7}$       iv)  $\frac{33}{35}$

**Exercise 35.4** page 448

1. 2  
 2. 25  
 3. a)  $\frac{1}{16}$       b)  $\frac{7}{16}$       c)  $\frac{1}{2}$       d)  $\frac{15}{16}$       e)  $\frac{11}{16}$   
 4. a)  $\frac{14}{45}$       b)  $\frac{7}{45}$       c)  $\frac{13}{30}$       d)  $\frac{1}{15}$       e)  $\frac{14}{15}$   
 5. 35 blue, 28 red, 21 yellow, 49 green, 7 white  
 6. 300  
 7. 14  
 8. 200  
 9. 2

**Student assessment 1** page 449

1. a)  $\frac{1}{6}$       b)  $\frac{5}{6}$       c)  $\frac{2}{3}$       d) 0  
 2. a)  $\frac{1}{4}$       b)  $\frac{1}{13}$       c)  $\frac{1}{2}$       d)  $\frac{3}{13}$   
 e)  $\frac{4}{13}$   
 3. a)  $\frac{1}{250}$       b)  $\frac{1}{50}$       c)  $\frac{2}{25}$       d)  $\frac{3}{10}$   
 e) 1  
 4. a)  $\frac{11}{40}$       b)  $\frac{1}{8}$       c)  $\frac{1}{4}$       d)  $\frac{4}{5}$   
 5. 160 red, 96 blue, 64 green  
 6. a)  $\frac{41}{150}$       b)  $\frac{29}{150}$       c)  $\frac{1}{25}$       d)  $\frac{4}{15}$   
 e)  $\frac{11}{15}$       f)  $\frac{137}{150}$       g)  $\frac{1}{30}$   
 7. a) The girl's results are likely to be more reliable as she repeated the experiment more times.  
 b) It is likely that the dice is biased towards the number 3.

**Student assessment 2** page 450

1. a)  $\frac{1}{8}$       b)  $\frac{7}{8}$       c)  $\frac{5}{8}$       d) 0

2. a) 32 cards in pack  
 b) i)  $\frac{1}{8}$       ii)  $\frac{3}{8}$       iii)  $\frac{1}{4}$       iv)  $\frac{1}{8}$       v)  $\frac{11}{32}$   
 3. a)  $\frac{1}{180}$       b)  $\frac{1}{20}$       c)  $\frac{1}{12}$       d)  $\frac{2}{9}$       e) 1  
 4. a)  $\frac{9}{32}$       b)  $\frac{3}{8}$       c)  $\frac{21}{32}$   
 5. 128 red, 80 blue, 112 green  
 6. a)  $\frac{3}{20}$       b)  $\frac{19}{20}$       c)  $\frac{7}{10}$   
 7. a) 50 000  
 b) You have to assume that all entrants have an equal chance of winning.

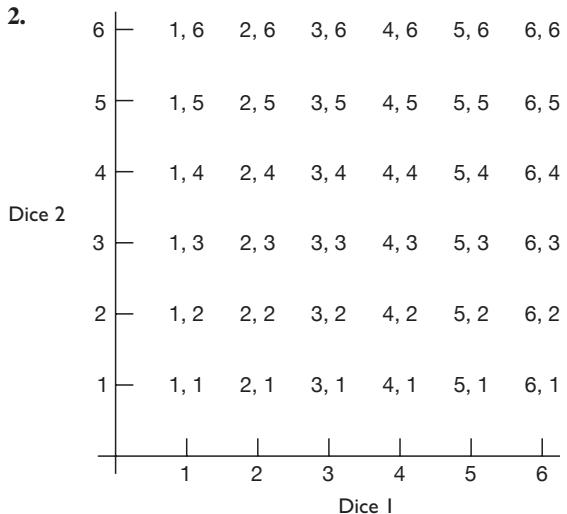
**36 Further probability****Exercise 36.1** page 452

1. a)

|        |   | Dice 1 |      |      |      |
|--------|---|--------|------|------|------|
|        |   | 1      | 2    | 3    | 4    |
| Dice 2 | 1 | 1, 1   | 2, 1 | 3, 1 | 4, 1 |
|        | 2 | 1, 2   | 2, 2 | 3, 2 | 4, 2 |
|        | 3 | 1, 3   | 2, 3 | 3, 3 | 4, 3 |
|        | 4 | 1, 4   | 2, 4 | 3, 4 | 4, 4 |

b)  $\frac{1}{4}$       c)  $\frac{1}{4}$       d)  $\frac{9}{16}$

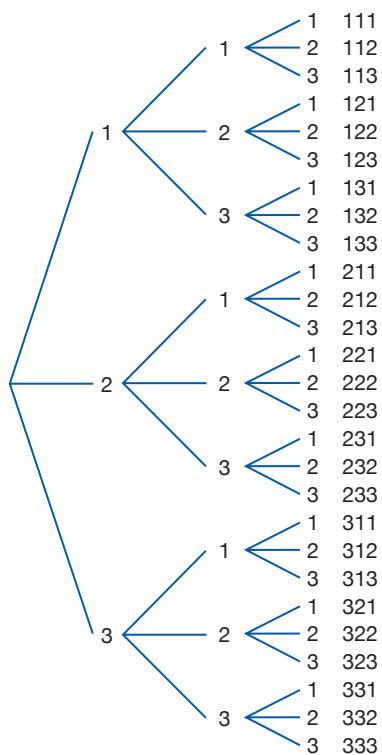
2.



- a)  $\frac{1}{36}$       b)  $\frac{1}{6}$       c)  $\frac{1}{18}$       d)  $\frac{1}{6}$       e)  $\frac{1}{4}$       f)  $\frac{3}{4}$   
 g)  $\frac{5}{18}$       h)  $\frac{1}{6}$       i)  $\frac{11}{18}$

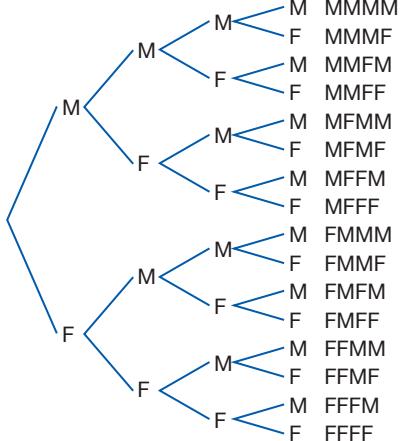
**Exercise 36.2** page 454

1. a)



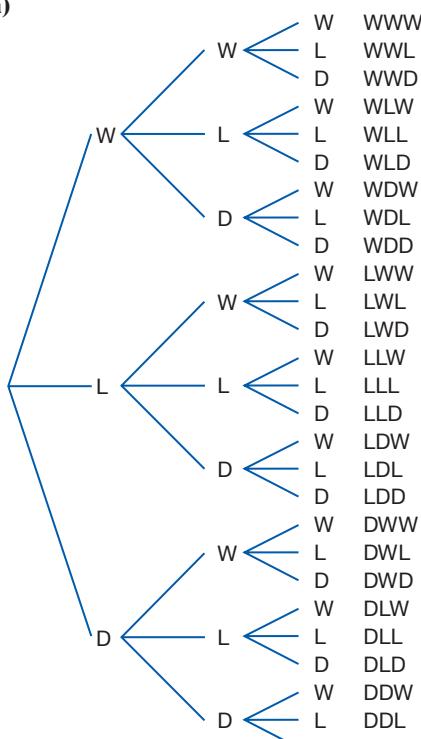
b) i)  $\frac{1}{27}$     ii)  $\frac{1}{3}$     iii)  $\frac{1}{9}$     iv)  $\frac{1}{3}$     v)  $\frac{5}{9}$

2. a)



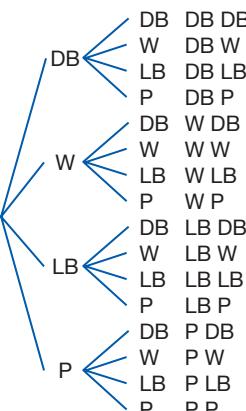
b) i)  $\frac{1}{16}$     ii)  $\frac{3}{8}$     iii)  $\frac{15}{16}$     iv)  $\frac{5}{16}$

3. a)

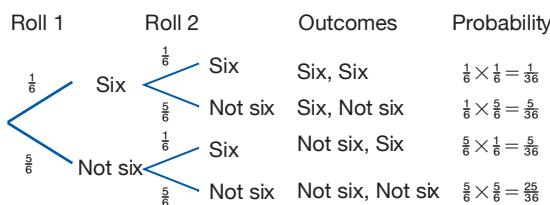


b) i)  $\frac{1}{27}$     ii)  $\frac{10}{27}$     iii)  $\frac{19}{27}$     iv)  $\frac{8}{27}$

4. a)



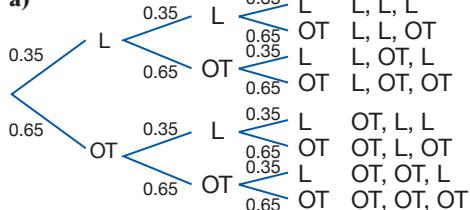
b) i)  $\frac{1}{16}$     ii)  $\frac{1}{4}$     iii)  $\frac{1}{8}$

**Exercise 36.3** page 456**1. a)**

**b)** i)  $\frac{1}{6}$  ii)  $\frac{11}{36}$  iii)  $\frac{5}{36}$  iv)  $\frac{125}{216}$  v)  $\frac{91}{216}$

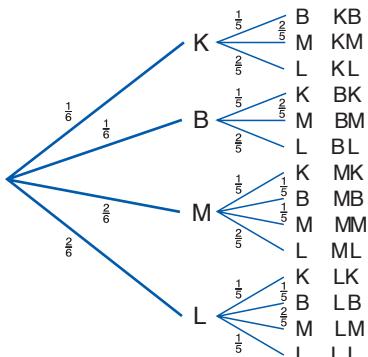
**c)** Add up to 1

**2.** a)  $\frac{4}{25}$  b)  $\frac{54}{125}$  c)  $\frac{98}{125}$

**3. a)**

**b)** i) 0.275 (3 s.f.) ii) 0.123 (3 s.f.) iii) 0.444 (3 s.f.) iv) 0.718 (3 s.f.)

**4.** a) 0.0588 (3 s.f.) b) 0.0129 (3 s.f.) c) 0.414 (3 s.f.) d) 0.586 (3 s.f.)

**5. a)**

**b)** i)  $\frac{1}{15}$  ii)  $\frac{1}{15}$  iii)  $\frac{3}{5}$

**6.** 0.027

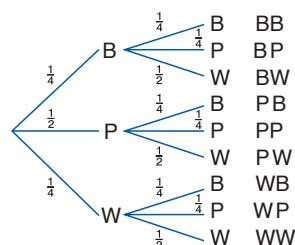
**7.** a)  $0.75^2$  (0.563)  
b)  $0.75^3$  (0.422)  
c)  $0.75^{10}$  (0.056)

**Student assessment I** page 457

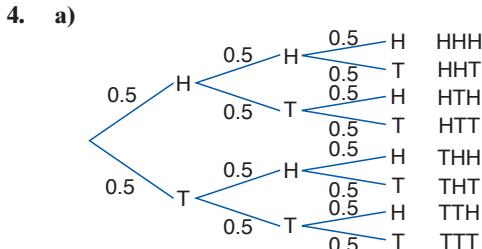
**1. a)** i)  $\frac{3}{5}$  ii)  $\frac{1}{19}$   
**b)** Infinite

**2. a)**

|   |    |    |    |    |    |    |
|---|----|----|----|----|----|----|
|   | I  | 2  | 3  | 4  | 5  | 6  |
| H | IH | 2H | 3H | 4H | 5H | 6H |
| T | IT | 2T | 3T | 4T | 5T | 6T |

  
**b)** i)  $\frac{1}{12}$  ii)  $\frac{1}{4}$  iii)  $\frac{1}{4}$ 
**3. a)** A B

**b)** i)  $\frac{1}{16}$  ii)  $\frac{1}{8}$  iii)  $\frac{1}{4}$



**b)** i)  $\frac{1}{8}$  ii)  $\frac{3}{8}$  iii)  $\frac{1}{8}$  iv)  $\frac{7}{8}$

**5. a)**  $\frac{4}{9}$  **b)**  $\frac{26}{27}$  **c)**  $\frac{2}{9}$

**6. a)**  $\frac{9}{16}$  **b)**  $\frac{1}{16}$  **c)**  $\frac{1}{4}$

**7.** 0.00995 (3 s.f.)

**Student assessment 2** page 458

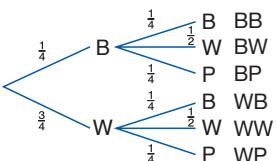
1. a)

|        |   | Dice 1 |   |   |    |    |    |
|--------|---|--------|---|---|----|----|----|
|        |   | 1      | 2 | 3 | 4  | 5  | 6  |
| Dice 2 | 1 | 2      | 3 | 4 | 5  | 6  | 7  |
|        | 2 | 3      | 4 | 5 | 6  | 7  | 8  |
|        | 3 | 4      | 5 | 6 | 7  | 8  | 9  |
|        | 4 | 5      | 6 | 7 | 8  | 9  | 10 |
|        | 5 | 6      | 7 | 8 | 9  | 10 | 11 |
|        | 6 | 7      | 8 | 9 | 10 | 11 | 12 |

b) i)  $\frac{1}{36}$       ii)  $\frac{1}{6}$       iii)  $\frac{1}{12}$       iv)  $\frac{7}{12}$   
 c) 25

2. a) i)  $\frac{1}{4}$       ii)  $\frac{3}{8}$   
 b) i)  $\frac{3}{64}$       ii)  $\frac{3}{32}$       iii)  $\frac{7}{16}$       iv)  $\frac{39}{64}$

3. a)

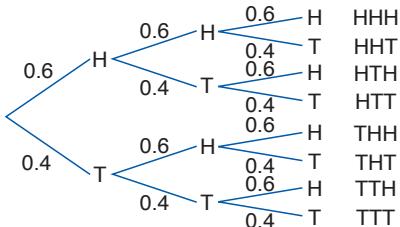


b) i)  $\frac{1}{16}$       ii)  $\frac{3}{8}$       iii)  $\frac{3}{16}$       iv)  $\frac{7}{8}$

4. a)  $\frac{1}{12}$       b)  $\frac{1}{6}$       c)  $\frac{1}{6}$

5. a) 0.72      b) 0.729

6. a)



b) i) 0.216      ii) 0.064      iii) 0.648  
 7. a) i) 0.8      ii) 0.7      iii) 0.3  
 b) i) 0.06      ii) 0.56      iii) 0.38

**Topic 8 Mathematical investigations and ICT****Probability drop** page 460

- Tray 1: LLL      Tray 2: LLR      LRL      RLL  
 Tray 3: LRR      RLR      RRL  
 Tray 4: RRR
- Tray 1: LLLL      Tray 2: LLLR      LLRL      LRLL      RLLL  
 Tray 3: LLRR      LRLR      LRRL      RLLR  
 Tray 4: RRRR      RRLR      RLRR      LRRR  
 Tray 5: RRRR
- $\frac{1}{16}$  because there are 16 possible routes and only one results in the marble landing in Tray 1.
- Tray 2:  $\frac{4}{16} = \frac{1}{4}$   
 Tray 3:  $\frac{6}{16} = \frac{3}{8}$   
 Tray 4:  $\frac{4}{16} = \frac{1}{4}$   
 Tray 5:  $\frac{1}{16}$
- Student's investigation
- $\frac{210}{1024} = \frac{105}{512}$
- Each number in each row of Pascal's triangle corresponds to the number of routes to landing in each tray of the game.
- The binomial expansion generates the numbers in Pascal's triangle and therefore the number of routes to landing in each tray of the game.

**Dice sum** page 461

1.

|        |   | Dice 1 |   |   |    |    |    |
|--------|---|--------|---|---|----|----|----|
|        |   | 1      | 2 | 3 | 4  | 5  | 6  |
| Dice 2 | 1 | 2      | 3 | 4 | 5  | 6  | 7  |
|        | 2 | 3      | 4 | 5 | 6  | 7  | 8  |
|        | 3 | 4      | 5 | 6 | 7  | 8  | 9  |
|        | 4 | 5      | 6 | 7 | 8  | 9  | 10 |
|        | 5 | 6      | 7 | 8 | 9  | 10 | 11 |
|        | 6 | 7      | 8 | 9 | 10 | 11 | 12 |

2. 36
3. 7
4.  $\frac{3}{36} = \frac{1}{12}$
5.  $\frac{3}{36} = \frac{1}{6}$
6. You are four times more likely to get a 5 than a 2.

7.

|        |   | Dice 1 |   |   |   |   |
|--------|---|--------|---|---|---|---|
|        |   | 1      | 2 | 3 | 4 | 5 |
| Dice 2 | 1 | 2      | 3 | 4 | 5 |   |
|        | 2 | 3      | 4 | 5 | 6 |   |
|        | 3 | 4      | 5 | 6 | 7 |   |
|        | 4 | 5      | 6 | 7 | 8 |   |

8. 16
9. 5
10.  $\frac{4}{16} = \frac{1}{4}$
11. Student's investigation
12. a)  $m^2$       b)  $m + 1$       c)  $\frac{m}{m^2} = \frac{1}{m}$
13. a)  $m \times n$ 
  - b) The total can take any integer value in the range  $n + 1 \rightarrow m + 1$ .
- c)  $\frac{n}{nm} = \frac{1}{m}$

### ICT activity: Buffon's needle experiment page 462

- 1.–9. Student's experiment and results entered in a spreadsheet
10. The value of  $\frac{2}{p}$  should tend to  $\pi$ .

## 37 Mean, median, mode and range

### Exercise 37.1 page 467

1. Mean = 1.67 (3 s.f.)      Median = 1  
Mode = 1      Range = 5
2. Mean = 6.2      Median = 6.5  
Mode = 7      Range = 9

3. Mean = 14 yrs 3 mths  
Median = 14 yrs 3 mths  
Mode = 14 yrs 3 mths  
Range = 8 mths
4. Mean = 26.4      Median = 27  
Mode = 28      Range = 5
5. Mean = 13.9 s (3 s.f.)  
Median = 13.9 s  
Mode = 13.8 s  
Range = 0.6 s
6. 91.1 kg
7. 103 points

### Exercise 37.2 page 468

1. Mean = 3.35      Median = 3  
Mode = 1 and 4      Range = 5
2. Mean = 7.03
3. a) Mean = 6.33 (3 s.f.)  
Median = 7  
Mode = 8  
Range = 5
  - b) The mode, as it gives the highest number of flowers per bush

### Exercise 37.3 page 469

1. a)

| Height (m) | Frequency | Mid-interval value | Frequency × mid-interval value |
|------------|-----------|--------------------|--------------------------------|
| 1.8–       | 2         | 1.85               | 3.7                            |
| 1.9–       | 5         | 1.95               | 9.75                           |
| 2.0–       | 10        | 2.05               | 20.5                           |
| 2.1–       | 22        | 2.15               | 47.3                           |
| 2.2–       | 7         | 2.25               | 15.75                          |
| 2.3–2.4    | 4         | 2.35               | 9.4                            |

- b) Mean = 2.13 m (3 s.f.)  
c) Modal class = 2.1–2.2 m
2. a) Mean = 33 h (2 s.f.)  
b) Modal class = 30–39 h
3. a) Mean = 6.2 cm  
b) Modal class = 6.0–6.5 cm

**Student assessment 1** page 470

1. a) Mean = 16  
b) Median = 16.5  
c) Mode = 18  
d) Range = 39
2. a) 28  
b) i) Mean 7.75  
ii) Median = 8  
iii) Mode = 8  
iv) Range = 5
3. a) Mean = 19  
b) Modal class is  $19 \leq M < 20$

**Student assessment 2** page 471

1. Mean = 86.8 m Median = 90.5 m  
Mode = 93 m Range = 18 m
2. a) 26  
b) i) Mean = 7.73 (3 s.f.)  
ii) Median = 7.5  
iii) Mode = 10  
iv) Range = 6
3. a) Mean  $\approx 10.0$  kg (3 s.f.)  
b) Modal class is  $10.0 \leq M < 10.1$  kg

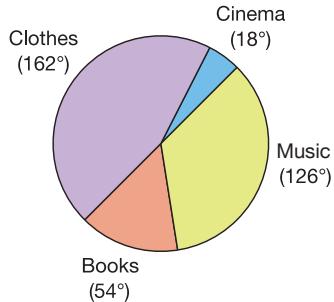
## 38 Collecting and displaying data

**Exercise 38.1** page 476

1.

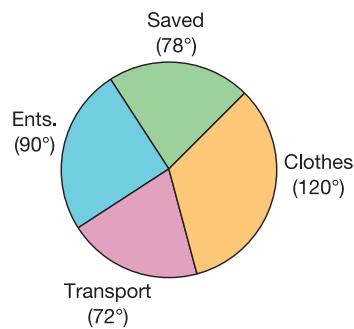
|       | Sleep  | Meals | Sport  | TV  | School |
|-------|--------|-------|--------|-----|--------|
| Ayse  | 8 h 20 | 2 h   | 5 h    | 2 h | 6 h 40 |
| Ahmet | 8 h 40 | 2 h   | 5 h 20 | 2 h | 6 h    |

2.

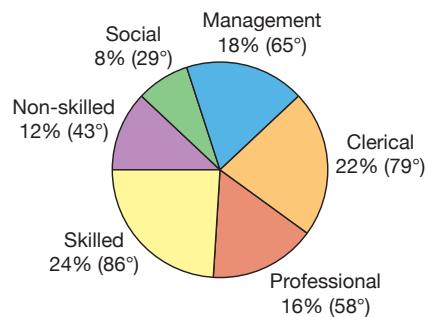


3.

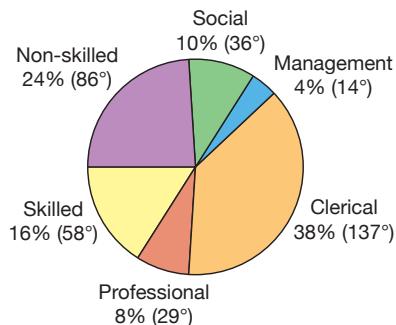
|           | Fraction        | \$  | Degrees |
|-----------|-----------------|-----|---------|
| Clothes   | $\frac{1}{3}$   | 800 | 120     |
| Transport | $\frac{1}{5}$   | 480 | 72      |
| Ents.     | $\frac{1}{4}$   | 600 | 90      |
| Saved     | $\frac{13}{60}$ | 520 | 78      |



4. Male



Female



a) Student's own two statements

b) Professional =  $8 \text{ million} \times 8\% = 640\,000$   
Management =  $8 \text{ million} \times 4\% = 320\,000$

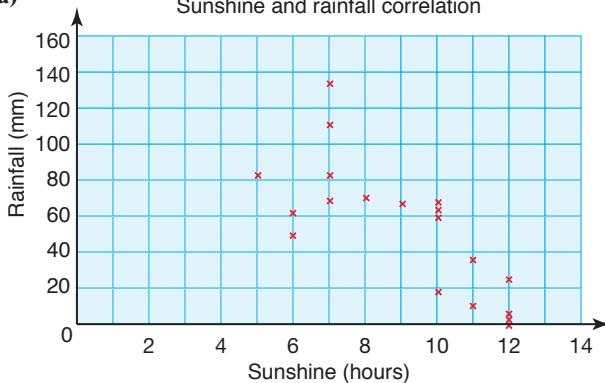
**Exercise 38.2** page 477

1. Student's own survey results and pie charts
2. Student's report

**Exercise 38.3** page 481

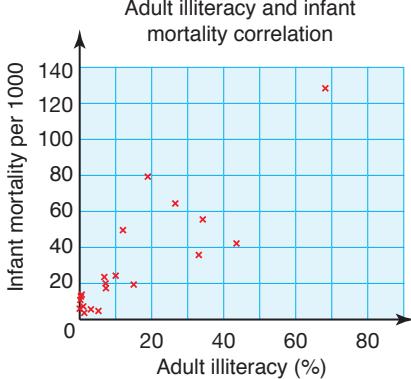
1. Student's answers may differ from those given below.
  - a) Possible positive correlation (strength depending on topics tested)
  - b) No correlation
  - c) Positive correlation (likely to be quite strong)
  - d) Negative correlation (likely to be strong). Assume that motorcycles are not rare/vintage.
  - e) Factors such as social class, religion and income are likely to affect results.  
Therefore little correlation is likely.
  - f) Negative correlation (likely to be strong)
  - g) 0–16 years likely to be a positive correlation
  - h) Strong positive correlation

2. a)



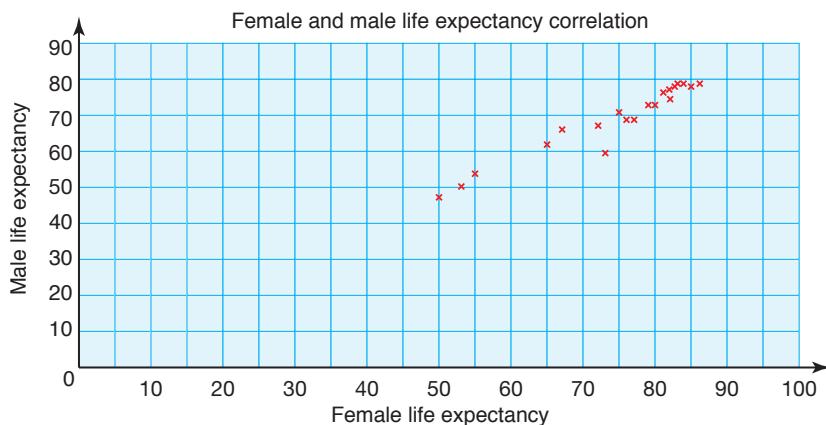
b) Graph shows a very weak negative correlation.

3. a)



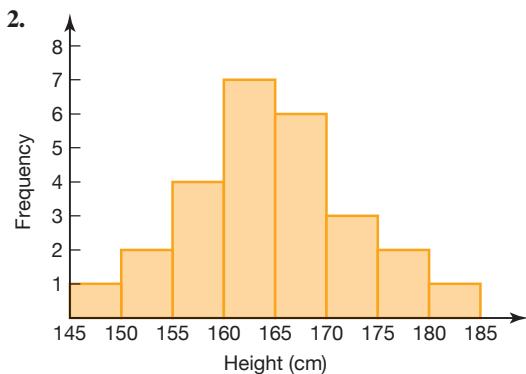
b) Positive correlation  
c) Student's answer. However, although there is a correlation, it doesn't imply that one variable affects the other

d)



4. a) Moderate/strong positive correlation  
 b) Approx. 31 tomatoes  
 c) Approx. 60 cm

### Exercise 38.4 page 485

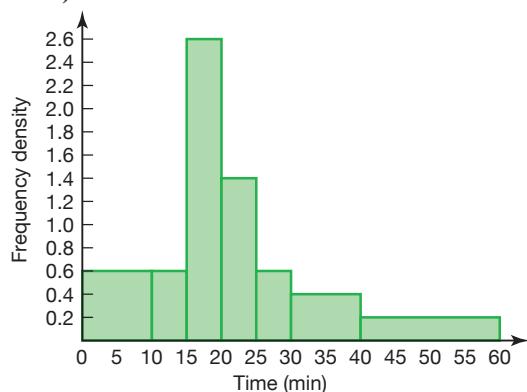


### Exercise 38.5 page 487

1. a)

| Time (min)    | 0-  | 10- | 15- | 20- | 25- | 30- | 40-60 |
|---------------|-----|-----|-----|-----|-----|-----|-------|
| Freq.         | 6   | 3   | 13  | 7   | 3   | 4   | 4     |
| Freq. density | 0.6 | 0.6 | 2.6 | 1.4 | 0.6 | 0.4 | 0.2   |

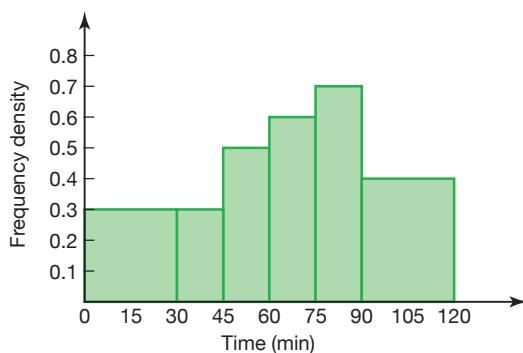
- b)



2. a)

| Time (min)        | Frequency | Frequency density |
|-------------------|-----------|-------------------|
| $0 \leq t < 30$   | 8         | 0.3               |
| $30 \leq t < 45$  | 5         | 0.3               |
| $45 \leq t < 60$  | 8         | 0.5               |
| $60 \leq t < 75$  | 9         | 0.6               |
| $75 \leq t < 90$  | 10        | 0.7               |
| $90 \leq t < 120$ | 12        | 0.4               |

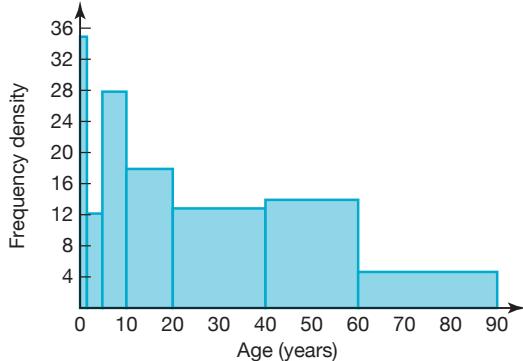
b)



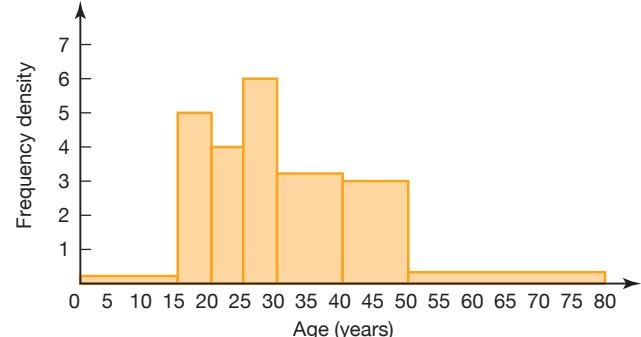
3. a)

| Age (years)                                  | 0–<br>1–<br>5–<br>10–<br>20–<br>40–<br>60–90 | Freq.                                 | Freq. density |
|--|--|---------------------------------------|---------------|
| 0–<br>1–<br>5–<br>10–<br>20–<br>40–<br>60–90 | 35<br>48<br>140<br>180<br>260<br>280<br>150  |                                       |               |
|  |  | 35<br>12<br>28<br>18<br>13<br>14<br>5 |               |

b)

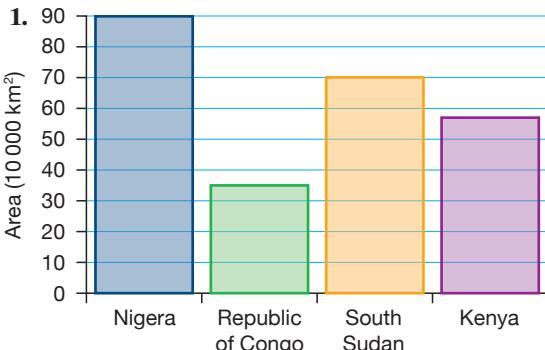


4. a)



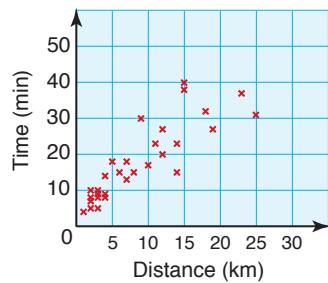
b) Student's own answers

### Student assessment I page 489



2. a)

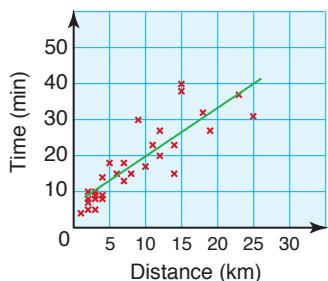
Distance travelled and time taken correlation



b) (Strong) positive correlation

c) It depends on their mode of transport.

d) Distance travelled and time taken correlation

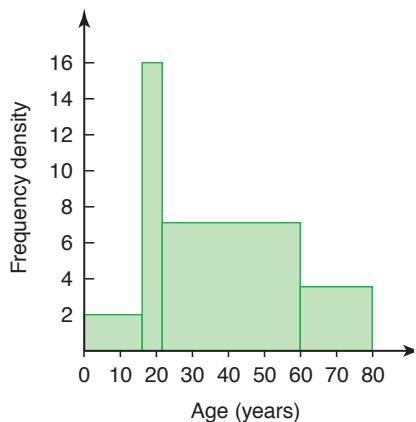


e) Approx. 9.5 km

3. a)

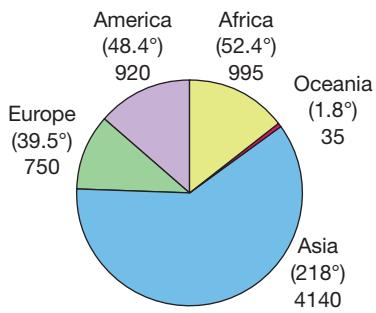
|               | Age   | Number | Frequency density |
|---------------|-------|--------|-------------------|
| Juniors       | 0–    | 32     | 2                 |
| Intermediates | 16–   | 80     | 16                |
| Full members  | 21–   | 273    | 7                 |
| Seniors       | 60–80 | 70     | 3.5               |

b)



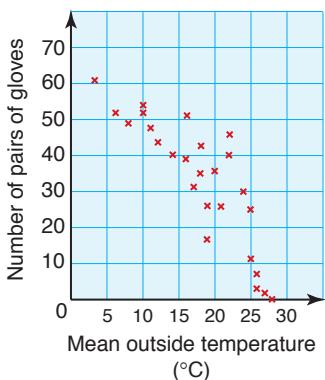
## Student assessment 2 page 490

1.



2. a)

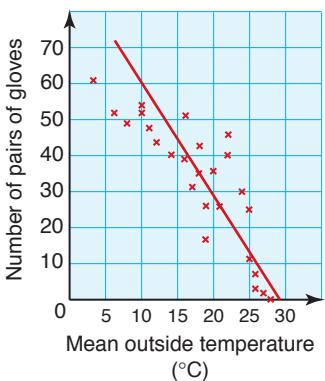
Gloves sold and outside temperature correlation



b) Negative correlation

c) Student's own answer

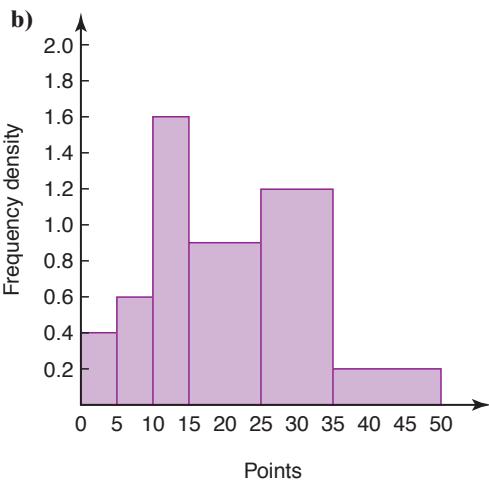
d) Gloves sold and outside temperature correlation



Approx. 30 pairs

3. a)

| Points          | 0–  | 5–  | 10– | 15– | 25– | 35–50 |
|-----------------|-----|-----|-----|-----|-----|-------|
| Number of games | 2   | 3   | 8   | 9   | 12  | 3     |
| Freq. density   | 0.4 | 0.6 | 1.6 | 0.9 | 1.2 | 0.2   |

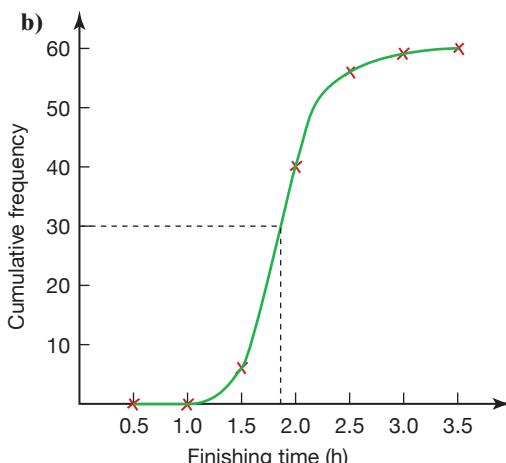


## 39 Cumulative frequency

### Exercise 39.1 page 492

1. a)

|                    |    |      |      |      |      |      |         |
|--------------------|----|------|------|------|------|------|---------|
| Finishing time (h) | 0– | 0.5– | 1.0– | 1.5– | 2.0– | 2.5– | 3.0–3.5 |
| Freq.              | 0  | 0    | 6    | 34   | 16   | 3    | 1       |
| Cum. freq.         | 0  | 0    | 6    | 40   | 56   | 59   | 60      |

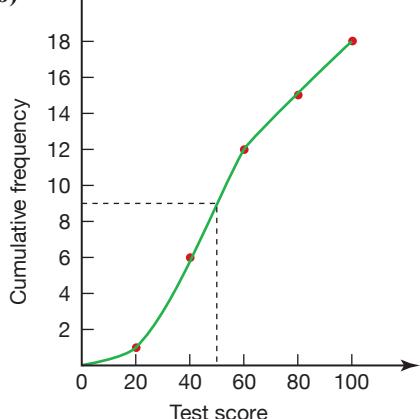


- c) Median  $\approx 1.8$  h
- d) As many runners finished before as after the median.

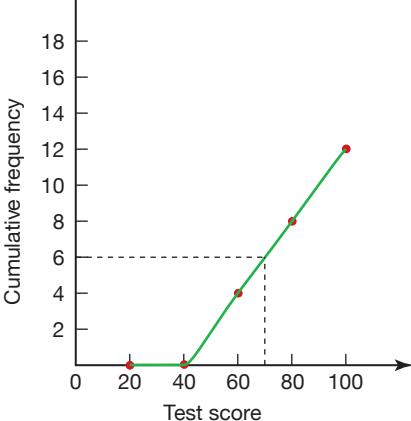
2. a)

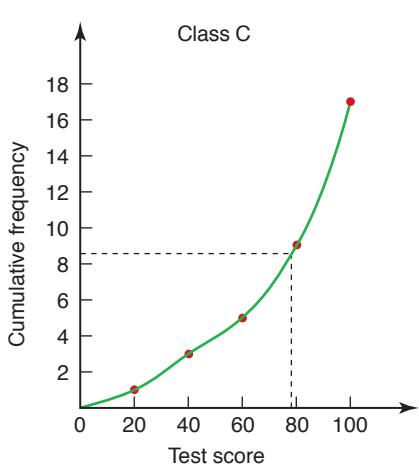
| Score             | Class A |            | Class B |            | Class C |            |
|-------------------|---------|------------|---------|------------|---------|------------|
|                   | Freq.   | Cum. freq. | Freq.   | Cum. freq. | Freq.   | Cum. freq. |
| $0 \leq x < 20$   | 1       | 1          | 0       | 0          | 1       | 1          |
| $20 \leq x < 40$  | 5       | 6          | 0       | 0          | 2       | 3          |
| $40 \leq x < 60$  | 6       | 12         | 4       | 4          | 2       | 5          |
| $60 \leq x < 80$  | 3       | 15         | 4       | 8          | 4       | 9          |
| $80 \leq x < 100$ | 3       | 18         | 4       | 12         | 8       | 17         |

b)



Class B

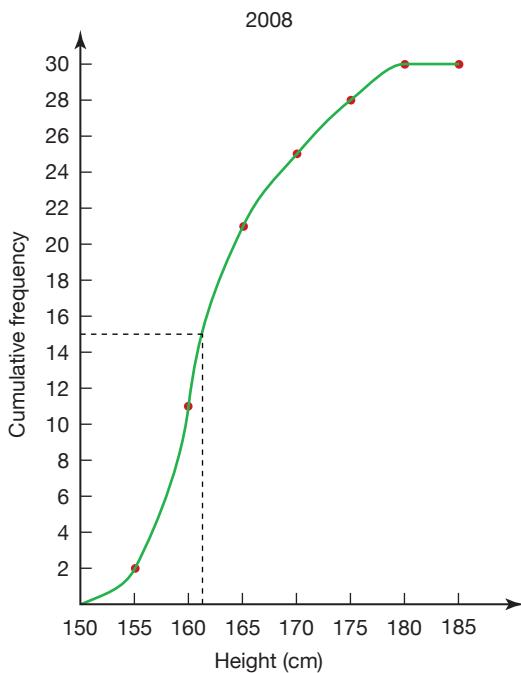
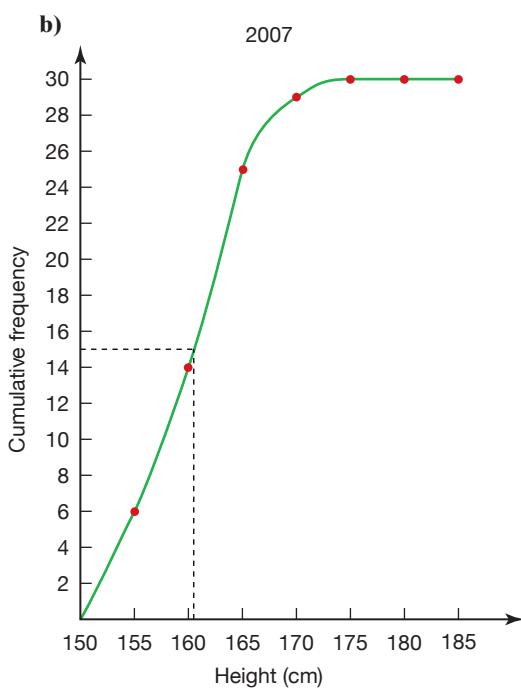


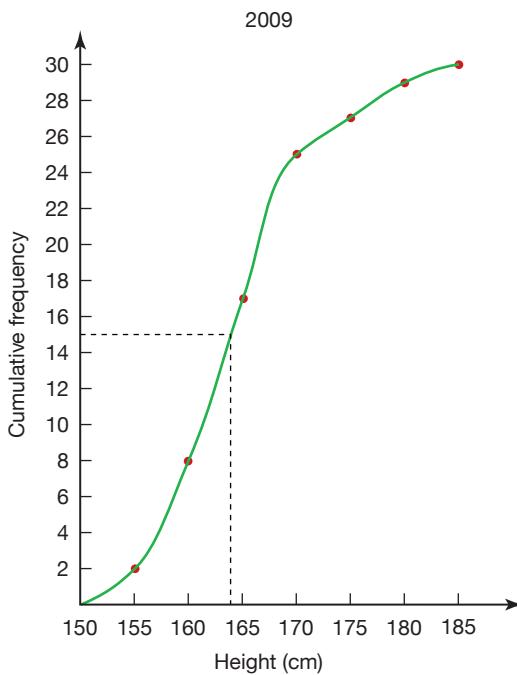


- c) Class A median  $\approx 50$   
 Class B median  $\approx 70$   
 Class C median  $\approx 78$   
 d) As many students were above as below the median.

3. a)

| Height (cm) | 2007  |            | 2008  |            | 2009  |            |
|-------------|-------|------------|-------|------------|-------|------------|
|             | Freq. | Cum. freq. | Freq. | Cum. freq. | Freq. | Cum. freq. |
| 150–        | 6     | 6          | 2     | 2          | 2     | 2          |
| 155–        | 8     | 14         | 9     | 11         | 6     | 8          |
| 160–        | 11    | 25         | 10    | 21         | 9     | 17         |
| 165–        | 4     | 29         | 4     | 25         | 8     | 25         |
| 170–        | 1     | 30         | 3     | 28         | 2     | 27         |
| 175–        | 0     | 30         | 2     | 30         | 2     | 29         |
| 180–185     | 0     | 30         | 0     | 30         | 1     | 30         |



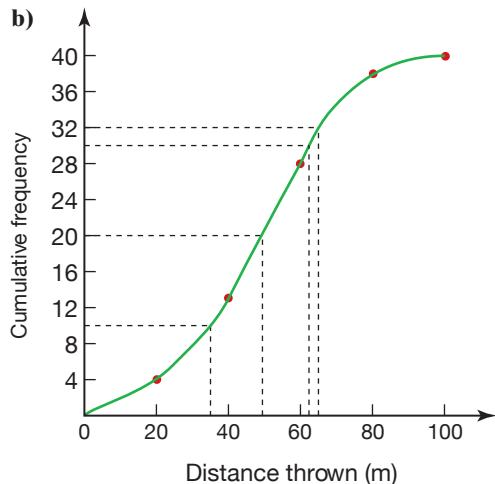


- c) Median (2007)  $\approx$  161 cm  
 Median (2008)  $\approx$  162 cm  
 Median (2009)  $\approx$  164 cm  
 d) As many students are taller than the median as shorter than the median.

### Exercise 39.2 page 495

- a) Class A  $\approx$  30 Class B  $\approx$  30 Class C  $\approx$  40  
 b) Student's own responses
- a) 2007  $\approx$  7 cm 2008  $\approx$  8 cm 2009  $\approx$  8 cm  
 b) Student's own responses
- a)

| Distance thrown (m) | 0– | 20– | 40– | 60– | 80–100 |
|---------------------|----|-----|-----|-----|--------|
| Freq.               | 4  | 9   | 15  | 10  | 2      |
| Cum. freq.          | 4  | 13  | 28  | 38  | 40     |

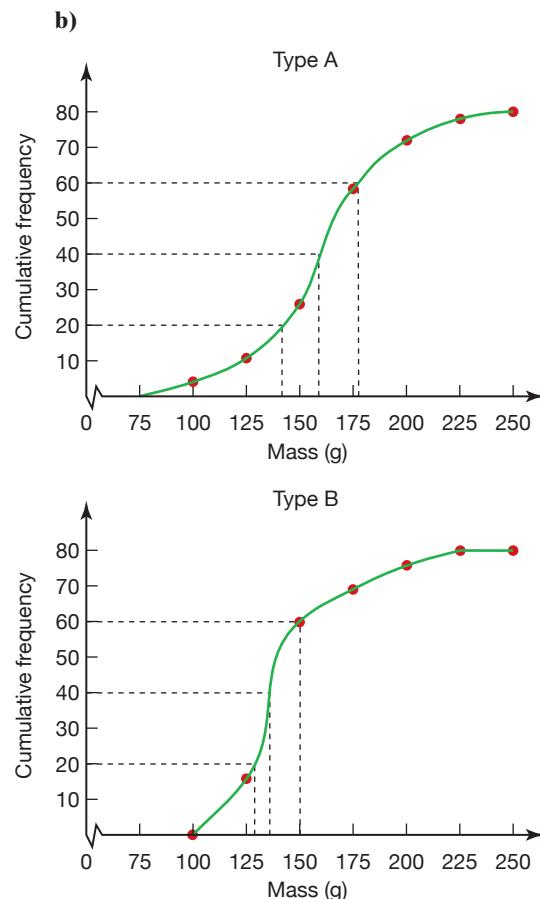


- c) Qualifying distance  $\approx$  66 m  
 d) Inter-quartile range  $\approx$  28 m  
 e) Median  $\approx$  50 m

4. a)

| Type A   |           |            |
|----------|-----------|------------|
| Mass (g) | Frequency | Cum. freq. |
| 75–      | 4         | 4          |
| 100–     | 7         | 11         |
| 125–     | 15        | 26         |
| 150–     | 32        | 58         |
| 175–     | 14        | 72         |
| 200–     | 6         | 78         |
| 225–250  | 2         | 80         |

| Type B   |           |            |
|----------|-----------|------------|
| Mass (g) | Frequency | Cum. freq. |
| 75–      | 0         | 0          |
| 100–     | 16        | 16         |
| 125–     | 43        | 59         |
| 150–     | 10        | 69         |
| 175–     | 7         | 76         |
| 200–     | 4         | 80         |
| 225–250  | 0         | 80         |

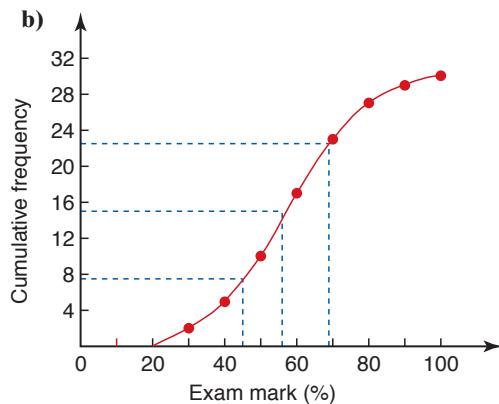


- c) Median type A  $\approx 157$  g  
Median type B  $\approx 137$  g
- d) i) Lower quartile type A  $\approx 140$  g  
Lower quartile type B  $\approx 127$  g  
ii) Upper quartile type A  $\approx 178$  g  
Upper quartile type B  $\approx 150$  g  
iii) Inter-quartile range type A  $\approx 38$  g  
Inter-quartile range type B  $\approx 23$  g
- e) Student's own report
5. a) Student's own explanation  
b) Student's own explanation

### Student assessment I page 497

1. a)

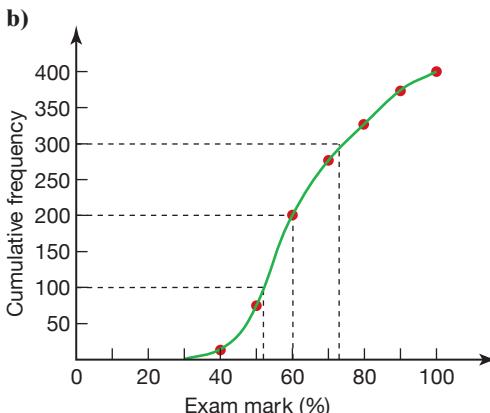
| Mark       | 20– | 30– | 40– | 50– | 60– | 70– | 80– | 90–100 |
|------------|-----|-----|-----|-----|-----|-----|-----|--------|
| Freq.      | 2   | 3   | 5   | 7   | 6   | 4   | 2   | 1      |
| Cum. freq. | 2   | 5   | 10  | 17  | 23  | 27  | 29  | 30     |



- c) i) Median  $\approx 57\%$   
ii) Lower quartile  $\approx 45\%$   
Upper quartile  $\approx 69\%$   
iii) Inter-quartile range  $\approx 24\%$

2. a)

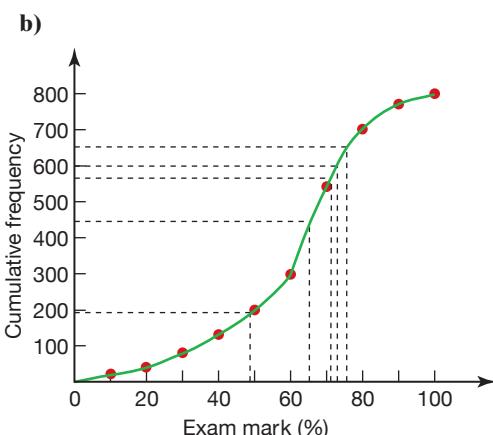
| Mark (%) | Frequency | Cumulative frequency |
|----------|-----------|----------------------|
| 31–40    | 21        | 21                   |
| 41–50    | 55        | 76                   |
| 51–60    | 125       | 201                  |
| 61–70    | 74        | 275                  |
| 71–80    | 52        | 327                  |
| 81–90    | 45        | 372                  |
| 91–100   | 28        | 400                  |



- c) i) Median  $\approx 60\%$   
 ii) Lower quartile  $\approx 52\%$   
 Upper quartile  $\approx 73\%$   
 iii) Inter-quartile range  $\approx 21\%$

3. a)

| Mark (%) | Frequency | Cumulative frequency |
|----------|-----------|----------------------|
| 1–10     | 10        | 10                   |
| 11–20    | 30        | 40                   |
| 21–30    | 40        | 80                   |
| 31–40    | 50        | 130                  |
| 41–50    | 70        | 200                  |
| 51–60    | 100       | 300                  |
| 61–70    | 240       | 540                  |
| 71–80    | 160       | 700                  |
| 81–90    | 70        | 770                  |
| 91–100   | 30        | 800                  |



- c) 'A' grade  $\approx 75\%$   
 d) Lower boundary  $\approx 66\%$   
 Upper boundary  $\approx 72\%$   
 e) Inter-quartile range  $\approx 25\%$

## Topic 9 Mathematical investigations and ICT

### Heights and percentiles

page 499

- Approx. 167 cm
- Approx. 168 cm (Note: This corresponds to the 25th percentile not the 75th.)
- Approx. 151 cm
- Student's calculations could include mean, median, inter-quartile range and comparisons with printed charts.
- It is likely that different cultures have different charts as some races are taller on average than others.

### Reading ages

page 501

- Possible answers include length of sentences, number of words with 3 or more syllables, size of type, etc.
- Student's choices
- Student's calculations
- Students should choose articles on a similar topic. Ignore proper nouns. Choose more than one article from each paper.

### ICT activity

page 501

- 6. Student's data, graph and comparisons