

Luke Robinson  
Sam Stevenson

**CCEA GCSE**

# MATHEMATICS M4 EXTENSION BOOK

## ANSWERS

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Colourpoint House  
Jubilee Business Park  
21 Jubilee Road  
Newtownards  
County Down  
Northern Ireland  
BT23 4YH

Tel: 028 9182 0505

E-mail: [sales@colourpoint.co.uk](mailto:sales@colourpoint.co.uk)

Web site: [www.colourpoint.co.uk](http://www.colourpoint.co.uk)

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# Chapter 1: Bounds

## Exercise 1A

- (a) £9.50, £10.50      (b) 350 chairs, 450 chairs  
(c) 2.75 cm, 2.85 cm    (d) £27 950, £28 050  
(e) 415.85 kg, 415.95 kg
- (a) 7.96                      (b) 15.03 (2 d.p.)
- 9.35 m, 10.45 m

## Exercise 1B

- 10 cm, 30 cm
- 2.1 kg, 2.3 kg
- 1.745 m, 1.855 m
- (a) 79.5 kg, 80.5 kg  
(b) 1.755 m, 1.765 m  
(c) 25.5, 26.1
- 18.02 W, 18.09 W
- 4.167883212 cm
- The total cost is £32 to the nearest pound, so the lower bound is £31.50 and the upper bound is £32.50  
The shirt cost £20 to the nearest pound, so the lower bound is £19.50 and the upper bound is £20.50  
The lower bound for the cost of the book is £31.50 – £20.50 = £11  
The upper bound for the cost of the book is £32.50 – £19.50 = £13  
So, the cost of the book is between £11 and £13  
It may not be £12 to the nearest pound.
- (a) 149.7 km/h, 154.6 km/h                      (b) 150 km/h
- (a) 5.34 m/s    (b) 88 seconds
- Smallest grass area dimensions are  $149.5 \times 119.5$  with circle of  $r = 40.5 \div 2$  giving  $16\,580 \text{ m}^2$   
Largest grass area dimensions are  $150.5 \times 120.5$  with circle of  $r = 39.5 \div 2$  giving  $16\,910 \text{ m}^2$

## Exercise 1C

- (a) 4.6  
(b) 1.51 (2 d.p.)
- (a) (i) 2.3    (ii) 0.81    (iii) 12.85  
(b) (i) 4    (ii) 1.56    (iii) 0.42
- 3.55, 3.57
- 1.12338512
- Lower bound for  $P$  is  $\frac{4.85 \times 10.65}{2.975^2} = 5.836\dots = 5.84$  (2 d.p.). Sean gave the correct answer.
- (a) (i) 2.46    (ii) 0.646    (iii) 8.175    (iv) 0.862    (v) 1.665    (vi) 0.755  
(b) (i) 2.02    (ii) 1.548    (iii) 8.145    (iv) 7.595    (v) 1.213    (vi) 13.230

# Chapter 2: Factorising Quadratic Equations

## Exercise 2A

- (a)  $9(9 - t)$                       (b)  $9(x + 2y)$                       (c)  $8x(4y - z)$   
 (d)  $3(p - 4q + 2)$                       (e)  $4(36 - 3y + x)$                       (f)  $5(t - 2 + 3q)$
- (a)  $(x - 7)(x + 7)$                       (b)  $(p - q)(p + q)$   
 (c)  $(6 - 7y)(6 + 7y)$                       (d)  $(14 - 5xy)(14 + 5xy)$   
 (e)  $(9xt - 13y)(9xt + 13y)$                       (f)  $(4y - 11)(4y + 11)$
- (a)  $(x - 7)(x + 3)$                       (b)  $(x + 2)(x + 3)$                       (c)  $(x + 3)(x - 4)$                       (d)  $(x - 3)(x - 4)$   
 (e)  $(x + 2)(x - 5)$                       (f)  $(x + 8)(x + 10)$                       (g)  $(x + 1)(x - 5)$                       (h)  $(x - 2)(x + 9)$   
 (i)  $(x + 2)(x - 15)$                       (j)  $(x + 2)(x - 10)$                       (k)  $(x + 6)(x - 10)$                       (l)  $(x + 10)(x - 11)$

## Exercise 2B

- (a) Difference of two squares                      (b) Not                      (c) Not  
 (d) Not                      (e) Not                      (f) Difference of two squares
- (a)  $(d + 2)(d - 2)$                       (b)  $(p + 6q)(p - 6q)$   
 (c)  $(3 - x)(3 + x)$                       (d)  $(4 - xy)(4 + xy)$   
 (e)  $(9xt - 4y)(9xt + 4y)$                       (f)  $(5q - 4)(5q + 4)$   
 (g)  $(17 - 13q)(17 + 13q)$                       (h)  $(4p - \frac{3q}{2})(4p + \frac{3q}{2})$   
 (i)  $(15 - 7t)(15 + 7t)$                       (j)  $(3 - 2x)(3 + 2x)$
- (a)  $5(2x - 5)(2x + 5)$                       (b)  $2pq(p - 2)(p + 2)$   
 (c)  $16(1 - 2p)(1 + 2p)$                       (d)  $7b(a - 2b)(a + 2b)$   
 (e)  $a(a - b)(a + b)$                       (f)  $9(3y - 4p)(3y + 4p)$   
 (g)  $p(3p - 10r)(3p + 10r)$                       (h)  $2(y - 7)(y + 7)$

## Exercise 2C

- $(x + 4y)(x - 2y)$
- $(p - 2q)(p + q)$
- $(x + 5y)(x - 2y)$
- $(p + 4q)(p + 6q)$
- $(x - 6y)(x + 2y)$
- $(p - 3q)(p - 3q) = (p - 3q)^2$
- $(x - 12y)(x + 5y)$
- $(p + 6q)(p - 5q)$
- $(x + 5y)(x + 5y) = (x + 5y)^2$

**Exercise 2D**

1.  $(x + 1)(y + 1)$
2.  $(p + 1)(q + 3)$
3.  $(s + 1)(5t - 1)$
4.  $(3x + 1)(4y + 1)$
5.  $(p - 1)(q - 1)$
6.  $(s - 1)(4t + 1)$
7.  $(x + 3)(y + 2)$
8.  $(5m - 2)(3n - 1)$
9.  $(x + p)(y + q)$
10.  $(p - d)(q - c)$
11.  $(x + 7p)(y + 3q)$
12.  $(3p - 5t)(7q - 2y)$
13.  $(4x + 7y)(3p - 2q)$
14.  $(5y - 8z)(8p - 5q)$

**Exercise 2E**

1.  $(4x - 1)(2x - 3)$
2.  $(7x - 20)(x + 1)$
3.  $(5x - 2)(x + 3)$
4.  $(2x + 5)(x - 1)$
5.  $(7 + 2x)(3 - x)$
6.  $(4x - 9)(x + 1)$
7.  $(5x - 1)(2x + 1)$
8.  $(2x - 3)(3x - 2)$
9.  $(4x - 1)(3x + 2)$
10.  $(5x - 3)(3x - 5)$
11.  $(2x + 1)(2x - 3)$
12.  $(3x - 1)(2x + 3)$
13.  $(5 + 2x)(2 - 2x)$
14.  $(2x + 3)(x - 3)$
15.  $(7x - 5)(x + 1)$
16.  $(5 - 2x)(x - 3)$
17.  $(2x - 1)^2$
18.  $(3 - 4x)^2$

# Chapter 3: Solving Quadratic Equations

## Exercise 3A

1.  $(x + 5)(x + 7)$
2.  $(x + 2)(x + 10)$
3.  $(x - 15)(x + 3)$
4.  $(x + 4)(x - 12)$
5.  $(x - 6)^2$
6.  $(x - 2)(x + 16)$
7.  $x = -1$  or  $-3$
8.  $x = -7$  or  $-8$
9.  $x = 1$  or  $6$
10.  $x = -10$  or  $12$
11.  $x = 2$  or  $-11$
12.  $x = -7$

## Exercise 3B

- |                        |                                      |
|------------------------|--------------------------------------|
| 1. $(5x - 2)(x - 5)$   | $x = \frac{2}{5}$ or $5$             |
| 2. $(4x - 7)(3x + 1)$  | $x = \frac{7}{4}$ or $-\frac{1}{3}$  |
| 3. $(5x + 6)^2$        | $x = -\frac{6}{5}$                   |
| 4. $(x - 3)(2x - 7)$   | $x = 3$ or $\frac{7}{2}$             |
| 5. $(6 + 5x)(2 - x)$   | $x = -\frac{6}{5}$ or $2$            |
| 6. $(3x + 2)(2x - 1)$  | $x = -\frac{2}{3}$ or $\frac{1}{2}$  |
| 7. $(x - 4)(4x - 3)$   | $x = 4$ or $\frac{3}{4}$             |
| 8. $(5x + 2)(3x + 5)$  | $x = -\frac{2}{5}$ or $-\frac{5}{3}$ |
| 9. $(7 - x)(8 + 3x)$   | $x = 7$ or $-\frac{8}{3}$            |
| 10. $(2 + 3x)(4 - 5x)$ | $x = -\frac{2}{3}$ or $\frac{4}{5}$  |
| 11. $(3 + x)(1 - 5x)$  | $x = -3$ or $\frac{1}{5}$            |
| 12. $(2x + 1)(7x + 8)$ | $x = -\frac{1}{2}$ or $-\frac{8}{7}$ |
| 13. $(2x + 5)(x + 2)$  | $x = -\frac{5}{2}$ or $-2$           |
| 14. $(2x - 3)(3x - 4)$ | $x = \frac{3}{2}$ or $\frac{4}{3}$   |
| 15. $(5x - 2)(5x - 3)$ | $x = \frac{2}{5}$ or $\frac{3}{5}$   |
| 16. $(x - 3)(6x - 1)$  | $x = 3$ or $\frac{1}{6}$             |

**Exercise 3C**

1.  $x = \frac{5}{2}$  or  $x = -\frac{1}{3}$

2.  $x = -2 \pm \sqrt{2} = -0.586$  or  $-3.414$

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

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

5.  $x = -1$  or  $-\frac{1}{3}$

6.  $x = \frac{-5 \pm \sqrt{29}}{2} = -5.193$  or  $0.193$

7.  $x = \frac{-5 \pm \sqrt{17}}{4} = -2.281$  or  $-0.219$

8.  $x = \frac{2}{7}$  or  $\frac{7}{2}$

9.  $x = \frac{1 \pm \sqrt{37}}{18} = -0.282$  or  $0.393$

10.  $x = \frac{1 \pm \sqrt{29}}{-2} = -3.193$  or  $2.193$

11.  $x = \frac{-7 \pm \sqrt{145}}{12} = -1.587$  or  $0.420$

12.  $x = \frac{-1 \pm \sqrt{5}}{2} = 0.618$  or  $-1.618$

13.  $x = -\frac{1}{2}$  or  $2$

14.  $x = -5$

15.  $x = \frac{3 \pm \sqrt{13}}{2} = -0.303$  or  $3.303$

16.  $x = \frac{-1 \pm \sqrt{41}}{4} = -1.851$  or  $1.351$

17.  $x = \frac{19 \pm \sqrt{313}}{12} = 0.109$  or  $3.058$

18.  $x = 4$

**Exercise 3D**

1.  $x = \frac{4}{3}$  or 2
2.  $x = \frac{2}{5}$  or  $\frac{3}{2}$
3.  $x = -\frac{1}{3}$  or 2 We rule out a negative distance so  $x = 2$   
Total time = 3 hours, time taken by the second rambler = 1 hour.
4.  $x = -\frac{2}{3}$  or  $\frac{4}{3}$  We rule out a negative time so  $x = \frac{4}{3}$   
Speed = 3 km/h
5.  $x = -4$  or  $\frac{3}{2}$  We rule out a negative length so  $x = \frac{3}{2}$   
Dimensions of rectangle =  $\frac{3}{2}$  cm  $\times$  8 cm
6.  $x = -2$  or  $\frac{8}{3}$  We rule out a negative length so  $x = \frac{8}{3}$   
Dimensions of rectangle =  $\frac{8}{3}$  cm  $\times$  6 cm
7.  $x = -\frac{3}{2}$  or  $\frac{7}{3}$  We rule out a negative length so  $x = \frac{7}{3}$   
Triangle base =  $\frac{14}{3}$  cm and height = 9 cm
8.  $x = -\frac{3}{2}$  or  $\frac{4}{5}$  We rule out the negative speed so  $x = \frac{4}{5}$   
Total distance = 19 km
9.  $x = -\frac{5}{3}$  or  $\frac{3}{2}$  We rule out the negative distance so  $x = \frac{3}{2}$   
Time of either =  $\frac{1}{2}$  hour = 30 mins

10. See sketch on right. Area remaining = Area of whole rectangle – area of vertical strips – area of horizontal strips + area of overlap.

Note: We have to add the area of overlap because it was counted twice – in the area of the vertical strips and again in the area of the horizontal strips.

$$(9 \times 12) - (3x \times 9) - (2x \times 12) + (3x \times 2x) = 18$$

$$108 - 27x - 24x + 6x^2 = 18$$

$$6x^2 - 51x + 108 - 18 = 0$$

$$6x^2 - 51x + 90 = 0$$

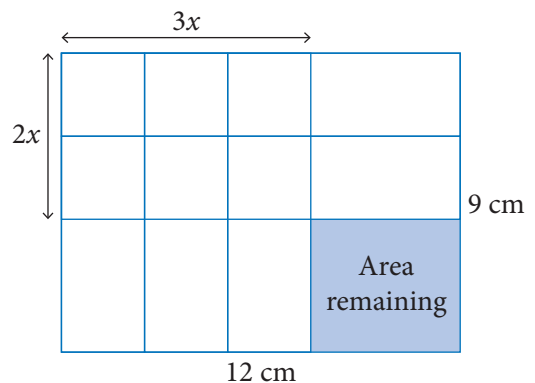
$$(6x - 15)(x - 6) = 0$$

$$6x - 15 = 0 \text{ or } x - 6 = 0$$

$$\text{So } x = \frac{5}{2} \text{ or } 6$$

But 3 strips of 6 cm can't be cut off this rectangle (it is too small).

Therefore width of strips = 2.5 cm



# Chapter 4: More Algebraic Fractions

## Exercise 4A

- |                          |                          |                            |                        |
|--------------------------|--------------------------|----------------------------|------------------------|
| 1. (a) $\frac{5x+26}{6}$ | (b) $\frac{11x+2}{12}$   | (c) $\frac{4x+3}{6}$       | (d) $\frac{4x+11}{12}$ |
| (e) $\frac{17-11x}{20}$  | (f) $\frac{9x-4}{12}$    | (g) $\frac{76-13x}{28}$    | (h) $\frac{11x-8}{6}$  |
| 2. (a) $x=2$             | (b) $x=9$                | (c) $x=3$                  |                        |
| (d) $x=7$                | (e) $x=5$                | (f) $x=4$                  |                        |
| 3. (a) $\frac{x+5}{2}$   | (b) $-\frac{1}{12}$      | (c) $\frac{16(3y+1)}{y+3}$ |                        |
| (d) 1                    | (e) $\frac{3(x+9)}{x-4}$ | (f) $\frac{x+6}{4x}$       |                        |

## Exercise 4B

Note in each question in this exercise, the denominator may be left in the unexpanded form.

For example the answer to question 1 may be given as  $\frac{13x+56}{x^2+7x+10}$  or  $\frac{13x+56}{(x+2)(x+5)}$

- |                                 |   |   |   |
|---------------------------------|---|---|---|
| 1. $\frac{13x+56}{x^2+7x+10}$   | 7. $\frac{14x+40}{3x^2+25x+50}$         | 13. $\frac{-3x^2+11x+32}{2x^2+6x-8}$    | 19. $\frac{14-16x-x^2}{4x^2-27x+35}$    |
| 2. $\frac{5x+26}{x^2+5x-14}$    | 8. $\frac{x+30}{2x^2+3x-20}$            | 14. $\frac{80x^2+78x+21}{60x^2+60x-45}$ | 20. $\frac{20x^2-54x-40}{25+20x-12x^2}$ |
| 3. $\frac{30x-31}{6x^2+17x-88}$ | 9. $\frac{x^2+7x+21}{3x^2+x-14}$        | 15. $\frac{3x^2+26x}{-6x^2-20x+16}$     | 21. $\frac{37x^2+52x+1}{5x^2+44x-9}$    |
| 4. $\frac{9x-17}{x^2-5x-24}$    | 10. $\frac{2x^2-6x-3}{3x-9}$            | 16. $\frac{2x^2+8x-9}{2x^2-x-3}$        | 22. $\frac{8x^2+11x-14}{15x^2+8x-12}$   |
| 5. $\frac{x-60}{x^2-3x-40}$     | 11. $\frac{12x^2+5x+80}{20x^2+55x-100}$ | 17. $\frac{15x^2+33x+15}{18x^2+27x+10}$ | 23. $\frac{17x^2+12x-36}{4x^2+24x}$     |
| 6. $\frac{15-x}{4x^2+34x+42}$   | 12. $\frac{5x^2+x+28}{5x^2+32x-21}$     | 18. $\frac{29x^2+72x+45}{20x^2+43x+21}$ | 24. $\frac{9x^2+22x-20}{12x-9x^2}$      |

## Exercise 4C

- |                        |                         |                      |                         |
|------------------------|-------------------------|----------------------|-------------------------|
| 1. $x=4, -5$           | 6. $x=3, -\frac{2}{11}$ | 11. $x=2.5, 6$       | 16. $x=17$              |
| 2. $x=6$               | 7. $x=2, 3$             | 12. $x=-6.73, -3.27$ | 17. $x=0, -\frac{7}{3}$ |
| 3. $x=4, 11$           | 8. $x=1, -\frac{5}{2}$  | 13. $x=-1.65, 3.65$  | 18. $x=-0.61, 6.61$     |
| 4. $x=3, \frac{7}{4}$  | 9. $x=1$ or 6           | 14. $x=-0.41, 2.41$  |                         |
| 5. $x=4, -\frac{3}{2}$ | 10. $x=-2, 4$           | 15. $x=4.53, 13.47$  |                         |

## Answers: Exercise 4D

### Exercise 4D

1. 6 km/h and 1 km/h (Note, as both speeds must be positive, we discard  $x = 2.5$  and take  $x = 6$ )
2. 9 km/h and 6 km/h (Note, as both speeds must be positive, we discard  $x = -2.5$  and take  $x = 5$ )
3.  $x = 3$ , so the common width = 1 cm
4. Both areas are  $5 \text{ cm}^2$
5.  $x = 4$ ; sum of lengths = 11 cm
6.  $x = -0.5$  as  $x = -\frac{5}{3}$  makes one of the densities negative
7. When  $x = 5$ , sum of masses = 30 g (when  $x = 3$ , the second mass would be zero)
8.  $x = 2.83$  cm; base of first triangle = 4.83 cm (both to 2 d.p.)

# Progress Review

## Progress Review (Chapters 1–4)

- 42.5 s, 47.5 s
- (a) £19 500, £20500    (b) £950, £1050    (c) £18 450, £19 550
- (a) 42.5965    (b) 5.1656
- (a) 995, 1005    (b) 950, 1050    (c) 0.948, 1.058
- The lower and upper bounds for the area of the rectangle are 49.5 and 50.5 cm<sup>2</sup>.  
The lower and upper bounds for the width of the rectangle are 4.95 and 5.05 cm.

$$\text{Area} = \text{Length} \times \text{Width, so Length} = \frac{\text{Area}}{\text{Width}}$$

$$\text{Lower bound for length} = \frac{49.5}{5.05} = 9.8 \text{ cm (1 d.p.)}$$

$$\text{Upper bound for length} = \frac{50.5}{4.95} = 10.2 \text{ cm (1 d.p.)}$$

To the nearest integer, the length must be 10 cm, so Sue is correct.

- (a)  $5p^2q(5q - 1)(5q + 1)$     (b)  $xy(x + y)(x - y)$   
(c)  $2y^2z(7 - 5y)(7 + 5y)$     (d)  $2(2x - \frac{1}{x})(2x + \frac{1}{x})$
- Shaded area =  $(7x + 3)^2 - (5x - 2)^2 = (12x + 1)(2x + 5)$  cm<sup>2</sup>
- (a)  $(x + 5y)^2$     (b)  $(x + 12y)(x - 20y)$   
(c)  $(x - 4y)(x - 9y)$     (d)  $(x - 5y)(x + 9y)$
- $x^2 + 10xy - 18y^2 - 17xy = x^2 - 7xy - 18y^2 = (x + 2y)(x - 9y)$
- $x(x - 3y) - y(x - 4y) = x^2 - 4xy + 4y^2 = (x - 2y)^2$
- (a)  $(t + q)(r - p)$     (b)  $(f - g)(m + n)$   
(c)  $(2x - y)(p + q)$     (d)  $(c - 2d)(e + 3f)$
- (a)  $(2x - 3)(3x + 1)$     (b)  $(4x - 1)(x + 7)$   
(c)  $(5x + 3)(2x - 5)$     (d)  $(3x + 2)(2x + 3)$
- (a)  $(2x - 7)(x + 5) = 0$  so  $x = \frac{7}{2}$  or  $-5$     (b)  $(3x + 1)(2 - x) = 0$  so  $x = -\frac{1}{3}$  or  $2$   
(c)  $(4x - 3)(3x - 4) = 0$  so  $x = \frac{3}{4}$  or  $\frac{4}{3}$     (d)  $(4x + 5)(x - 1) = 0$  so  $x = -\frac{5}{4}$  or  $1$
- (a)  $x = 1.85$  or  $x = -1.35$     (b)  $x = 0.472$  or  $x = -1.27$   
(c)  $x = 3.29$  or  $x = 0.709$     (d)  $x = 0.554$  or  $x = -1.80$
- (a)  $x = 8.83$  or  $x = 0.170$     (b)  $x = 2.31$  or  $x = 0.694$
- (a)  $\frac{1}{2}BC \times AB = 30$  so  $\frac{1}{2}x(x + 7) = 30$  or  $x^2 + 7x - 60 = 0$   
(b)  $x = 5$  so  $AB = 12$ cm,  $BC = 5$ cm and  $AC = 13$ cm
- 8 cm, 17 cm and 15 cm
- $n = 8$
- (a)  $\text{width}^2 + \text{length}^2 = \text{diagonal}^2$   
 $(x - 9)^2 + (x + 8)^2 = 625$   
 $(x^2 - 18x + 81) + (x^2 + 16x + 64) = 625$   
 $2x^2 - 2x + 145 = 625$   
(b)  $x = 16$  and sides are 7 cm, 24 cm and 25 cm

## Answers: Progress Review (Chapters 1–4)

20.  $4x^2 - 62x + 30 = 0$  giving  $x = 15$  (as the other solution  $x = \frac{1}{2}$  involves a negative length)

21.  $x = 2$  so height = 9 cm

22. 3 km/h

23.  $x = 2$  so dimensions are 1 cm  $\times$  8cm

24. (a)  $\frac{8x+1}{(x-3)(x+2)}$       (b)  $\frac{11x+13}{(x-5)(3x+2)}$       (c)  $\frac{14x+5}{(2x-5)(2x+5)}$       (d)  $\frac{-15x-18}{(6-5x)(x+6)}$

25. (a)  $\frac{2x^2+3x+8}{x(x+2)}$       (b)  $\frac{35}{x(x+5)}$       (c)  $\frac{2x^2+3x+3}{(x-1)(x-3)}$       (d)  $\frac{17x^2+4x-1}{4x(7x+1)}$

26. (a)  $\frac{1}{3}$  or 4      (b) 3.46 or -3.46      (c)  $-\frac{2}{11}$  or 3      (d)  $-\frac{3}{5}$  or 6

27.  $x = 7$  and their total time is  $6 + 5 = 11$  hours

28. (a)  $\frac{1}{2}(3x-1+5x+3)(6x-5) = (4x+1)(6x-5) = 24x^2 - 14x - 5 = 525$

So  $24x^2 - 14x - 530 = 0$

(b)  $12x^2 - 7x - 265 = 0$  so  $(x-5)(12x+53) = 0$  giving  $x = 5$

29. (a) Width of rectangle =  $\frac{(x+5)}{(x+1)}$  m

(b) The average of the parallel sides of the trapezium is  $\frac{1}{2}(x+1+3x+1) = (2x+1)$  m

From formula Area = Width  $\times$  (2x + 1) so Width =  $\frac{5x+7}{2x+1}$  m

(c) Total width =  $7 = \frac{(x+5)}{(x+1)} + \frac{5x+7}{2x+1}$

$7(x+1)(2x+1) = (x+5)(2x+1) + (5x+7)(x+1)$

$7(2x^2+3x+1) = 2x^2+11x+5+5x^2+12x+7$

$7x^2-2x-5=0$

(d)  $(x-1)(7x+5) = 0$

So  $x = 1$

(e) Total area =  $6 + 12 = 18 \text{ m}^2$

30.  $x = 3$  so width = 4m

# Chapter 5: Straight Lines

## Exercise 5A

- (a) Gradient 3,  $y$ -intercept  $-4$                       (b) Gradient  $-2$ ,  $y$ -intercept  $10$   
 (c) Gradient  $\frac{3}{4}$ ,  $y$ -intercept  $0$                       (d) Gradient  $0$ ,  $y$ -intercept  $7$
- (a)  $\frac{1}{4}$                       (b)  $-\frac{1}{5}$                       (c)  $10$                       (d)  $-7$
- (a)  $-\frac{1}{8}$                       (b)  $\frac{1}{2}$                       (c)  $-12$                       (d)  $\frac{3}{2}$
- (a) Gradients  $3$  and  $-3$ . These lines are not parallel.  
 (b) Gradients  $5$  and  $5$ . These lines are parallel.  
 (c) Gradients  $4$  and  $-4$ . These lines are not parallel.
- $L_1: y = x - 1$                        $L_2: y = -2x - 3$                        $L_3: y = \frac{1}{2}x + 2$                        $L_4: y = -x$

## Exercise 5B

- (a)  $-\frac{1}{8}$                       (b)  $-3$                       (c)  $\frac{1}{2}$                       (d)  $10$
- (a) Perpendicular                      (b) Parallel                      (c) Perpendicular
- (a) Neither                      (b) Perpendicular                      (c) Parallel
- Gradient of  $L_1$  is  $-1$ ; gradient of  $L_2$  is  $\frac{1}{2}$       The lines are neither parallel nor perpendicular.
- (a)  $L_1: y = x + 2$                        $L_2: y = 2x + 1$                        $L_3: y = -\frac{1}{2}x - 3$                        $L_4: y = -x - 4$   
 (b) Line  $L_1$  is perpendicular to line  $L_4$   
 Line  $L_2$  is perpendicular to line  $L_3$
- $y = \frac{3}{2}x - 6$
- $y = -\frac{1}{3}x - \frac{13}{3}$
- (a)  $y = \frac{1}{2}x + 3$                       (b)  $y = -2x + 13$
- $y = -\frac{1}{3}x + 6$
- $y = -\frac{5}{2}x + 4$
- $y = \frac{2}{3}x - 2$
- $y = -2x - 1$
- $y = -3x + 22$
- $y = \frac{1}{2}x + \frac{11}{2}$
- (a)  $y = 2x + 6$   
 (b) AD:  $y = -\frac{1}{2}x + 1$ ; BC:  $y = -\frac{1}{2}x + 6$   
 (c) B(2, 5), D(-2, 2)
- $k = 4$  or  $11$

# Chapter 6: Angles in Circles

## Exercise 6A

1. Circumference, radius, chord, diameter, arc, sector, segment, tangent

## Exercise 6B

1. (a)  $a = 37^\circ$   
 (b)  $b = 97^\circ$   
 (c)  $c = 43^\circ, d = 20^\circ$   
 (d)  $e = 45^\circ, f = 45^\circ, g = 17^\circ$   
 (e)  $h = 80^\circ, j = 280^\circ, k = 140^\circ$   
 (f)  $l = 93^\circ, m = 36^\circ, n = 51^\circ$

## Exercise 6C

1. (a)  $x = 100^\circ, y = 88^\circ$   
 (b)  $a = 96^\circ, b = 119^\circ$   
 (c)  $a = 78^\circ, b = 78^\circ, c = 102^\circ$   
 (d)  $p = 44^\circ, q = 88^\circ$
2.  $44^\circ$

## Exercise 6D

1.  $44^\circ$
2.  $x = 29^\circ, y = 29^\circ$
3. (a) The two radii OA and OC must be equal in length, so OAC is an isosceles triangle. Therefore, the angles OAC and OCA must be equal, so  $y = 30^\circ$ .  
 (b)  $x = 60^\circ, z = 60^\circ$
4.  $w = 35^\circ, x = 35^\circ, y = 110^\circ, z = 55^\circ$
5. (a)  $31^\circ$   
 (b)  $62^\circ$   
 (c)  $28^\circ$   
 (d)  $59^\circ$
6. (a)  $63^\circ$   
 (b)  $27^\circ$   
 (c)  $63^\circ$

## Exercise 6E

1. (a)  $x = 34^\circ$   
 (b)  $x = 56^\circ, y = 112^\circ$   
 (c)  $x = 59^\circ, y = 59^\circ$   
 (d)  $x = 28^\circ, y = 56^\circ, z = 28^\circ$   
 (e)  $x = 38^\circ, y = 76^\circ$   
 (f)  $x = 43^\circ, y = 38^\circ, z = 99^\circ$

## Answers: Exercise 6F

### Exercise 6F

- (a)  $x = 116^\circ, y = 58^\circ$   
(b)  $x = 76^\circ, y = 104^\circ$   
(c)  $x = 104^\circ, y = 76^\circ$   
(d)  $w = 110^\circ, x = 35^\circ, y = 55^\circ, z = 55^\circ$   
(e)  $a = 34^\circ, b = 112^\circ, c = 56^\circ, d = 68^\circ, e = 56^\circ$
- $64^\circ$

### Exercise 6G

- $y = 180 - x$
- $x = 43^\circ, y = 99^\circ, z = 45^\circ$
- $x = 66^\circ$
- $\text{CAO} = 39^\circ$
- (a) OTS is an isosceles triangle because OT and OS are both the radius. So  $\text{OST} = \text{OTS} = x$   
(b)  $180 - 2x$   
(c)  $180 - 3x$   
(d)  $x = 20$
- (a)  $180 - x$   
(b)  $90 - \frac{1}{2}x$   
(c)  $90 - \frac{1}{2}x$   
(d)  $\frac{1}{2}x$
- (a)  $58^\circ$  (alternate segment theorem)  
(b)  $64^\circ$  (opposite angles in the cyclic quadrilateral ABCD add up to  $180^\circ$ )  
(c)  $58^\circ$  (angles on straight line add up to  $180^\circ$ )  
(d) Angles BDA and FAD are equal, so AF is parallel to BD using alternate angles (Z angles)

# Chapter 7: Surface Area and Volume

## Exercise 7A

- (a) TSA = 55.68 cm<sup>2</sup>  
(b) V = 25.6 cm<sup>3</sup>
- (a) CSA = 250.5 cm<sup>2</sup>  
(b) TSA = 383.2 cm<sup>2</sup>  
(c) V = 460.2 cm<sup>3</sup>
- TSA = 115 cm<sup>2</sup>; V = 89.8 cm<sup>3</sup>

## Exercise 7B

- (a) V = 564.3 cm<sup>3</sup>      TSA = 511.1 cm<sup>2</sup>  
(b) V = 229.1 cm<sup>3</sup>      TSA = 229.9 cm<sup>2</sup>  
(c) V = 274.8 cm<sup>3</sup>      TSA = 278.1 cm<sup>2</sup>  
(d) V = 1310.7 cm<sup>3</sup>      TSA = 769.9 cm<sup>2</sup>  
(e) V = 282.5 cm<sup>3</sup>      TSA = 290.8 cm<sup>2</sup>  
(f) V = 22.2 cm<sup>3</sup>      TSA = 45.3 cm<sup>2</sup>
- (a) 980.2 cm<sup>3</sup>  
(b) 405.3 cm<sup>2</sup>
- 3500π cm<sup>3</sup>
- r = 5 cm
- 4.5 cm
- (a)  $V = \frac{1}{3}\pi R^2 H - \frac{1}{3}\pi r^2 h$   
 $V = \frac{1}{3}\pi(R^2 H - r^2 h)$   
 $V = \frac{1}{3}\pi(R^3 - r^3)$       since  $H = R$  and  $h = r$   
 $V = \frac{1}{3}\pi\left(R^3 - \left(\frac{R}{2}\right)^3\right)$       since  $r = \frac{R}{2}$   
 $V = \frac{1}{3}\pi\left(R^3 - \frac{R^3}{8}\right)$   
 $V = \frac{1}{3}\pi\left(\frac{7R^3}{8}\right)$   
 $V = \frac{7\pi R^3}{24}$   
 (b) R = 6 cm; r = 3 cm

## Answers: Exercise 7C

### Exercise 7C

- (a)  $240 \text{ m}^3$   
(b)  $188 \text{ m}^2$
- $1770 \text{ cm}^3$
- $2640 \text{ cm}^2$
- (a)  $1200\pi h \text{ cm}^3$   
(b)  $8h$   
(c)  $28\,800\pi h \text{ cm}^3$   
(d)  $30\,000\pi h \text{ cm}^3$   
(e)  $50 \text{ cm}$
- (a)  $240$   
(b)  $132\pi \text{ cm}^2$
- (a) The two hemispheres together make up a sphere with volume  $\frac{4}{3}\pi r^3$   
The cylinder has volume  $\pi r^2 h$ , which is  $\pi r^2(2r) = 2\pi r^3$   
The total volume is  $\frac{4}{3}\pi r^3 + 2\pi r^3 = \frac{10}{3}\pi r^3$   
(b)  $r = 6 \text{ cm}$   
(c)  $288\pi$

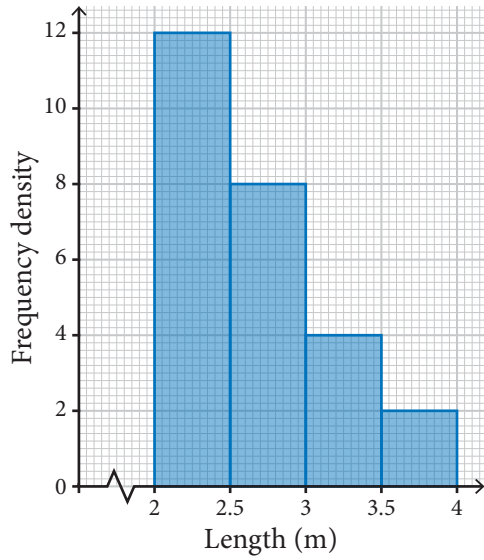
# Chapter 8: Histograms and Sampling

## Exercise 8A

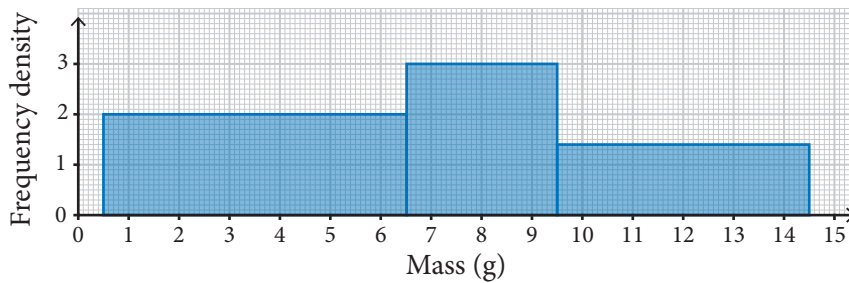
1. (a) 16                      (b) 30                      (c) 0.93 mm (2 d.p.)

## Exercise 8B

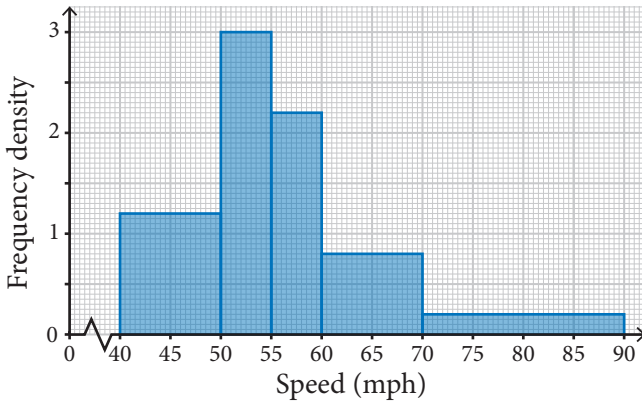
1. (a)



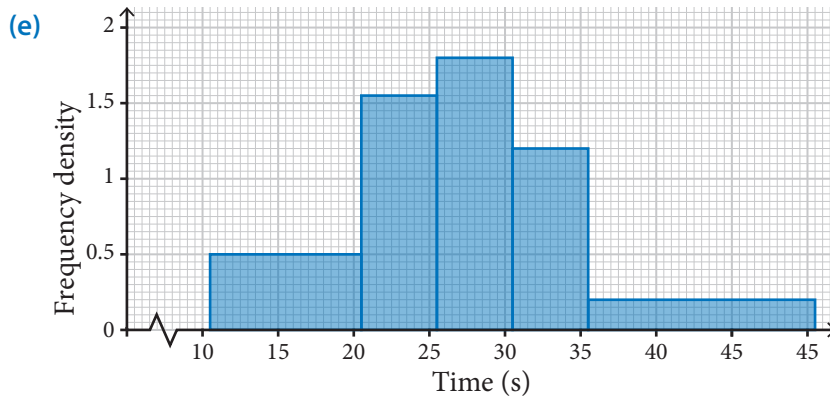
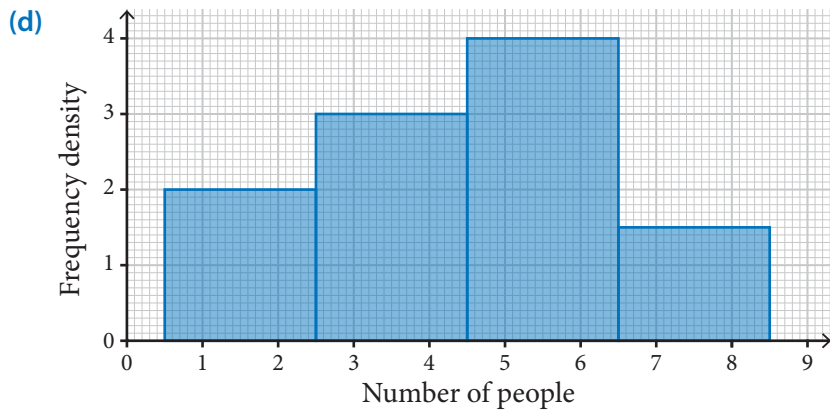
- (b)



- (c)



### Answers: Exercise 8B



## Answers: Exercise 8C

### Exercise 8C

1. (a) – (b)

Height $h$ (cm)	Class width	Frequency density	Frequency
$110 < h \leq 120$	10	1.4	14
$120 < h \leq 125$	5	1.8	9
$125 < h \leq 130$	5	2.4	12
$130 < h \leq 135$	5	3.2	16
$135 < h \leq 140$	5	4.2	21
$140 < h \leq 150$	10	2.8	28
$150 < h \leq 160$	10	2	20

2. (a)  $a = 1, b = 2, c = 3, d = 4$

(b)

Weekly income $w$ (£)	Frequency
$150 < w \leq 170$	20
$170 < w \leq 210$	120
$210 < w \leq 250$	160
$250 < w \leq 270$	60

(c) 360

(d) 50

(e) It assumes that  $\frac{1}{4}$  of the 120 households in the  $170 < w \leq 210$  group are between £170 and £180

3. (a) The first histogram shows data with a larger mean (the bars are further towards the right) and slightly larger range (roughly 60 cm compared with 50 cm).

(b) The first histogram may represent older children.

4. (a) 469

(b) 180

(c) 30

(d) 389

5. (a)

Time taken $t$ (minutes)	Frequency
$0 < t \leq 20$	40
$20 < t \leq 25$	15
$25 < t \leq 35$	35
$35 < t \leq 50$	36

(b) 26.3 minutes (3 s.f.)

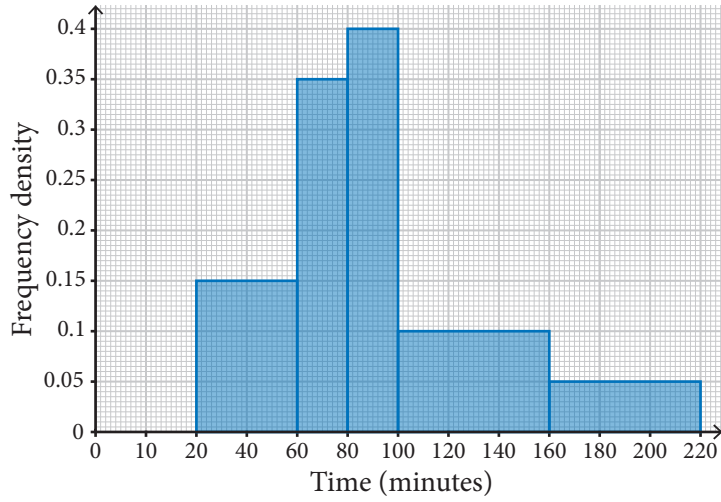
6. (a)  $5^\circ\text{C}$

(b)  $3^\circ\text{C}$

(c)  $8^\circ\text{C}$

(d)  $5^\circ\text{C}$

7. (a), (b) and (d)



(c) 6

## Answers: Exercise 8D

### Exercise 8D

1. (a) Simple random sampling is quick and easy to carry out, and it can therefore be cheaper than a stratified sample. However, the sample may be unrepresentative of the population.  
(b) In a stratified sample, the sample is always representative of the population. However, it is more time consuming than a simple random sample and therefore can be more expensive.

2. (a) 11 (b) 43 (c) £250

3. (a)

P1	P2	P3	P4	P5	P6	P7
3	3	2	3	3	4	3

(b) All the year groups are fairly represented in the sample.

4. (a) 1 soprano, 3 alto, 2 tenors and 1 baritone  
(b) Each group is fairly represented in the sample, so the overall sound of the choir remains the same.

5. (a)  $\frac{26}{65}$  or  $\frac{2}{5}$  (b) French 40, Spanish 45, German 20 (c) 170

6. Football 20, kayaking 10, archery 30, tennis 10. Total estimate: 70 children

7. (a) 5 (b) 25

8. (a) Belfast 40, Lisburn 10, Antrim 4, Bangor 18 (b) 81

9. (a) 112

- (b) • The number of monkeys may change between the first and second samples. The second sample should be taken as soon as possible after the first one.  
• The sample size may be too small. A larger sample would give a more reliable result.  
• The dye may wear off before the second sample is taken.

10. Any two from:

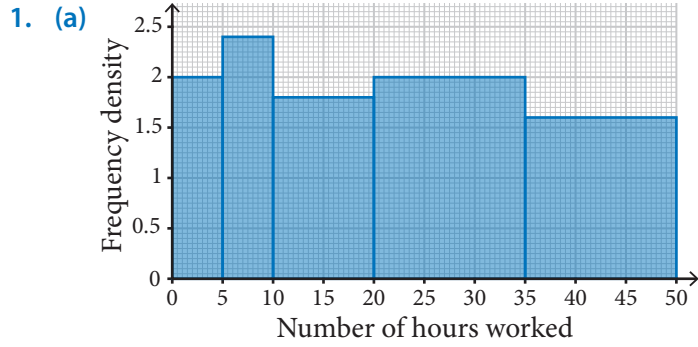
- Kai should choose a neutral location to carry out her survey. By standing outside a cinema, she is likely to speak to people who visit the cinema often, and her survey will be biased.
- Kai should include data from various different times of the week. Some bias may be introduced by using only a Saturday afternoon.
- Kai should ask a wider age range of people, not just teenagers.

11. (a) 112 500

(b) Possibly an under-estimate. If the sample had included older people there may have been a larger proportion wearing glasses.

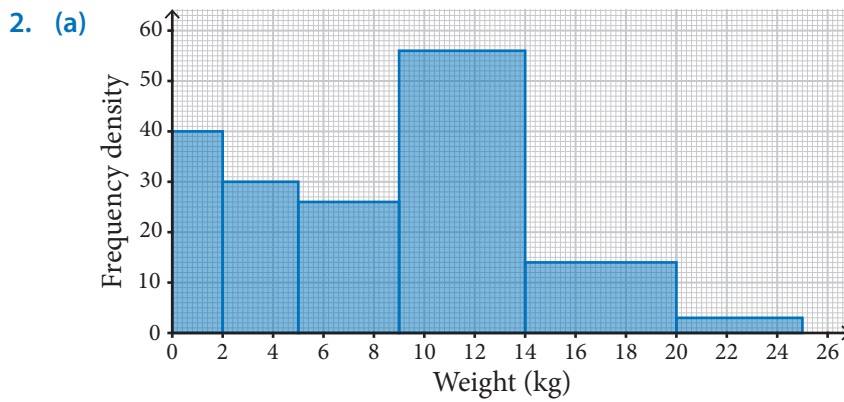
12. (a) 9 (b) 5

**Exercise 8E**



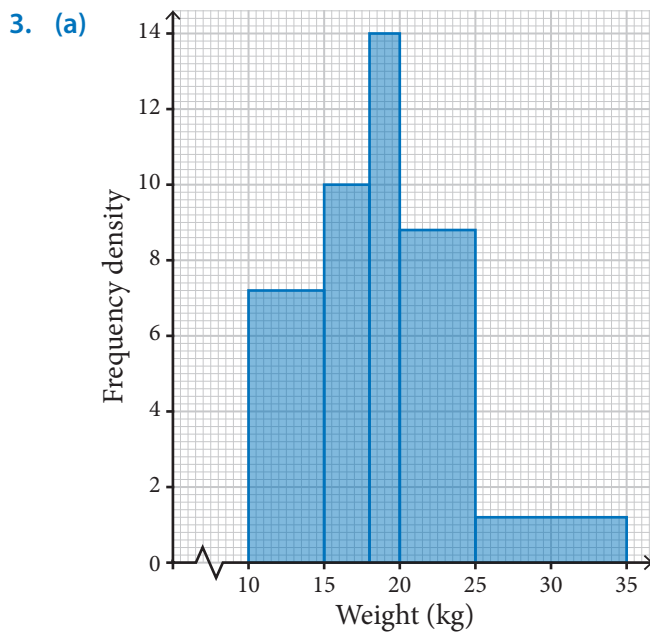
(b) In a stratified sample, each group of workers is fairly represented in the sample.

(c) 6



(b) 57

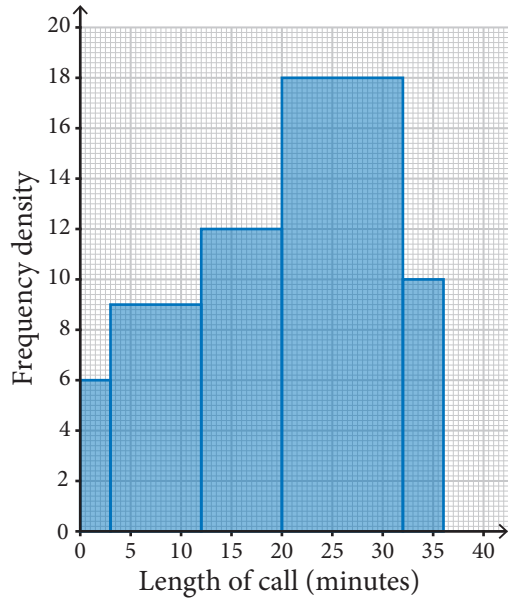
(c) 4



(b) 6

Answers: Exercise 8E

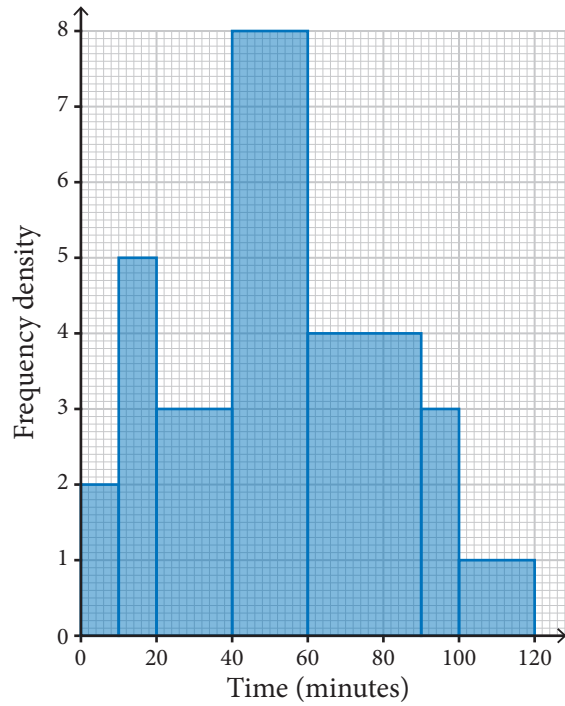
4. (a)



(b) 3

5. (a) 50, 120

(b)



(c) 2 pupils

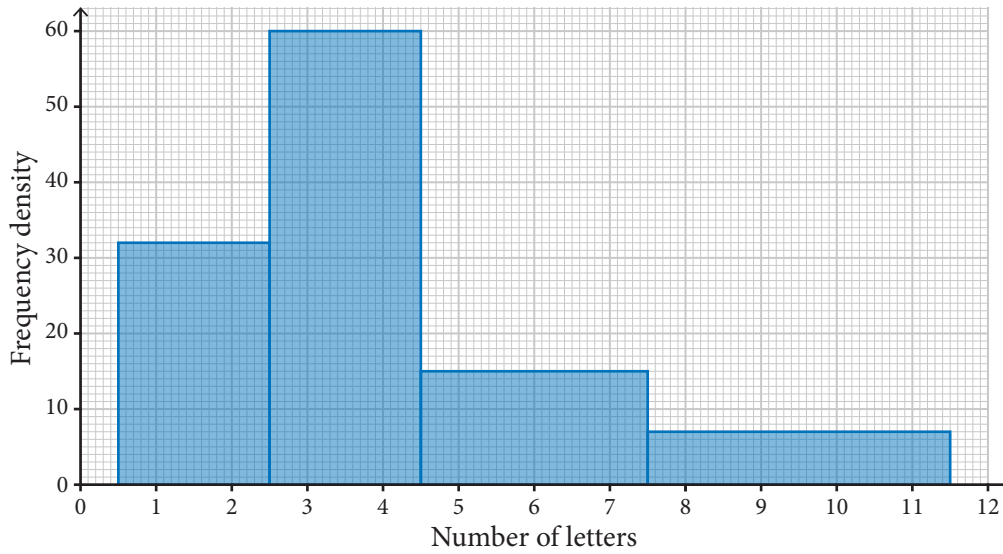
# Progress Review

## Progress Review (Chapters 5–8)

1. (a)  $-\frac{1}{9}$                       (b)  $\frac{1}{10}$                       (c)  $-4$                       (d)  $6$
2. (a) Parallel  
(b) Neither  
(c) Perpendicular
3. Equation of BD:  $y = -\frac{7}{5}x + \frac{28}{5}$
4.  $y = -\frac{1}{3}x + 6$
5.  $y = -\frac{4}{3}x - 15$
6.  $y = -\frac{1}{4}x + \frac{15}{4}$
7.  $x = 44, y = 88$
8.  $x = 117^\circ$
9.  $a = 70^\circ, b = 140^\circ$
10.  $w = 29^\circ, x = 29^\circ, y = 122^\circ, z = 61^\circ$
11.  $a = 27^\circ, b = 126^\circ, c = 63^\circ, d = 54^\circ, e = 63^\circ$
12. (a) 3.38 cm  
(b) (i)  $244 \text{ cm}^3$  (ii)  $281 \text{ cm}^2$
13. (a)  $102 \text{ cm}^3$   
(b)  $157 \text{ cm}^2$
14. Volume of hemisphere =  $\frac{2}{3}\pi r^3$   
 Volume of frustum =  $\frac{1}{3}\pi(2r)^2(2r) - \frac{1}{3}\pi(r)^2(r) = \frac{1}{3}\pi(8r^3) - \frac{1}{3}\pi(r^3) = \frac{7}{3}\pi r^3$   
 Total volume =  $\frac{2}{3}\pi r^3 + \frac{7}{3}\pi r^3 = 3\pi r^3$
15. (a)  $81 \text{ cm}^3$   
(b)  $111.53 = 112 \text{ cm}^2$  to nearest whole number
16. (a) 13.416 cm  
(b) The cylinder and cone have the same volume, so:  $\pi(6^2)h = \frac{1}{3}\pi(6^2)(12)$   
 Divide both sides by  $6^2$  and by  $\pi$ , giving  $h = \frac{1}{3}(12) \Rightarrow h = 4 \text{ cm}$   
(c)  $630 \text{ cm}^2$

**Answers: Progress Review (Chapters 5–8)**

17.



18. (a) 20                                      (b) 24                                      (c) 12                                      (d) 2

19. (a) A stratified sample ensures each of the classes is fairly represented in the sample.

(b) Class 1: 2, Class 2: 2, Class 3: 3, Class 4: 3, Class 5: 2, Class 6: 2

20. (a) Stainberry's 6; Priceland 4; Superstuff 3; Scrounders 2

(b) It would not be possible to use a sample stratified by supermarket as the original population of shoppers can no longer be divided into non-overlapping groups.