

Answers

Chapter 1

Exercise 1A

- 1 a 3 b 9 c 1 d -8 e 5 f 2 g $\frac{5}{3}$
 h $\frac{-7}{2}$ i $\frac{7}{3}$ j $\frac{20}{3}$ k $\frac{-10}{3}$ l $\frac{14}{5}$
- 2 a $a + b$ b $a - b$ c $\frac{b}{a}$ d ab e $\frac{bc}{a}$
- 3 a 7 b 5 c -3 d 14 e $\frac{7}{2}$ f $\frac{14}{3}$
 g 48 h $\frac{3}{2}$ i 2 j 3 k 7 l 2
- 4 a $\frac{4}{3}$ b -5 c 2
- 5 a -1 b 18 c $\frac{6}{5}$ d 23 e 0 f 10
 g 12 h 8 i $-\frac{14}{5}$ j $\frac{12}{5}$ k $\frac{7}{2}$
- 6 a $\frac{-b}{a}$ b $\frac{e-d}{c}$ c $\frac{c}{a} - b$ d $\frac{b}{c-a}$
 e $\frac{ab}{b+a}$ f $a + b$ g $\frac{b-d}{a-c}$ h $\frac{bd-c}{a}$
- 7 a -18 b -78.2 c 16.75
 d 28 e 34 f $\frac{3}{26}$

Exercise 1B

- 1 a $x + 2 = 6, 4$ b $3x = 10, \frac{10}{3}$
 c $3x + 6 = 22, \frac{16}{3}$ d $3x - 5 = 15, \frac{20}{3}$
 e $6(x + 3) = 56, \frac{19}{3}$ f $\frac{x + 5}{4} = 23, 87$
- 2 A = \$8, B = \$24, C = \$16
 3 14 and 28 4 8 kg 5 1.3775 m²
 6 49, 50, 51 7 17, 19, 21, 23 8 4200 L
 9 21 10 3 km 11 9 and 12 dozen
 12 7.5 km/h 13 3.6 km 14 30, 6

Exercise 1C

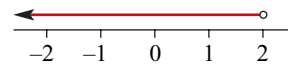
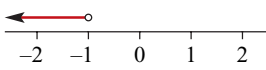
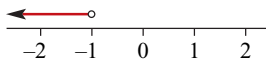
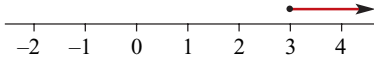
- 1 a $x = -1, y = -1$ b $x = 5, y = 21$
 c $x = -1, y = 5$

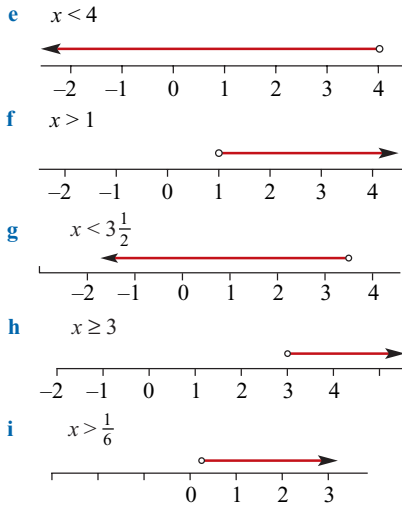
- 2 a $x = 8, y = -2$ b $x = -1, y = 4$
 c $x = 7, y = \frac{1}{2}$
- 3 a $x = 2, y = -1$ b $x = 2.5, y = -1$
 c $m = 2, n = 3$ d $x = 2, y = -1$
 e $s = 2, t = 5$ f $x = 10, y = 13$
 g $x = \frac{4}{3}, y = \frac{7}{2}$ h $p = 1, q = -1$
 i $x = -1, y = \frac{5}{2}$

Exercise 1D

- 1 25, 113 2 22.5, 13.5
 3 a \$70 b \$12 c \$3
 4 a \$168 b \$45 c \$15
 5 17 and 28 6 44 and 12
 7 5 pizzas, 25 hamburgers
 8 Started with 60 and 50; finished with 30 each
 9 \$17 000 10 120 shirts and 300 ties
 11 360 Outbacks and 300 Bush Walkers
 12 Mydney = 2800; Selbourne = 3200
 13 20 kg at \$10, 40 kg at \$11 and 40 kg at \$12.

Exercise 1E

- 1 a $x < 1$ b $x > 13$ c $x \geq 3$ d $x \leq 12$
 e $x \leq -6$ f $x > 3$ g $x > -2$
 h $x \geq -8$ i $x \leq \frac{3}{2}$
- 2 a $x < 2$

- b $x < -1$

- c $x < -1$

- d $x \geq 3$




3 a $x > \frac{-1}{2}$ **b** $x < 2$ **c** $x > -5$
4 $3x < 20, x < \frac{20}{3}, 6 \text{ pages}$ **5** 87

Exercise 1F

1 a 18 **b** 9 **c** 3 **d** -18
e 3 **f** 81 **g** 5 **h** 20
2 a $S = a + b + c$ **b** $P = xy$ **c** $C = 5p$
d $T = dp + cq$ **e** $T = 60a + b$
3 a 15 **b** 31.4 **c** 1000
d 12 **e** 314 **f** 720
4 a $V = \frac{c}{p}$ **b** $a = \frac{F}{m}$
c $P = \frac{I}{rt}$ **d** $r = \frac{w - H}{C}$
e $t = \frac{S - lP}{Pr}$ **f** $r = \frac{R(V - 2)}{V}$
5 a $T = 48$ **b** $b = 8$ **c** $h = 3.82$ **d** $b = 10$
6 a $(4a + 3w) \text{ m}$ **b** $(h + 2b) \text{ m}$
c $3wh \text{ m}^2$ **d** $(4ah + 8ab + 6wb) \text{ m}^2$
7 a **i** $T = 2\pi(p + q) + 4h$ **ii** $88\pi + 112$
b $p = \frac{A}{h} - q$
8 a $D = \frac{2}{3}$ **b** $b = 2$
c $n = \frac{60}{29}$ **d** $r = 4.8$
9 a $D = \frac{1}{2}bc(1 - k^2)$ **b** $k = \sqrt{1 - \frac{2D}{bc}}$
c $k = \sqrt{\frac{2}{3}} = \frac{\sqrt{6}}{3}$
10 a $P = 4b$ **b** $A = 2bc - c^2$ **c** $b = \frac{A + c^2}{2c}$
11 a $b = \frac{a^2 - a}{2}$ **b** $x = \frac{-ay}{b}$
c $r = \sqrt{3q - p^2x^2}$ **d** $v = \sqrt{u^2 \left(1 - \frac{x^2}{y^2}\right)}$

Multiple-choice questions

- 1** D **2** D **3** C **4** A **5** C
6 C **7** B **8** B **9** A **10** B

Short-answer questions (technology-free)

1 a 1 **b** $\frac{-3}{2}$ **c** $\frac{-2}{3}$ **d** -27
e 12 **f** $\frac{44}{13}$ **g** $\frac{1}{8}$ **h** 31
2 a $t = a - b$ **b** $\frac{cd - b}{a}$ **c** $\frac{d}{a} + c$
d $\frac{cb - a}{c - 1}$ **e** $\frac{2b}{c - a}$ **f** $\frac{1 - cd}{ad}$
3 a $x < \frac{2}{3}$ **b** $x \leq 148\frac{1}{2}$
c $x < \frac{22}{29}$ **d** $x \geq \frac{-7}{17}$
4 $x = 2(z + 3t), -10$
5 a $d = e^2 + 2f$ **b** $f = \frac{d - e^2}{2}$ **c** $f = \frac{1}{2}$
6 $x = \frac{a^2 + b^2 + 2ab}{ac + bc} = \frac{a + b}{c}$ **7** $x = \frac{ab}{a - b - c}$

Extended-response questions

1 a $c = \frac{-10}{9}$ **b** $F = 86$ **c** $x = -40$
d $x = -62.5$ **e** $x = \frac{-160}{13}$ **f** $k = 5$
2 a $r = \frac{2uv}{u + v}$ **b** $m = \frac{v}{u}$
3 a $T = 6w + 6l$
b **i** $T = 8w$ **ii** $l = \frac{25}{6}, w = 12\frac{1}{2}$
c **i** $y = \frac{L - 6x}{8}$ **ii** $y = 22$
d $x = 10, y = 5$
4 a distance that Tom travelled = ut km and distance Julie travelled = vt km
b **i** $t = \frac{d}{u + v}$ **ii** distance from A = $\frac{ud}{u + v}$ km
c $t = 1.25$ h, distance from town A = 37.5 km
5 a average speed = $\frac{uv}{u + v}$
b **i** $\frac{uT}{v}$ **ii** $\frac{vT + uT}{v}$
6 a $\frac{3}{a} + \frac{3}{b}$
c **i** $c = \frac{2ab}{a + b}$ **ii** $\frac{40}{3}$
7 a $\frac{x}{8}, \frac{y}{10}$ **b** $\frac{80(x + y)}{10x + 8y}$
c $x = \frac{320}{9}, y = \frac{310}{9}$

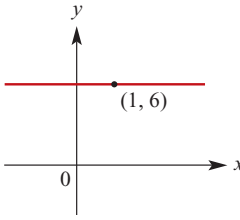
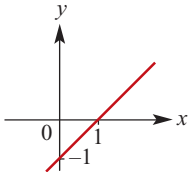
Chapter 2

Exercise 2A

1 a 4 b 2 c $\frac{1}{4}$ d -4 e 1 f -1

g $\frac{5}{4}$ h -2 i $-\frac{5}{4}$ j $\frac{4}{3}$ k 0

2 Any line parallel to the one shown



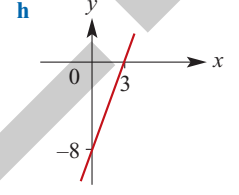
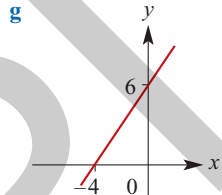
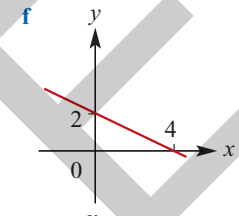
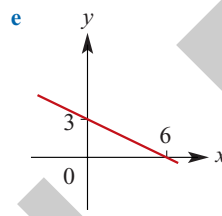
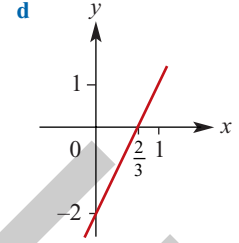
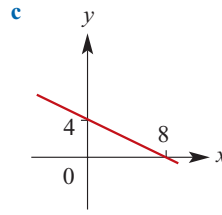
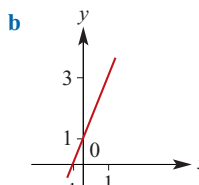
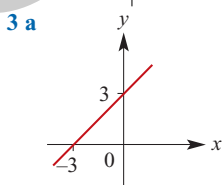
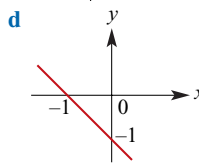
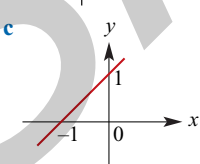
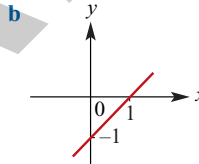
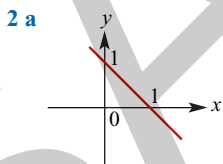
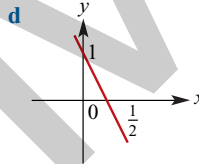
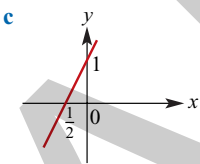
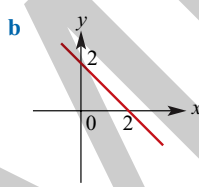
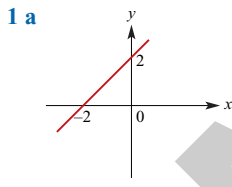
4 a $-\frac{1}{4}$ b $-\frac{5}{2}$ c -2 d -8 e 0 f -1

g 7 h 11 i -13 j 11 k 111 l 61

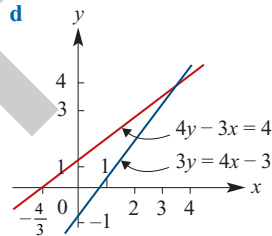
5 a -2 b $\frac{2}{5}$ 6 a 54 b $\frac{5}{6}$

7 a $x = 4$ b $y = 11$

Exercise 2B



4 Pairs which are parallel: a, b and c; Non-parallel:



5 c only 6 a -1 b 0 c -1 d 1

Exercise 2C

1 a $y = 3x + 5$ b $y = -4x + 6$ c $y = 3x - 4$

2 a $y = 3x - 11$ b $y = -2x + 9$

3 a 2 b $y = 2x + 6$

4 a -2 b $y = -2x + 6$

5 a $y = 2x + 4$ b $y = -2x + 8$

6 a $y = 4x + 4$ b $y = -\frac{2}{3}x$ c $y = -x - 2$

d $y = \frac{1}{2}x - 1$ e $y = 3\frac{1}{2}$ f $x = -2$

7 Some possible answers:

a $y = 4x - 3$ b $y = -\frac{2}{3}x - 1$ c $y = -x - 1$

d $y = \frac{1}{2}x + 1$ e $y = 4$ f $x = -1$

Check with your teacher for other answers.

8 a $y = \frac{3}{4}x + 9\frac{1}{2}$ b $y = -\frac{1}{2}x - 1$

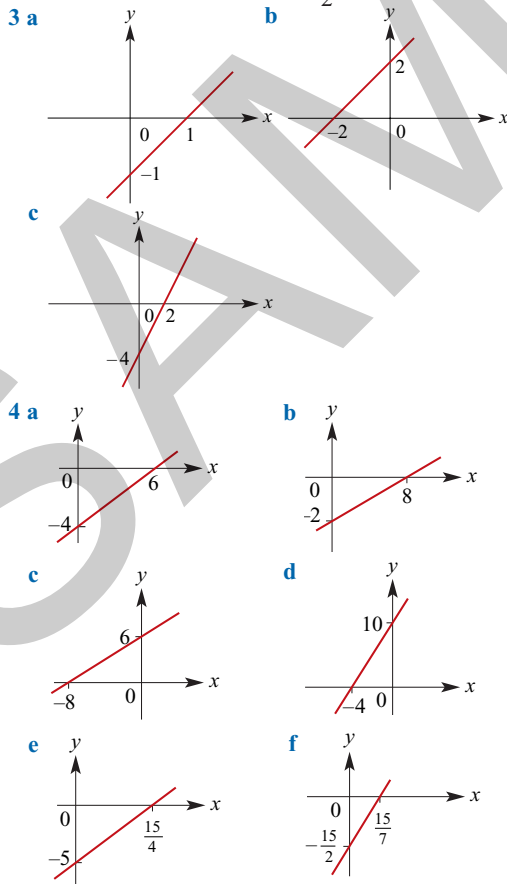
c $y = 3$ d $y = -3$

9 a $y = \frac{4}{3}x + 3$ b $y = -\frac{1}{2}x + 3$

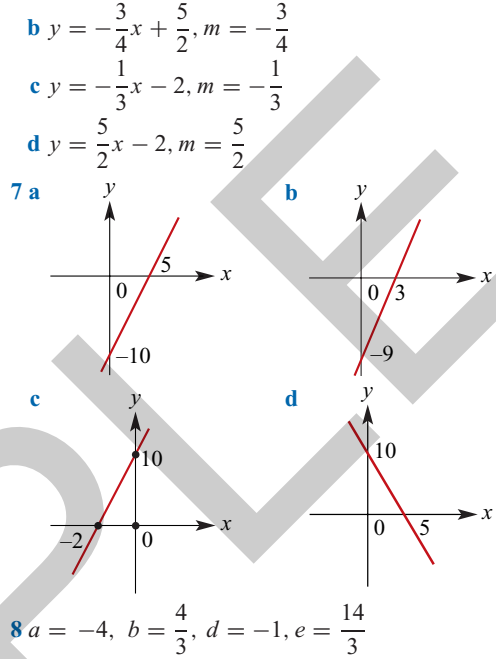
- c $y = -0.7x + 6.7$ d $y = 1\frac{1}{2}x - 3$
 e $y = -\frac{3}{4}x + 6$ f $y = -x$
 10 a $y = -\frac{2}{3}x + 4$ b $y = -2x - 6$
 c $y = -\frac{1}{2}x + 4$ d $y = -x + 8$
 11 a $y = \frac{2}{3}x + 4$ b $y = \frac{2}{3}x - \frac{2}{3}$
 c $y = \frac{1}{2}x + 1\frac{1}{2}$ d $y = -\frac{1}{2}x + 2$
 e $y = x + 3.5$ f $y = -\frac{1}{2}x + 0.25$
 12 Yes
 13 AB: $y = \frac{2x}{3} + \frac{1}{3}$ BC: $y = -\frac{3x}{2} + 9$
 AC: $y = \frac{1}{8}x - \frac{3}{4}$

Exercise 2D

- 1 a (0, 4), (4, 0) b (0, -4), (4, 0)
 c (0, -6), (-6, 0) d (0, 8), (-8, 0)
 2 a $y = -2x + 6$ b $y = \frac{1}{2}x - 2$
 c $y = x$ d $y = \frac{-1}{2}x + 3$

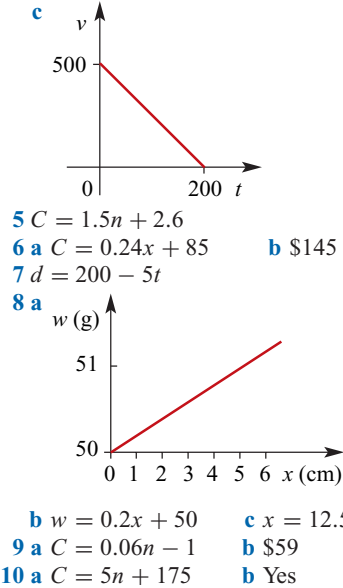


- 5 a $x + 3y = 11$ b $7x + 5y = 20$
 c $2x + y = 4$ d $-11x + 3y = -61$
 6 a $y = 2x - 9, m = 2$

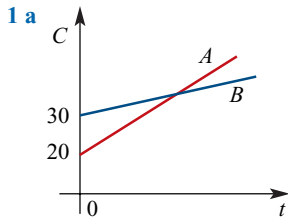


Exercise 2E

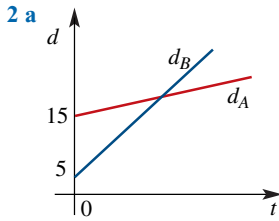
- 1 a $d = 50t$ b $d = 40t + 5$
 2 a $V = 5t$ b $V = 10 + 5t$
 3 $w = 20n + 350$, possible values for $n = N \cup \{0\}$
 4 a $v = 500 - 2.5t$
 b domain: $0 \leq t \leq 200$, range: $0 \leq v \leq 500$



Exercise 2F

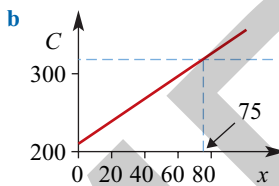


b $t = 5$

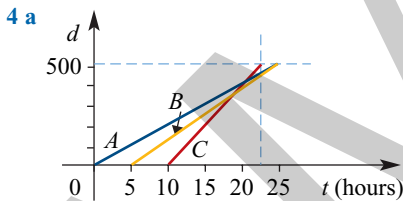


b 2.00 pm

3 a $C_1 = 210 + 1.6x$
 $C_2 = 330$



c Fixed charge method is cheaper when $x > 75$.



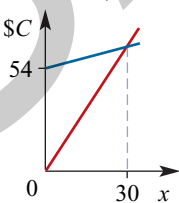
b C wins the race

d C, leaving 5 hours after B, overtakes B $13\frac{1}{2}$ hours after B had started and then overtakes A 20 hours after A had started. C wins the race with a total handicap time of $22\frac{1}{2}$ hours ($12\frac{1}{2}$ hours for journey + 10 hours handicap) with A and B deadheading for 2nd, each with a total handicap time of 25 hours.

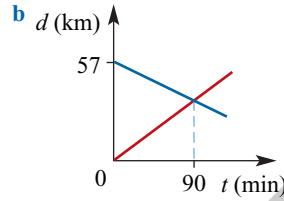
5 Both craft will pass over the point $(\frac{5}{3}, -4)$

6 a $C_T = 2.8x$, $C_B = 54 + x$

b $\$C$ **c** > 30 students



7 a $d_A = \frac{1}{3}t$, $d_M = 57 - \frac{3}{10}t$



c 10.30 am **d** Maureen 30 km, Anne 27 km

8 $a = 0.28$ and $b = 0.3, \frac{10}{3}$ m/s

Exercise 2G

1 a 135° **b** 45° **c** 26.57° **d** 135°

2 a 45° **b** 135° **c** 45° **d** 135°

e 63.43° (to 2 d.p.) **f** 116.57° (to 2 d.p.)

3 a 45° **b** $26^\circ 34'$ **c** $161^\circ 34'$

d $49^\circ 24'$ **e** $161^\circ 34'$ **f** 135°

4 a $71^\circ 34'$ **b** 135° **c** 45° **d** $161^\circ 34'$

5 $m_{BC} = -\frac{3}{5}$, $m_{AB} = \frac{5}{3}$

$\therefore m_{BC} \times m_{AB} = -\frac{3}{5} \times \frac{5}{3} = -1$

$\therefore \triangle ABC$ is a right-angled triangle

6 $m_{RS} = -\frac{1}{2}$, $m_{ST} = 2 \therefore RS \perp ST$

$m_{UT} = -\frac{1}{2}$, $m_{ST} = 2 \therefore UT \perp ST$ (Also need to show $SR = UT$.)

$\therefore RSTU$ is a rectangle.

7 $y = 2x + 2$

8 a $2x - 3y = 14$ **b** $2y + 3x = 8$

9 $l = -\frac{16}{3}$, $m = \frac{80}{3}$

Exercise 2H

1 a 7.07 **b** 4.12 **c** 5.83 **d** 13

2 29.27 **3** DN

Exercise 2I

1 a $(5, 8)$ **b** $(\frac{1}{2}, \frac{1}{2})$
c $(1.6, 0.7)$ **d** $(-0.7, 0.85)$

2 $M_{AB} (3, 3)$, $M_{BC} (8, 3\frac{1}{2})$, $M_{AC} (6, 1\frac{1}{2})$

3 Coordinates of C are $(6, 8.8)$

4 a $PM = 12.04$ **b** No, it passes through $(0, 3\frac{1}{3})$

5 a $(4, 4)$ **b** $(2, -0.2)$ **c** $(-2, 5)$ **d** $(-4, -3)$

6 $(\frac{1+a}{2}, \frac{4+b}{2})$; $a = 9, b = -6$

Exercise 2J

1 a $34^\circ 41'$ **b** 45° **c** 90° **d** $49^\circ 24'$ **e** $26^\circ 33'$

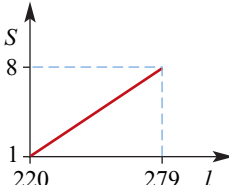
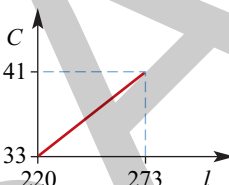
Multiple-choice questions

1 A **2** E **3** C **4** D **5** B
6 E **7** D **8** C **9** E **10** E

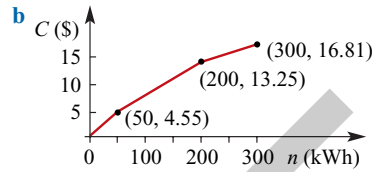
**Short-answer questions
(technology-free)**

- 1 a $\frac{9}{4}$ b $-\frac{10}{11}$ c undefined d -1 e $\frac{b}{a}$ f $\frac{-b}{a}$
 2 a $y = 4x$ b $y = 4x + 5$ c $y = 4x + 2$
 d $y = 4x - 5$
 3 a $a = -2$ b $\frac{20}{3}$
 4 $4y + 3x = -7$ 5 $3y + 2x = -5$
 6 $a = -3, b = 5, c = 14$
 7 a $y = 11$ b $y = 6x - 10$ c $3y + 2x = -3$
 8 a midpoint = $(3, 2)$, length = 4
 b midpoint = $(-\frac{1}{2}, -\frac{9}{2})$, length = $\sqrt{74}$
 c midpoint = $(5, \frac{5}{2})$, length = 5
 9 $\sqrt{3}y - x = 3\sqrt{3} - 2$ 10 $y + x = 1$ 11 $37^\circ 52'$

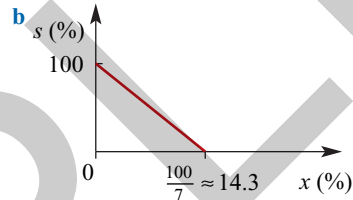
Extended-response questions

- 1 a 
 b Since the graph is a line of best fit answers may vary according to the method used; e.g. if the two end points are used then the rule is $S = \frac{7}{59}l - 25.1$ (or $l = \frac{59}{7}S + \frac{1481}{7}$)
 If a least squares method is used the rule is $l = 8.46S + 211.73$.
 c 
 d Again this is a line of best fit. If the two end points are used then $C = \frac{8}{53}l - \frac{11}{53}$ (or $l = \frac{53C - 11}{8}$)
 A least squares method gives $l = 6.65C + 0.6166$.
 2 a $C = 110 + 38n$ b 12 days
 c Less than 5 days
 3 a Cost of the plug
 b Cost per metre of the cable
 c 1.8 d $11\frac{1}{9}$ m
 4 a The maximum profit (when $x = 0$)
 b 43 seats
 c The profit reduces by \$24 for every seat empty.

- 5 a i $C = 0.091n$ ii $C = 1.65 + 0.058n$
 iii $C = 6.13 + 0.0356n$



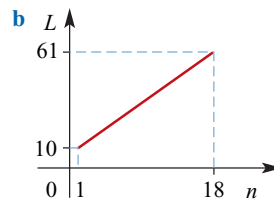
- i For 30 kWh, $C = 2.73$
 ii For 90 kWh, $C = 6.87$
 iii For 300 kWh, $C = 16.81$
 c 389.61 kWh
 6 a $y = -\frac{7}{3}x + 14\frac{2}{3}$ b $20\frac{1}{3}$ km south
 7 a $s = 100 - 7x$



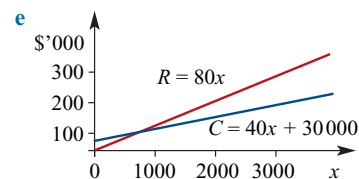
- b $\frac{5}{7}\%$ d $14\frac{2}{7}\%$
 e Probably not a realistic model at this value of s
 f $0 \leq x \leq 14\frac{2}{7}$
 8 a $AB, y = x + 2; CD, y = 2x - 6$
 b Intersection is at $(8, 10)$, i.e. on the near bank.
 9 a $\frac{128}{19}$ b $y = -\frac{199}{190}x + \frac{128}{19}$
 c No, since gradient of AB is $\frac{20}{19}$ (1.053), whereas the gradient of VC is -1.047
 10 a No b $1\frac{41}{71}$ km to the east of H

- 11 a $y = x - 38$ b $B(56, 18)$
 c $y = -2x + 166$ d $(78, 10)$

- 12 a $L = 3n + 7$



- 13 a $C = 40x + 30\,000$
 b \$45 c 5000 d $R = 80x$

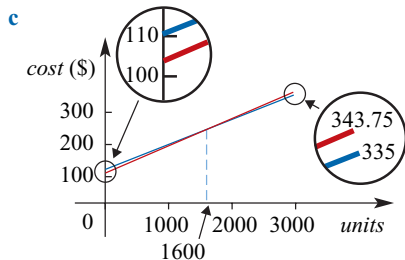


- f 751 g $P = 40x - 30\,000$

14 a Method 1: Cost = \$226.75; Method 2:
Cost = \$227; ∴ Method 1 cheaper

	0	1000	2000	3000
b Method 1	100	181.25	262.50	343.75
Method 2	110	185	260	335

Cost the same for approx. 1600 units



d $C_1 = 0.08125x + 100$ (1)
 $C_2 = 0.075x + 110$ (2)
 $x = 1600$

15 a (17, 12) b $3y = 2x + 2$

16 a $PD: y = \frac{2}{3}x + 120$; $DC: y = \frac{2}{5}x + 136$;

$CB: y = -\frac{5}{2}x + 600$

$AB: y = \frac{2}{5}x + 20$; $AP: y = -\frac{3}{5}x + 120$

b At B and C since product of gradients is -1

e.g. $m_{DC} = \frac{2}{5}$, $m_{CB} = -\frac{5}{2}$;

$\frac{2}{5} \times -\frac{5}{2} = -1$

17 a $y = 3x + 2$ b (0, 2) c $y = 3x - 8$

d (2, -2) e Area = 10 square units

f Area = 40 square units

Chapter 3

Exercise 3A

1 a 2×2 b 2×3 c 1×4 d 4×1

2 a $\begin{bmatrix} 1 & 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 & 1 \end{bmatrix}$ b $\begin{bmatrix} 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \end{bmatrix}$

3 $\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}$ Only the seats for top-left to bottom-right diagonal are occupied.

4 $\begin{bmatrix} 200 & 180 & 135 & 110 & 56 & 28 \\ 110 & 117 & 98 & 89 & 53 & 33 \end{bmatrix}$

5 a $[0 \ x] = [0 \ 4]$ if $x = 4$

b $\begin{bmatrix} 4 & 7 \\ 1 & -2 \end{bmatrix} = \begin{bmatrix} x & 7 \\ 1 & -2 \end{bmatrix}$ if $x = 4$

c $\begin{bmatrix} 2 & x & 4 \\ -1 & 10 & 3 \end{bmatrix} = \begin{bmatrix} y & 0 & 4 \\ -1 & 10 & 3 \end{bmatrix}$
 $= \begin{bmatrix} 2 & 0 & 4 \\ -1 & 10 & 3 \end{bmatrix}$ if $x = 0, y = 2$

6 a $x = 2, y = 3$ b $x = 3, y = 2$
c $x = 4, y = -3$ d $x = 3, y = -2$

7 $\begin{bmatrix} 0 & 3 & 1 & 0 \\ 3 & 0 & 2 & 1 \\ 1 & 2 & 0 & 1 \\ 0 & 1 & 1 & 0 \end{bmatrix}$ 8 $\begin{bmatrix} 21 & 5 & 5 \\ 8 & 2 & 3 \\ 4 & 1 & 1 \\ 14 & 8 & 60 \\ 0 & 1 & 2 \end{bmatrix}$

Exercise 3B

1 $\mathbf{X} + \mathbf{Y} = \begin{bmatrix} 4 \\ -2 \end{bmatrix}$, $2\mathbf{X} = \begin{bmatrix} 2 \\ -4 \end{bmatrix}$,

$4\mathbf{Y} + \mathbf{X} = \begin{bmatrix} 13 \\ -2 \end{bmatrix}$, $\mathbf{X} - \mathbf{Y} = \begin{bmatrix} -2 \\ -2 \end{bmatrix}$,

$-3\mathbf{A} = \begin{bmatrix} -3 & 3 \\ -6 & -9 \end{bmatrix}$, $-3\mathbf{A} + \mathbf{B} = \begin{bmatrix} 1 & 3 \\ -7 & -7 \end{bmatrix}$

2 a $\begin{bmatrix} 6 & 12 & 4 \\ 8 & 4 & 2 \end{bmatrix}$ b $\begin{bmatrix} 5 & 1 & 0 \\ 18 & 7 & 13 \end{bmatrix}$

c $\begin{bmatrix} 5 & 1 & 0 \\ 3 & 3 & 7 \\ 6 & 3 & 13 \end{bmatrix}$

3 $2\mathbf{A} = \begin{bmatrix} 2 & -2 \\ 0 & 4 \end{bmatrix}$, $-3\mathbf{A} = \begin{bmatrix} -3 & 3 \\ 0 & -6 \end{bmatrix}$,

$-6\mathbf{A} = \begin{bmatrix} -6 & 6 \\ 0 & -12 \end{bmatrix}$

4 a Yes b Yes

5 a $\begin{bmatrix} 6 & 4 \\ -4 & -4 \end{bmatrix}$ b $\begin{bmatrix} 0 & -9 \\ 12 & 3 \end{bmatrix}$

c $\begin{bmatrix} 6 & -5 \\ 8 & -1 \end{bmatrix}$ d $\begin{bmatrix} -6 & -13 \\ 16 & 7 \end{bmatrix}$

6 a $\begin{bmatrix} 0 & 1 \\ 2 & 3 \end{bmatrix}$ b $\begin{bmatrix} -2 & 3 \\ 6 & 3 \end{bmatrix}$ c $\begin{bmatrix} 3 & 3 \\ -1 & 7 \end{bmatrix}$

7 $\mathbf{X} = \begin{bmatrix} 2 & 4 \\ 0 & -3 \end{bmatrix}$, $\mathbf{Y} = \begin{bmatrix} -9 & -23 \\ 2 & 11 \end{bmatrix}$

8 $\mathbf{X} + \mathbf{Y} = \begin{bmatrix} 310 & 180 & 220 & 90 \\ 200 & 0 & 125 & 0 \end{bmatrix}$, representing the total production at two factories in two successive weeks.

Exercise 3C

1 $AX = \begin{bmatrix} 4 \\ -5 \end{bmatrix}$, $BX = \begin{bmatrix} 4 \\ 1 \end{bmatrix}$, $AY = \begin{bmatrix} -5 \\ 8 \end{bmatrix}$,

$IX = \begin{bmatrix} 2 \\ -1 \end{bmatrix}$, $AC = \begin{bmatrix} 0 & -1 \\ 1 & 2 \end{bmatrix}$,

$CA = \begin{bmatrix} 1 & -1 \\ 0 & 1 \end{bmatrix}$, $(AC)X = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$,

$C(BX) = \begin{bmatrix} 9 \\ 5 \end{bmatrix}$, $AI = \begin{bmatrix} 1 & -2 \\ -1 & 3 \end{bmatrix}$,

$IB = \begin{bmatrix} 3 & 2 \\ 1 & 1 \end{bmatrix}$, $AB = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$,

$BA = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$, $A^2 = \begin{bmatrix} 3 & -8 \\ -4 & 11 \end{bmatrix}$,

$B^2 = \begin{bmatrix} 11 & 8 \\ 4 & 3 \end{bmatrix}$, $A(CA) = \begin{bmatrix} 1 & -3 \\ -1 & 4 \end{bmatrix}$,

$A^2C = \begin{bmatrix} -2 & -5 \\ 3 & 7 \end{bmatrix}$

2 a AY , CI are defined, YA , XY , X^2 , XI are not defined.

b $AB = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$

3 No

4 $LX = [7]$, $XL = \begin{bmatrix} 4 & -2 \\ -6 & 3 \end{bmatrix}$

5 AB and BA are not defined unless $m = n$.

6 $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

7 One possible answer is

$A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$, $B = \begin{bmatrix} -2 & 1 \\ 1.5 & -0.5 \end{bmatrix}$

8 One possible answer is $A = \begin{bmatrix} 1 & 2 \\ 4 & 3 \end{bmatrix}$,

$B = \begin{bmatrix} 0 & 1 \\ 2 & 3 \end{bmatrix}$, $C = \begin{bmatrix} -1 & 2 \\ -2 & 1 \end{bmatrix}$,

$A(B + C) = \begin{bmatrix} -1 & 11 \\ -4 & 24 \end{bmatrix}$,

$AB + AC = \begin{bmatrix} -1 & 11 \\ -4 & 24 \end{bmatrix}$,

$(B + C)A = \begin{bmatrix} 11 & 7 \\ 16 & 12 \end{bmatrix}$

9 $\begin{bmatrix} 29 \\ 8.50 \end{bmatrix}$ represents John spending 29 minutes consuming food which cost him \$8.50.

$\begin{bmatrix} 29 & 22 & 12 \\ 8.50 & 8.00 & 3.00 \end{bmatrix}$ John's friends spent

\$8.00 and \$3.00 and took 22 and 12 minutes respectively to consume their food.

10 $\begin{bmatrix} 6.00 \\ 8.00 \\ 2.00 \\ 11.00 \\ 6.50 \end{bmatrix}$ represents how much each student spends in a week on magazines.

11 a $SC = \begin{bmatrix} s_{11}c_1 + s_{12}c_2 + s_{13}c_3 \\ s_{21}c_1 + s_{22}c_2 + s_{23}c_3 \end{bmatrix}$

b SC represents the income from car sales for each showroom.

c $SC = \begin{bmatrix} s_{11}c_1 + s_{12}c_2 + s_{13}c_3 & s_{11}u_1 + s_{12}u_2 + s_{13}u_3 \\ s_{21}c_1 + s_{22}c_2 + s_{23}c_3 & s_{21}u_1 + s_{22}u_2 + s_{23}u_3 \end{bmatrix}$

represents the income for each showroom for new car sales and used car sales.

d CV gives the profit on each new car and each used car for the three models.

Exercise 3D

1 a 1 b $\begin{bmatrix} 2 & -2 \\ -3 & 2 \end{bmatrix}$

c 2 d $\frac{1}{2} \begin{bmatrix} 2 & 2 \\ -3 & -2 \end{bmatrix}$

2 a $\begin{bmatrix} -1 & 1 \\ -4 & 3 \end{bmatrix}$ b $\begin{bmatrix} \frac{2}{7} & \frac{-1}{14} \\ 1 & \frac{3}{14} \end{bmatrix}$

c $\begin{bmatrix} 1 & 0 \\ 0 & \frac{1}{k} \end{bmatrix}$ d $\begin{bmatrix} \cos \theta & \sin \theta \\ -\sin \theta & \cos \theta \end{bmatrix}$

3 $A^{-1} = \begin{bmatrix} \frac{1}{2} & \frac{1}{2} \\ 0 & -1 \end{bmatrix}$, $B^{-1} = \begin{bmatrix} 1 & 0 \\ -3 & 1 \end{bmatrix}$,

$AB = \begin{bmatrix} 5 & 1 \\ -3 & -1 \end{bmatrix}$, $(AB)^{-1} = \begin{bmatrix} \frac{1}{2} & \frac{1}{2} \\ -3 & -5 \end{bmatrix}$,

$A^{-1}B^{-1} = \begin{bmatrix} -1 & \frac{1}{2} \\ 3 & -1 \end{bmatrix}$,

$B^{-1}A^{-1} = \begin{bmatrix} \frac{1}{2} & \frac{1}{2} \\ -3 & -5 \end{bmatrix}$, $(AB)^{-1} = B^{-1}A^{-1}$

4 a $\begin{bmatrix} -\frac{1}{2} & \frac{3}{2} \\ 1 & -2 \end{bmatrix}$ b $\begin{bmatrix} 0 & 7 \\ 1 & -8 \end{bmatrix}$

c $\begin{bmatrix} \frac{5}{2} & \frac{-7}{2} \\ \frac{11}{2} & \frac{-21}{2} \end{bmatrix}$

5 a $\begin{bmatrix} -3 & 11 \\ 8 & 8 \\ 1 & 7 \\ \frac{1}{16} & \frac{1}{16} \end{bmatrix}$ b $\begin{bmatrix} -\frac{11}{4} & \frac{17}{4} \\ \frac{16}{4} & \frac{16}{4} \\ -\frac{1}{4} & \frac{3}{4} \end{bmatrix}$

6 $\begin{bmatrix} \frac{1}{a_{11}} & 0 \\ 0 & \frac{1}{a_{22}} \end{bmatrix}$

8 $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}; \begin{bmatrix} 1 & 0 \\ k & -1 \end{bmatrix}, \begin{bmatrix} -1 & 0 \\ k & 1 \end{bmatrix};$

$\begin{bmatrix} 1 & k \\ 0 & -1 \end{bmatrix}, \begin{bmatrix} -1 & k \\ 0 & 1 \end{bmatrix}, k \in R$

$\begin{bmatrix} a & b \\ \frac{1-a^2}{b} & -a \end{bmatrix}, b \neq 0$

Exercise 3E

1 a $\begin{bmatrix} 3 \\ 10 \end{bmatrix}$ b $\begin{bmatrix} 5 \\ 17 \end{bmatrix}$

2 a $\begin{bmatrix} -1 \\ \frac{3}{14} \\ \frac{3}{14} \end{bmatrix}$ b $\begin{bmatrix} 4 \\ \frac{7}{7} \\ \frac{2}{7} \\ \frac{7}{7} \end{bmatrix}$

3 a $x = -\frac{1}{7}, y = \frac{10}{7}$ b $x = 4, y = 1.5$

c $x = -\frac{30}{7}, y = -\frac{2}{7}$

d $x = -2.35, y = 0.69$

4 (2, -1) 5 books \$12, CDs \$18

6 a $\begin{bmatrix} 2 & -3 \\ 4 & -6 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 3 \\ 6 \end{bmatrix}$

b $\begin{bmatrix} 2 & -3 \\ 4 & -6 \end{bmatrix}$ is a singular matrix, not a regular matrix.

c There is no unique solution for this system, but a solution can be found.

d The solution set contains an infinite number of pairs.

Multiple-choice questions

1 B 2 E 3 C 4 E 5 C
6 A 7 E 8 A 9 E 10 D

Short-answer questions (technology-free)

1 a $\begin{bmatrix} 1 & 5 \\ 3 & 9 \end{bmatrix}$ b $\begin{bmatrix} -1 & -1 \\ 3 & -1 \end{bmatrix}$ c $\begin{bmatrix} 0 & 10 \\ 3 & 29 \end{bmatrix}$

d -6 e $\begin{bmatrix} -\frac{2}{3} & \frac{1}{3} \\ \frac{1}{1} & 0 \end{bmatrix}$

2 a $\begin{bmatrix} 0 & 0 \\ 12 & 8 \end{bmatrix}$ b $\begin{bmatrix} 0 & 0 \\ 8 & 8 \end{bmatrix}$

3 $\begin{bmatrix} a \\ 2 - \frac{3}{4}a \end{bmatrix}, a \in R$

4 a AB does not exist, AC, CD, BE exist.

b $DA = [14 \ 0], A^{-1} = \frac{1}{7} \begin{bmatrix} 1 & 2 \\ 3 & -1 \end{bmatrix}$

5 $AB = \begin{bmatrix} 2 & 0 \\ 2 & -2 \end{bmatrix}, C^{-1} = \begin{bmatrix} -2 & 1 \\ \frac{3}{2} & -\frac{1}{2} \end{bmatrix}$

6 $\begin{bmatrix} -1 & 2 \\ -3 & 5 \end{bmatrix}$

7 $A^2 = \begin{bmatrix} 4 & 0 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 4 \end{bmatrix}, A^{-1} = \begin{bmatrix} \frac{1}{2} & 0 & 0 \\ 0 & 0 & \frac{1}{2} \\ 0 & \frac{1}{2} & 0 \end{bmatrix}$

8 8

9 a i $\begin{bmatrix} 3 & -5 \\ 5 & 8 \end{bmatrix}$ ii $\begin{bmatrix} 1 & -18 \\ 18 & 19 \end{bmatrix}$

iii $\frac{1}{7} \begin{bmatrix} 3 & 1 \\ -1 & 2 \end{bmatrix}$

b $x = 2, y = 1$

Extended-response questions

1 a i $\begin{bmatrix} 5 & 0 \\ 6 & -2 \end{bmatrix}$ ii $\begin{bmatrix} 1 & 2 \\ -4 & -6 \end{bmatrix}$

iii $\begin{bmatrix} 12 & -1 \\ 17 & -2 \end{bmatrix}$ iv $\begin{bmatrix} -7 & -2 \\ 2 & 1 \\ 1 & 7 \end{bmatrix}$

b i $\begin{bmatrix} 11 & -1 \\ -18 & -9 \end{bmatrix}$ ii $\frac{1}{13} \begin{bmatrix} 4 & 1 \\ 1 & -3 \end{bmatrix}$

iii $\frac{1}{13} \begin{bmatrix} 13 & -2 \\ -13 & -7 \end{bmatrix}$ iv $\frac{1}{13} \begin{bmatrix} 7 & 5 \\ 22 & -1 \end{bmatrix}$

2 a $\begin{bmatrix} -8 & 2 & 11 \\ -5 & -3 & -1 \\ 14 & 18 & 7 \end{bmatrix}$ b $\begin{bmatrix} -2 & 6 & 6 \\ 3 & -3 & 3 \\ 15 & 12 & 3 \end{bmatrix}$

c $\begin{bmatrix} -3 & 3 & -3 \\ 12 & -6 & 4 \\ 14 & 9 & 2 \end{bmatrix}$

d $\begin{bmatrix} \frac{50}{33} & \frac{2}{11} & \frac{-2}{11} \\ \frac{-7}{33} & \frac{11}{5} & \frac{-5}{11} \\ \frac{1}{33} & \frac{11}{11} & \frac{11}{11} \end{bmatrix}$ e $\frac{1}{33} \begin{bmatrix} 0 & -33 & 0 \\ -18 & 70 & 10 \\ -6 & 5 & 29 \end{bmatrix}$

f $A^{-1}CBC^{-1}$ g $C^{-1}B$

3 a i $\begin{bmatrix} 2 & -3 \\ 4 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 3 \\ 5 \end{bmatrix}$

ii $14, \frac{1}{14} \begin{bmatrix} 1 & 3 \\ -4 & 2 \end{bmatrix}$ iii $\frac{1}{7} \begin{bmatrix} 9 \\ -1 \end{bmatrix}$

iv $\left(\frac{9}{7}, -\frac{1}{7}\right)$ is the point of intersection of the two lines

b i $\begin{bmatrix} 2 & 1 \\ 4 & 2 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 3 \\ 8 \end{bmatrix}$

ii 0; A is a singular matrix

c lines represented by the equations are parallel

Chapter 4

Exercise 4A

1 a $2x - 8$ b $-2x + 8$ c $6x - 12$
 d $-12 + 6x$ e $x^2 - x$ f $2x^2 - 10x$

2 a $6x + 1$ b $3x - 6$ c $x + 1$ d $5x - 3$

3 a $14x - 32$ b $2x^2 - 11x$
 c $32 - 16x$ d $6x - 11$

4 a $2x^2 - 11x$ b $3x^2 - 15x$ c $-20x - 6x^2$
 d $6x - 9x^2 + 6x^3$ e $2x^2 - x$ f $6x - 6$

5 a $6x^2 - 2x - 28$ b $x^2 - 22x + 120$
 c $36x^2 - 4$ d $8x^2 - 22x + 15$
 e $x^2 - (\sqrt{3} + 2)x + 2\sqrt{3}$ f $2x^2 + \sqrt{5}x - 5$

6 a $x^2 - 8x + 16$ b $4x^2 - 12x + 9$
 c $36 - 24x + 4x^2$ d $x^2 - x + \frac{1}{4}$
 e $x^2 - 2\sqrt{5}x + 5$ f $x^2 - 4\sqrt{3}x + 12$

7 a $6x^3 - 5x^2 - 14x + 12$ b $x^3 - 1$
 c $24 - 20x - 8x^2 + 6x^3$ d $x^2 - 9$
 e $4x^2 - 16$ f $81x^2 - 121$

g $3x^2 + 4x + 3$ h $-10x^2 + 5x - 2$
 i $x^2 + y^2 - z^2 - 2xy$
 j $ax - ay - bx + by$

8 a i $x^2 + 2x + 1$ ii $(x + 1)^2$
 b i $(x - 1)^2 + 2(x - 1) + 1$ ii x^2

Exercise 4B

1 a $2(x + 2)$ b $4(a - 2)$ c $3(2 - x)$
 d $2(x - 5)$ e $6(3x + 2)$ f $8(3 - 2x)$

2 a $2x(2x - y)$ b $8x(a + 4y)$
 c $6b(a - 2)$ d $2xy(3 + 7x)$
 e $x(x + 2)$ f $5x(x - 3)$
 g $-4x(x + 4)$ h $7x(1 + 7x)$
 i $x(2 - x)$ j $3x(2x - 3)$
 k $xy(7x - 6y)$ l $2xy^2(4x + 3)$

3 a $(x^2 + 1)(x + 5)$
 b $(x - 1)(x + 1)(y - 1)(y + 1)$
 c $(a + b)(x + y)$ d $(a^2 + 1)(a - 3)$
 e $(x - a)(x + a)(x - b)$

4 a $(x - 6)(x + 6)$ b $(2x - 9)(2x + 9)$
 c $2(x - 7)(x + 7)$ d $3a(x - 3)(x - 3)$
 e $(x - 6)(x + 2)$ f $(7 + x)(3 - x)$
 g $3(x - 1)(x + 3)$ h $-5(2x + 1)$
 5 a $(x - 9)(x + 2)$ b $(y - 16)(y - 3)$
 c $(3x - 1)(x - 2)$ d $(2x + 1)(3x + 2)$
 e $(a - 2)(a - 12)$ f $(a + 9)^2$
 g $(5x + 3)(x + 4)$ h $(3y + 6)(y - 6)$
 i $2(x - 7)(x - 2)$ j $4(x - 3)(x - 6)$
 k $3(x + 2)(x + 3)$ l $a(x + 3)(x + 4)$
 m $x(5x - 6)(x - 2)$ n $3x(4 - x)^2$
 o $x(x + 2)$

Exercise 4C

1 a 2 or 3 b 0 or 2 c 4 or 3
 d 4 or 3 e 3 or -4 f 0 or 1

g $\frac{5}{2}$ or 6 h -4 or 4

2 a -0.65 or 4.65 b -0.58 or 2.58
 c -2.58 or 0.58

3 a 4, 2 b 11, -3 c 4, -16
 d 2, -7 e $-\frac{3}{2}, -1$ f $\frac{1}{2}, \frac{3}{2}$

g -3, 8 h $-\frac{2}{3}, -\frac{3}{2}$ i $-\frac{3}{2}, 2$

j $\frac{5}{6}, 3$ k $-\frac{3}{2}, 3$ l $\frac{1}{2}, \frac{3}{5}$

m $-\frac{3}{4}, \frac{2}{3}$ n $\frac{1}{2}$ o -5, 1

p 0, 3 q -5, -3 r $\frac{1}{5}, 2$

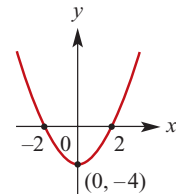
4 4 and 9 5 3 6 2, $2\frac{3}{8}$

7 13 8 50 9 6 cm, 2 cm

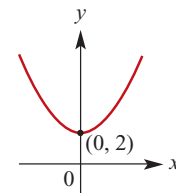
10 5 11 \$90, \$60 12 42

Exercise 4D

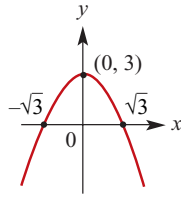
a i (0, -4)
 ii $x = 0$
 iii (-2, 0), (2, 0)



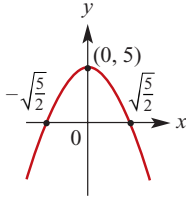
b i (0, 2)
 ii $x = 0$
 iii none



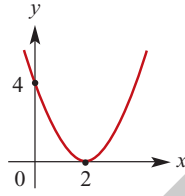
- c** **i** (0, 3)
ii $x = 0$
iii $(-\sqrt{3}, 0), (\sqrt{3}, 0)$



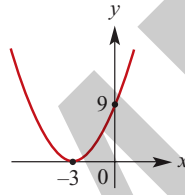
- d** **i** (0, 5)
ii $x = 0$
iii $(-\sqrt{\frac{5}{2}}, 0), (\sqrt{\frac{5}{2}}, 0)$



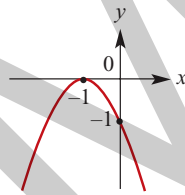
- e** **i** (2, 0)
ii $x = 2$
iii (2, 0)



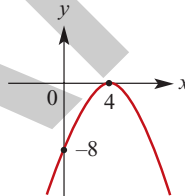
- f** **i** (-3, 0)
ii $x = -3$
iii (-3, 0)



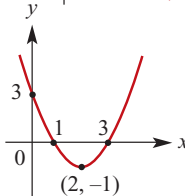
- g** **i** (-1, 0)
ii $x = -1$
iii (-1, 0)



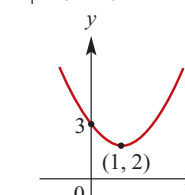
- h** **i** (4, 0)
ii $x = 4$
iii (4, 0)



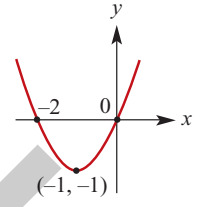
- i** **i** (2, -1)
ii $x = 2$
iii (1, 0)(3, 0)



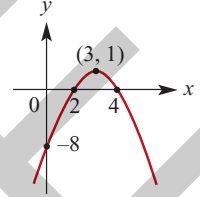
- j** **i** (1, 2)
ii $x = 1$
iii none



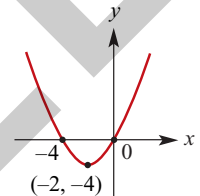
- k** **i** (-1, -1)
ii $x = -1$
iii (-2, 0)(0, 0)



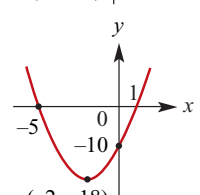
- l** **i** (3, 1)
ii $x = 3$
iii (2, 0)(4, 0)



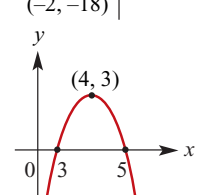
- m** **i** (-2, -4)
ii $x = -2$
iii (-4, 0), (0, 0)



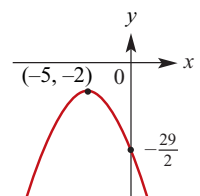
- n** **i** (-2, -18)
ii $x = -2$
iii (-5, 0), (1, 0)



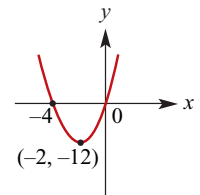
- o** **i** (4, 3)
ii $x = 4$
iii (3, 0), (5, 0)



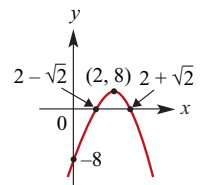
- p** **i** (-5, -2)
ii $x = -5$
iii none



- q** **i** (-2, -12)
ii $x = -2$
iii (0, 0), (-4, 0)



- r** **i** (2, 8)
ii $x = 2$
iii $(2 - \sqrt{2}, 0)(2 + \sqrt{2}, 0)$



Exercise 4E

- 1 a $x^2 - 2x + 1$ b $x^2 + 4x + 4$ c $x^2 - 6x + 9$
 d $x^2 - 6x + 9$ e $x^2 + 4x + 4$ f $x^2 - 10x + 25$
 g $x^2 - x + \frac{1}{4}$ h $x^2 - 3x + \frac{9}{4}$

- 2 a $(x - 2)^2$ b $(x - 6)^2$ c $-(x - 2)^2$
 d $2(x - 2)^2$ e $-2(x - 3)^2$ f $(x - \frac{1}{2})^2$

- g $(x - \frac{3}{2})^2$ h $(x + \frac{5}{2})^2$

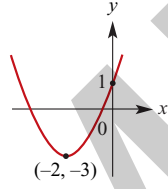
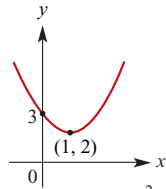
- 3 a $1 \pm \sqrt{2}$ b $2 \pm \sqrt{6}$ c $3 \pm \sqrt{7}$

- d $\frac{5 \pm \sqrt{17}}{2}$ e $\frac{2 \pm \sqrt{2}}{2}$ f $-\frac{1}{3}, 2$

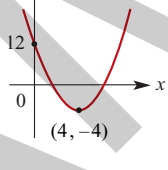
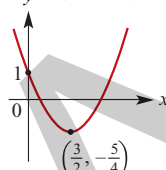
- g $-1 \pm \sqrt{1 - k}$ h $\frac{-1 \pm \sqrt{1 - k^2}}{k}$

- i $\frac{3k \pm \sqrt{9k^2 - 4}}{2}$

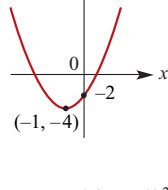
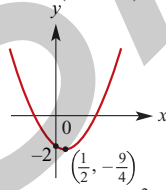
- 4 a $y = (x - 1)^2 + 2$ t. pt (1, 2) b $y = (x + 2)^2 - 3$ t. pt (-2, -3)



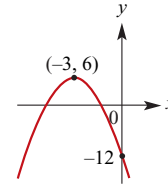
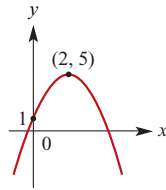
- c $y = (x - \frac{3}{2})^2 - \frac{5}{4}$ t. pt $(\frac{3}{2}, -\frac{5}{4})$ d $y = (x - 4)^2 - 4$ t. pt (4, -4)



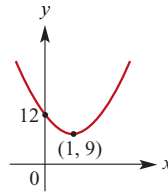
- e $y = (x - \frac{1}{2})^2 - \frac{9}{4}$ t. pt $(\frac{1}{2}, -\frac{9}{4})$ f $y = 2(x + 1)^2 - 4$ t. pt (-1, -4)



- g $y = -(x - 2)^2 + 5$ t. pt (2, 5) h $y = -2(x + 3)^2 + 6$ t. pt (-3, 6)

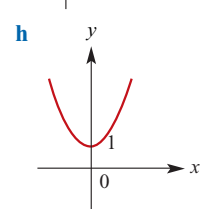
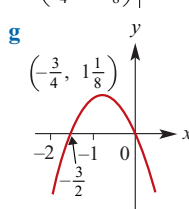
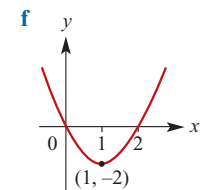
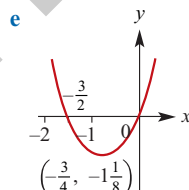
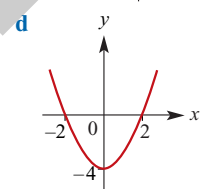
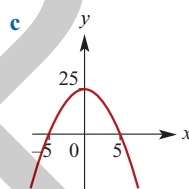
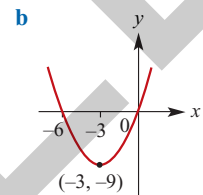
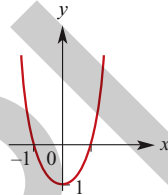


- i $y = 3(x - 1)^2 + 9$ t. pt (1, 9)

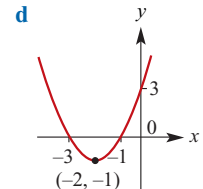
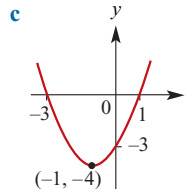
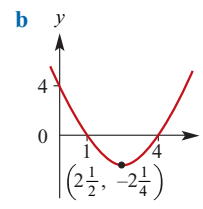
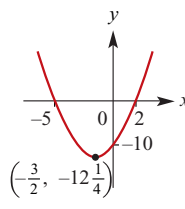


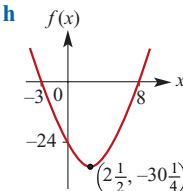
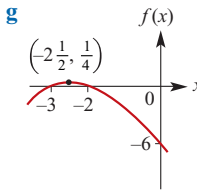
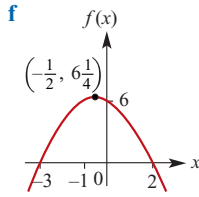
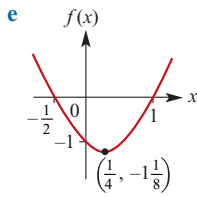
Exercise 4F

- 1 a 7 b 7 c 1
 2 a -2 b 8 c -4
 3 a b



- 4 a $y = (x - \frac{3}{2})^2 - 12\frac{1}{4}$ t. pt $(\frac{3}{2}, -12\frac{1}{4})$ b $y = (x - 2)^2 - 4$ t. pt (2, -4)





Exercise 4G

- 1 **a** i 40 **ii** $2\sqrt{10}$ **b** i 28 **ii** $2\sqrt{7}$
c i 172 **ii** $2\sqrt{43}$ **d** i 96 **ii** $4\sqrt{6}$
e i 189 **ii** $3\sqrt{21}$

2 **a** $1 + \sqrt{5}$ **b** $\frac{3 - \sqrt{5}}{2}$

c $\frac{1 + \sqrt{5}}{2}$ **d** $1 + 2\sqrt{2}$

3 **a** $-3 \pm \sqrt{13}$ **b** $\frac{7 \pm \sqrt{61}}{2}$ **c** $\frac{1}{2}, 2$

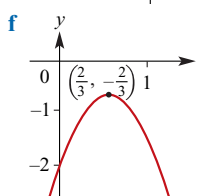
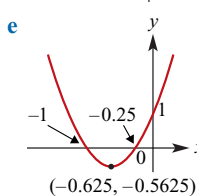
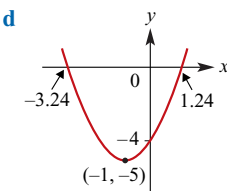
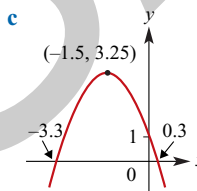
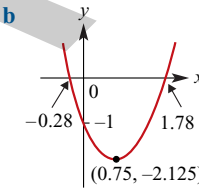
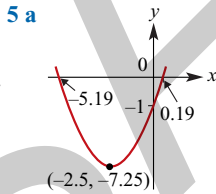
d $-1 \pm \frac{3}{2}\sqrt{2}$ **e** $-2 \pm \frac{3}{2}\sqrt{2}$ **f** $1 \pm \frac{\sqrt{30}}{5}$

g $1 \pm \frac{\sqrt{2}}{2}$ **h** $1, -\frac{3}{2}$ **i** $\frac{-3 \pm \sqrt{6}}{5}$

j $\frac{-13 \pm \sqrt{145}}{12}$ **k** $\frac{2 \pm \sqrt{4 - 2k^2}}{2k}$

l $\frac{2k \pm \sqrt{6k^2 - 2k}}{2(1 - k)}$

4 $r = 2.16$ m



Exercise 4H

- a** 1.5311 **b** -1.1926 **c** 1.8284 **d** 1.4495

Exercise 4I

- 1 **a** 20 **b** -12 **c** 25 **d** 41 **e** 41
2 **a** Crosses the x -axis **b** Does not cross
c Just touches the x -axis
d Crosses the x -axis **e** Does not cross
f Does not cross
3 **a** 2 real roots **b** No real roots **c** 2 real roots
d 2 real roots **e** 2 real roots **f** No real roots
4 **a** $\Delta = 0$, one rational root
b $\Delta = 1$, two rational roots
c $\Delta = 17$, two irrational roots
d $\Delta = 0$, one rational root
e $\Delta = 57$, two irrational roots
f $\Delta = 1$, two rational roots
5 The discriminant $= (m + 4)^2 \geq 0$ for all m , therefore rational solution(s).

Exercise 4J

- 1 **a** $\{x : x \geq 2\} \cup \{x : x \leq -4\}$
b $\{x : -3 < x < 8\}$ **c** $\{x : -2 \leq x \leq 6\}$
d $\{x : x > 3\} \cup \{x : x < -\frac{3}{2}\}$
e $\{x : -\frac{3}{2} < x < -\frac{2}{3}\}$ **f** $\{x : -3 \leq x \leq -2\}$
g $\{x : x > \frac{2}{3}\} \cup \{x : x < -\frac{3}{4}\}$
h $\{x : \frac{1}{2} \leq x \leq \frac{3}{5}\}$ **i** $\{x : -4 \leq x \leq 5\}$
j $\left\{p : \frac{1}{2}(5 - \sqrt{41}) \leq p \leq \frac{1}{2}(5 + \sqrt{41})\right\}$
k $\{y : y < -1\} \cup \{y : y > 3\}$
l $\{x : x \leq -2\} \cup \{x : x \geq -1\}$
2 **a** **i** $-\sqrt{5} < m < \sqrt{5}$ **ii** $m = \pm\sqrt{5}$
iii $m > \sqrt{5}$ or $m < -\sqrt{5}$
b **i** $0 < m < \frac{4}{3}$ **ii** $m = \frac{4}{3}$
iii $m > \frac{4}{3}$ or $m < 0$
c **i** $-\frac{4}{5} < m < 0$ **ii** $m = 0$ or $m = -\frac{4}{5}$
iii $m < -\frac{4}{5}$ or $m > 0$
d **i** $-2 < m < 1$ **ii** $m = -2$ or 1
iii $m > 1$ or $m < -2$
3 **p** $> \frac{4}{3}$ **4** $p = \frac{-1}{2}$ **5** $-2 < p < 8$

Exercise 4K

- 1 **a** (2, 0), (-5, 7) **b** (1, -3), (4, 9)
c (1, -3), (-3, 1) **d** (-1, 1), (-3, -3)

$$e \left(\frac{1 + \sqrt{33}}{2}, -3 - \sqrt{33} \right),$$

$$\left(\frac{1 - \sqrt{33}}{2}, -3 + \sqrt{33} \right)$$

$$f \left(\frac{5 + \sqrt{33}}{2}, 23 + 3\sqrt{33} \right),$$

$$\left(\frac{5 - \sqrt{33}}{2}, 23 - 3\sqrt{33} \right)$$

- 2 a Touch at (2, 0) b Touch at (3, 9)
 c Touch at (-2, -4) d Touch at (-4, -8)

3 a $x = 8, y = 16$ and $x = -1, y = 7$

b $x = -\frac{16}{3}, y = 37\frac{1}{3}$ and $x = 2, y = 30$

c $x = \frac{4}{5}, y = 10\frac{2}{5}$ and $x = -3, y = 18$

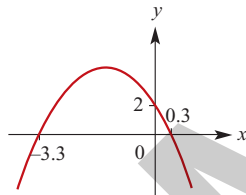
d $x = 10\frac{2}{3}, y = 0$ and $x = 1, y = 29$

e $x = 0, y = -12$ and $x = \frac{3}{2}, y = -7\frac{1}{2}$

f $x = 1.14, y = 14.19$ and $x = -1.68, y = 31.09$

4 a -13

b i



ii $m = -6 \pm \sqrt{32} = -6 \pm 4\sqrt{2}$

5 a $c = \frac{-1}{4}$ b $c > -\frac{1}{4}$

6 $a = 3$ or $a = -1$ 7 $b = 1$

8 $y = (2 + 2\sqrt{3})x - 4 - 2\sqrt{3}$
 and $y = (2 - 2\sqrt{3})x - 4 + 2\sqrt{3}$

Exercise 4L

1 2 2 a = -4, c = 8
 3 a = $\frac{4}{7}$, b = $\frac{-24}{7}$ 4 a = -2, b = 1, c = 6

5 a $y = -\frac{5}{16}x^2 + 5$ b $y = x^2$

c $y = \frac{1}{11}x^2 + \frac{7}{11}x$ d $y = x^2 - 4x + 3$

e $y = -\frac{5}{4}x^2 - \frac{5}{2}x + 3\frac{3}{4}$

f $y = x^2 - 4x + 6$

6 $y = \frac{5}{16}(x + 1)^2 + 3$

7 $y = -\frac{1}{2}(x^2 - 3x - 18)$

8 $y = (x + 1)^2 + 3$ 9 $y = \frac{1}{180}x^2 - x + 75$

10 a C b B c D d A
 11 $y = 2x^2 - 4x$ 12 $y = x^2 - 2x - 1$

13 $y = -2x^2 + 8x - 6$

14 a $y = ax(x - 10), a > 0$

b $y = a(x + 4)(x - 10), a < 0$

c $y = \frac{1}{18}(x - 6)^2 + 6$

d $y = a(x - 8)^2, a < 0$

15 a $y = -\frac{1}{4}x^2 + x + 2$

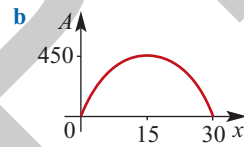
b $y = x^2 + x - 5$

16 $r = -\frac{1}{8}t^2 + 2\frac{1}{2}t - 6\frac{3}{8}$

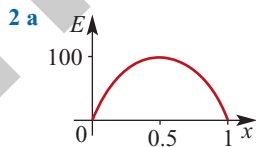
17 a B b D

Exercise 4M

1 a $A = 60x - 2x^2$

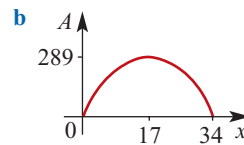


c Maximum area = 450 m²

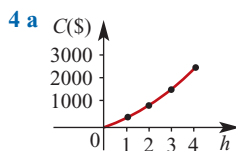


b 0 and 1 c 0.5 d 0.23 and 0.77

3 a $A = 34x - x^2$



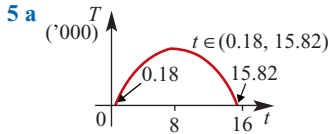
c 289 cm²



The domain depends on the height of the alpine area. For example in Victoria the highest mountain is approx. 2 km high and the minimum alpine height would be approx. 1 km, thus for Victoria, Domain = [1, 2].

b Theoretically no, but of course there is a practical maximum

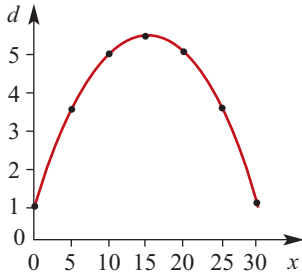
c \$ 1225



b 8874 units

6 a

x	0	5	10	15	20	25	30
d	1	3.5	5	5.5	5	3.5	1



b i 5.5 m

ii $15 - 5\sqrt{7}$ m or $15 + 5\sqrt{7}$ m from the bat

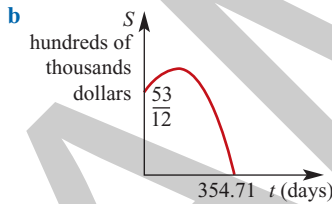
iii 1 m above the ground.

7 a $y = -2x^2 - x + 5$ b $y = 2x^2 - x - 5$

c $y = 2x^2 + \frac{5}{2}x - \frac{11}{2}$

8 a $a = -\frac{16}{15}$, $b = \frac{8}{5}$, $c = 0$

9 a $a = -\frac{7}{21600}$, $b = \frac{41}{400}$, $c = \frac{53}{12}$



c i $S = \$1\,236\,666$ ii $S = \$59\,259$

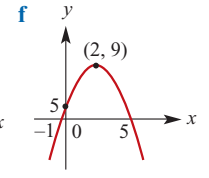
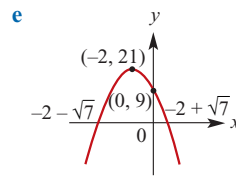
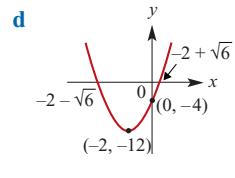
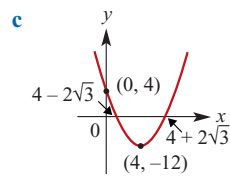
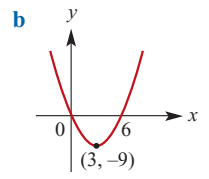
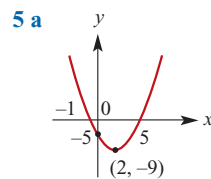
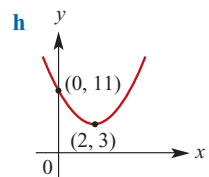
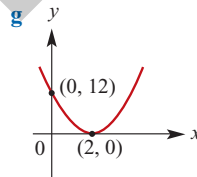
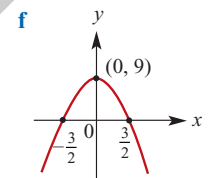
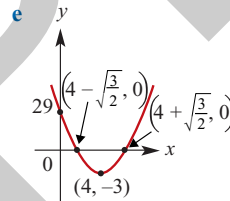
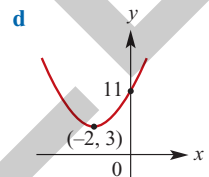
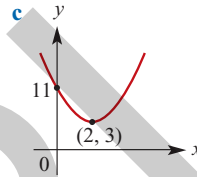
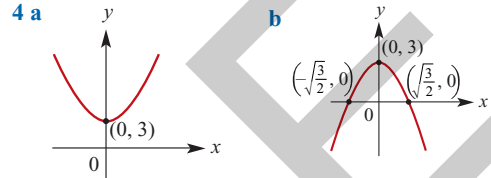
Multiple-choice questions

- 1 A 2 C 3 C 4 E 5 B
6 C 7 E 8 E 9 D 10 A

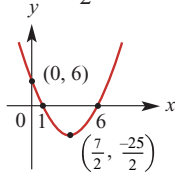
Short-answer questions (technology-free)

- 1 a $(x + \frac{9}{2})^2$ b $(x + 9)^2$ c $(x - \frac{2}{5})^2$
d $(x + b)^2$ e $(3x - 1)^2$ f $(5x + 2)^2$
2 a $-3x + 6$ b $-ax + a^2$ c $49a^2 - b^2$
d $x^2 - x - 12$ e $2x^2 - 5x - 12$ f $x^2 - y^2$
g $a^3 - b^3$ h $6x^2 + 8xy + 2y^2$ i $3a^2 - 5a - 2$
j $4xy$ k $2u + 2v - uv$ l $-3x^2 + 15x - 12$

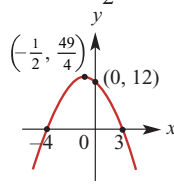
- 3 a $4(x - 2)$ b $x(3x + 8)$ c $3x(8a - 1)$
d $(2 - x)(2 + x)$ e $a(u + 2v + 3w)$
f $a^2(2b - 3a)(2b + 3a)$ g $(1 - 6ax)(1 + 6ax)$
h $(x + 4)(x - 3)$ i $(x + 2)(x - 1)$
j $(2x - 1)(x + 2)$ k $(3x + 2)(2x + 1)$
l $(3x + 1)(x - 3)$ m $(3x - 2)(x + 1)$
n $(3a - 2)(2a + 1)$ o $(3x - 2)(2x - 1)$



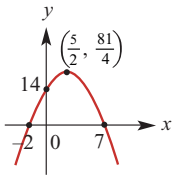
6 a ii $x = \frac{7}{2}$



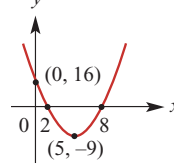
b ii $x = -\frac{1}{2}$



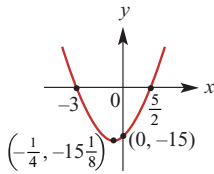
c ii $x = \frac{5}{2}$



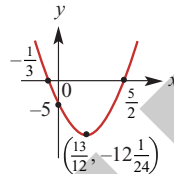
d ii $x = 5$



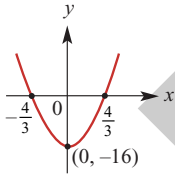
e ii $x = -\frac{1}{4}$



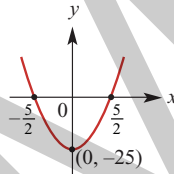
f ii $x = \frac{13}{12}$



g ii $x = 0$



h ii $x = 0$



7 a $-0.55, -5.45$

b $-1.63, -7.37$

c $3.414, 0.586$

d $-0.314, -3.186$

e $-0.719, -2.781$

f $0.107, -3.107$

8 $y = \frac{5}{3}x(x - 5)$

9 $y = 3(x - 5)^2 + 2$

10 $y = 5(x - 1)^2 + 5$

11 a $(3, 9), (-1, 1)$

b $(-1.08, 2.34), (5.08, 51.66)$

c $(0.26, 2), (-2.6, 2)$

d $(\frac{1}{2}, \frac{1}{2}), (-2, 8)$

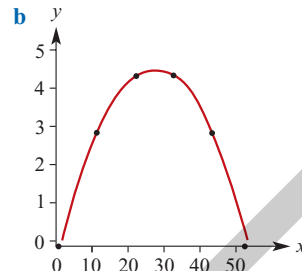
12 a $m = \pm\sqrt{8} = \pm 2\sqrt{2}$

b $m \leq -\sqrt{5}$ or $m \geq \sqrt{5}$

c $b^2 - 4ac = 16 > 0$

Extended-response questions

1 a $y = -0.0072x(x - 50)$



c 10.57 m and 39.43 m

$(25 - \frac{25\sqrt{3}}{3} \text{ m and } 25 + \frac{25\sqrt{3}}{3} \text{ m})$

d 3.2832 m

e 3.736 m (correct to 3 decimal places)

2 a Width of rectangle = $\frac{12 - 4x}{6}$ m, length of rectangle = $\frac{12 - 4x}{3}$ m

b $A = \frac{17}{9}x^2 - \frac{16}{3}x + 8$

c Length for square = $\frac{96}{17}$ m and length for rectangle = $\frac{108}{17}$ m ($\approx 5.65 \times 6.35$ m)

3 a $V = 0.72x^2 - 1.2x$

b 22 hours

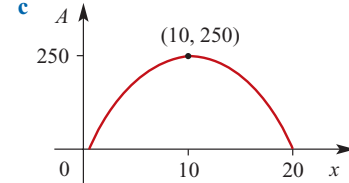
4 a $V = 10\,800x + 120x^2$

b $V = 46.6x^2 + 5000x$

c $l = 55.18$ m

5 a $l = 50 - \frac{5x}{2}$

b $A = 50x - \frac{5}{2}x^2$



d Maximum area = 250 m² when $x = 10$ m

6 $x = \frac{-1 + \sqrt{5}}{2}$

7 a $\sqrt{25 + x^2}$

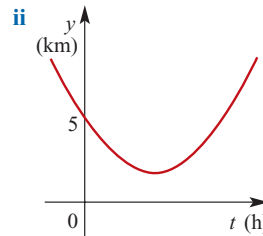
b i $16 - x$ ii $\sqrt{x^2 - 32x + 265}$

c 7.5

d 10.840

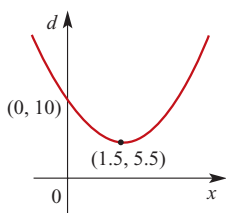
e 12.615

8 a i $y = \sqrt{64t^2 + 100(t - 0.5)^2}$
 $= \sqrt{164t^2 - 100t + 25}$



- iii $t = \frac{1}{2}$; 1.30 pm $t = \frac{9}{82}$; 1.07 pm
- iv 0.305; 1.18 pm; distance 3.123 km
- b i $0, \frac{25}{41}$ ii $\frac{25 \pm 2\sqrt{269}}{82}$

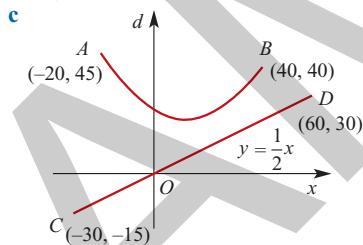
- 9 b $2x + 2y = b$
- c $8x^2 - 4bx + b^2 - 16a^2 = 0$
- e i $x = 6 \pm \sqrt{14}, y = 6 \mp \sqrt{14}$
- ii $x = y = \sqrt{2}a$
- f $x = \frac{(5 \pm \sqrt{7})a}{4}, y = \frac{(5 \mp \sqrt{7})a}{4}$
- 10 a $b = -2, c = 4, h = 1$
- b i $(x, -6 + 4x - x^2)$ ii $(x, x - 1)$
- iii $(0, -1) (1, 0) (2, 1) (3, 2) (4, 3)$
- iv $y = x - 1$
- c i $d = 2x^2 - 6x + 10$



iii min value of $d = 5.5$ occurs when $x = 1.5$

- 11 a $45\sqrt{5}$
- b i $y = \frac{1}{600}(7x^2 - 190x + 20400)$

ii $\left(\frac{190}{14}, \frac{5351}{168}\right)$

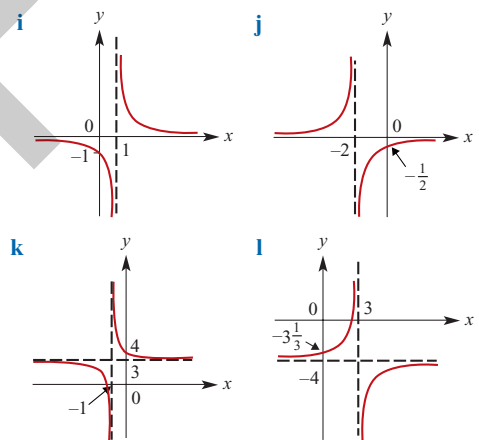
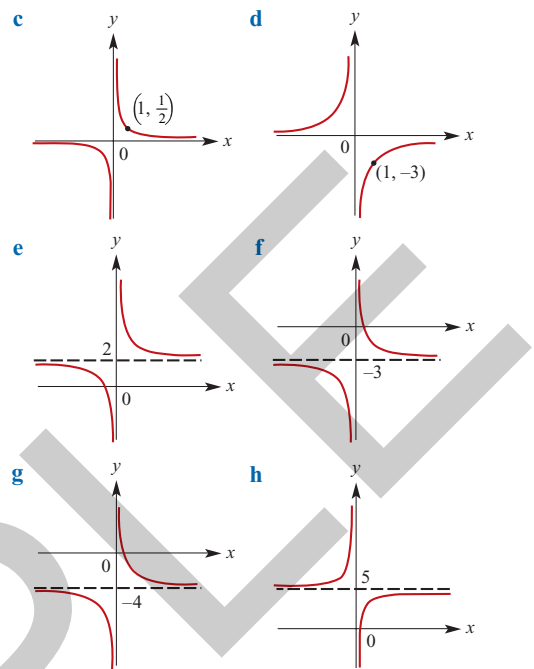
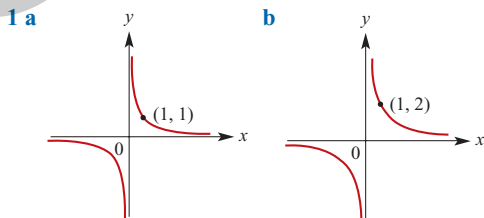


d i The distance (measured parallel to the y -axis) between path and pond.

ii minimum value = $\frac{473}{24}$ when $x = 35$

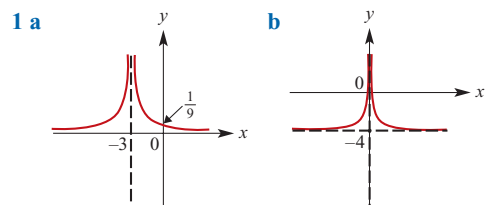
Chapter 5

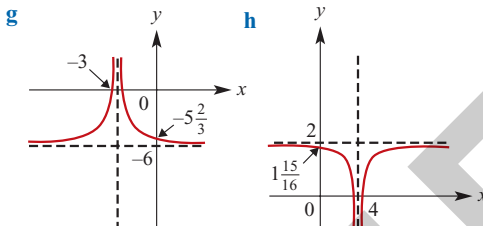
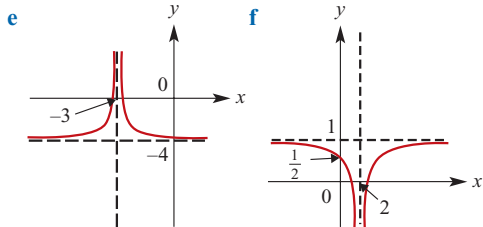
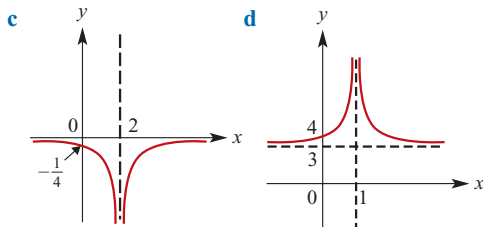
Exercise 5A



- 2 a $y = 0, x = 0$ b $y = 0, x = 0$
- c $y = 0, x = 0$ d $y = 0, x = 0$
- e $y = 2, x = 0$ f $y = -3, x = 0$
- g $y = -4, x = 0$ h $y = 5, x = 0$
- i $y = 0, x = 1$ j $y = 0, x = -2$
- k $y = 3, x = -1$ l $y = -4, x = 3$

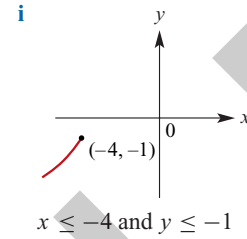
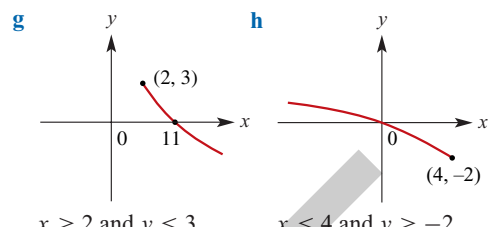
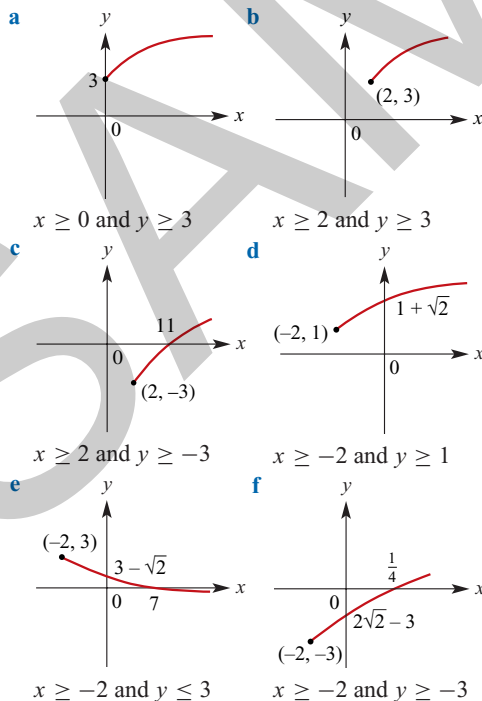
Exercise 5B





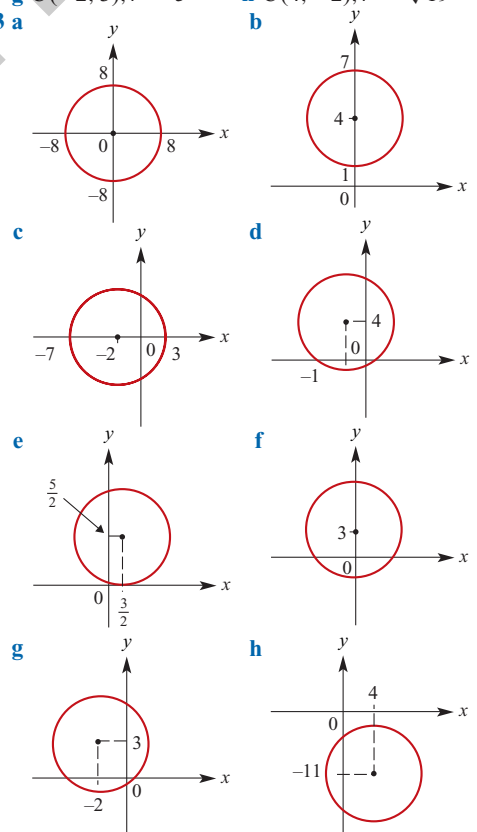
- 2 a** $y = 0, x = -3$ **b** $y = -4, x = 0$
c $y = 0, x = 2$ **d** $y = 3, x = 1$
e $y = -4, x = -3$ **f** $y = 1, x = 2$
g $y = -6, x = -3$ **h** $y = 2, x = 4$

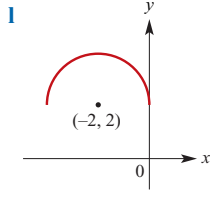
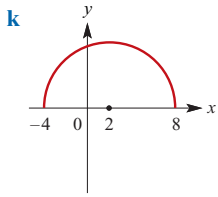
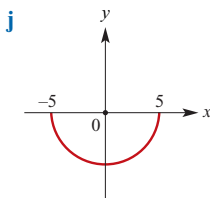
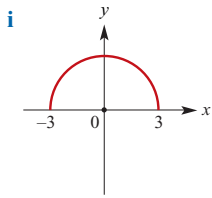
Exercise 5C



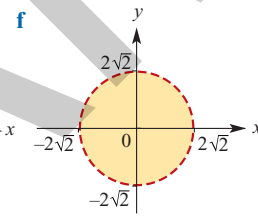
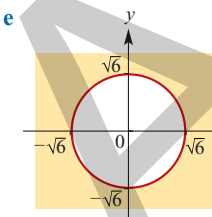
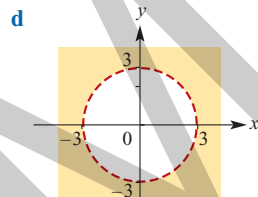
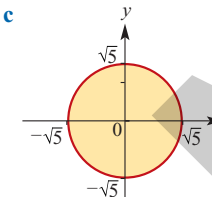
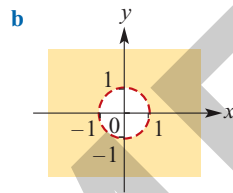
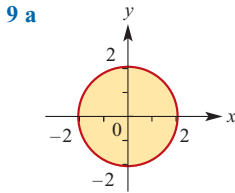
Exercise 5D

- 1 a** $x^2 + y^2 = 9$ **b** $x^2 + y^2 = 16$
c $(x - 1)^2 + (y - 3)^2 = 25$
d $(x - 2)^2 + (y + 4)^2 = 9$
e $(x + 3)^2 + (y - 4)^2 = \frac{25}{4}$
f $(x + 5)^2 + (y + 6)^2 = (4.6)^2$
- 2 a** $C(1, 3), r = 2$ **b** $C(2, -4), r = \sqrt{5}$
c $C(-3, 2), r = 3$ **d** $C(0, 3), r = 5$
e $C(-3, -2), r = 6$ **f** $C(3, -2), r = 2$
g $C(-2, 3), r = 5$ **h** $C(4, -2), r = \sqrt{19}$
- 3 a**





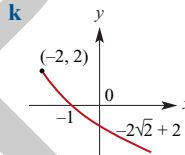
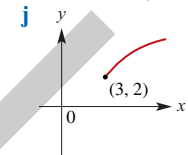
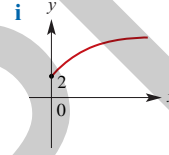
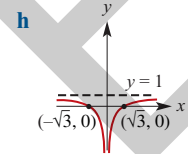
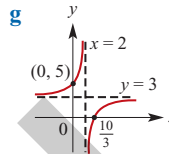
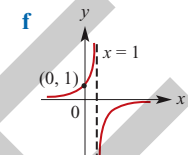
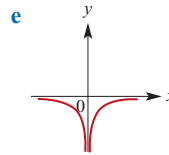
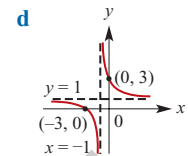
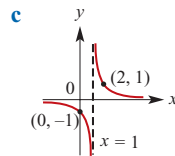
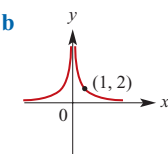
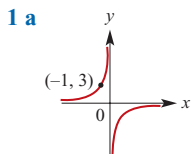
- 4** $(x - 2)^2 + (y + 3)^2 = 9$
5 $(x - 2)^2 + (y - 1)^2 = 20$
6 $(x - 4)^2 + (y - 4)^2 = 20$
7 Centre $(-2, 3)$, radius = 6
8 $2\sqrt{21}$ (x-axis), $4\sqrt{6}$ (y-axis)



Multiple-choice questions

- 1** E **2** B **3** E **4** A **5** A
6 D **7** D **8** C **9** E **10** B

Short-answer questions (technology-free)



2 a $(x - 3)^2 + (y + 2)^2 = 25$

b $(x - \frac{3}{2})^2 + (y + \frac{5}{2})^2 = \frac{50}{4}$

c $(x - \frac{1}{4})^2 + (y + \frac{1}{4})^2 = \frac{17}{8}$

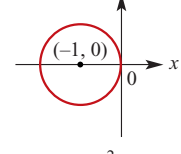
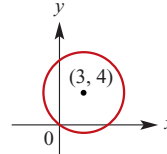
d $(x + 2)^2 + (y - 3)^2 = 13$

e $(x - 3)^2 + (y - 3)^2 = 18$

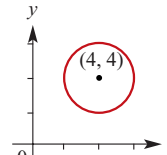
f $(x - 2)^2 + (y + 3)^2 = 13$

3 $2y + 3x = 0$ **4** $2x + 2y = 1$ or $y = x - \frac{5}{2}$

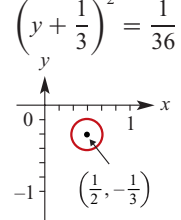
5 a $(x - 3)^2 + (y - 4)^2 = 25$ **b** $(x + 1)^2 + y^2 = 1$

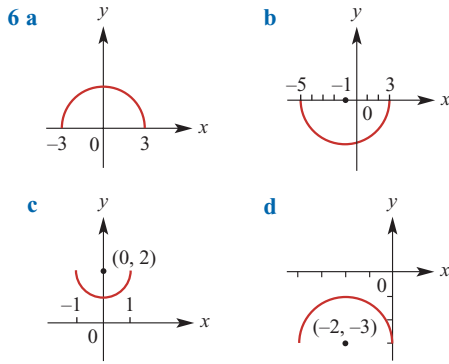


c $(x - 4)^2 + (y - 4)^2 = 4$



d $(x - \frac{1}{2})^2 + (y + \frac{1}{3})^2 = \frac{1}{36}$





Extended-response questions

1 a $(x - 10)^2 + y^2 = 25$ c $m = \pm \frac{\sqrt{3}}{3}$

d $P\left(\frac{15}{2}, \pm \frac{5\sqrt{3}}{2}\right)$ e $5\sqrt{3}$

2 a $x^2 + y^2 = 16$

b ii $m = \pm \frac{\sqrt{3}}{3}; y = \frac{\sqrt{3}}{3}x - \frac{8\sqrt{3}}{3},$
 $y = -\frac{\sqrt{3}}{3}x + \frac{8\sqrt{3}}{3}$

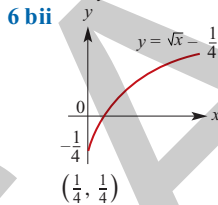
3 a $\frac{4}{3}$ b $-\frac{3}{4}$ c $4y + 3x = 25$ d $\frac{125}{12}$

4 a i $\frac{y_1}{x_1}$ ii $-\frac{x_1}{y_1}$

c $\sqrt{2}x + \sqrt{2}y = 8$ or $\sqrt{2}x + \sqrt{2}y = -8$

5 a $y = \frac{-\sqrt{3}}{3}x + \frac{2\sqrt{3}}{3}a, y = \frac{\sqrt{3}}{3}x - \frac{2\sqrt{3}}{3}a$

b $x^2 + y^2 = 4a^2$



c i $\frac{-1}{4} < k < 0$ ii $k = 0$ or $k < \frac{-1}{4}$

iii $k > 0$

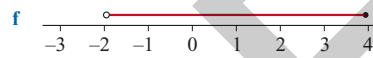
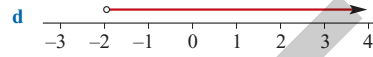
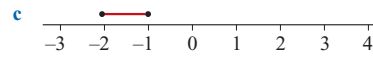
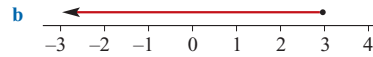
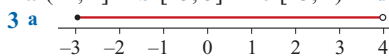
7 a $0 < k < \frac{1}{4}$ b $k = \frac{1}{4}$ or $k \leq 0$

Chapter 6

Exercise 6A

- 1 a $\{7, 11\}$ b $\{7, 11\}$
 c $\{1, 2, 3, 5, 7, 11, 15, 25, 30, 32\}$
 d $\{1, 2, 3, 5, 15\}$ e $\{1\}$ f $\{1, 7, 11\}$

2 a $(-2, 1]$ b $[-3, 3]$ c $[-3, 2)$ d $(-1, 2)$

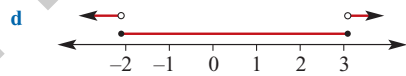
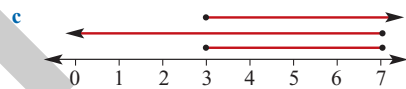
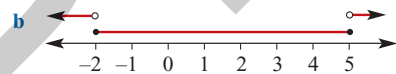
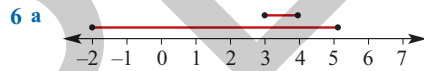


4 a $[-1, 2]$ b $(-4, 2]$ c $(0, \sqrt{2})$

d $\left(-\frac{\sqrt{3}}{2}, \frac{1}{\sqrt{2}}\right]$ e $(-1, \infty)$ f $(-\infty, -2]$

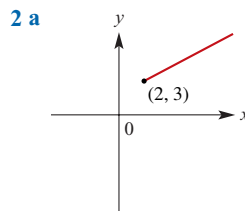
g $(-\infty, \infty)$ h $[0, \infty)$ i $(-\infty, 0]$

5 a $\{1, 7\}$ b $\{7\}$
 c B , i.e. $\{7, 11, 25, 30, 32\}$ d $(2, \infty)$

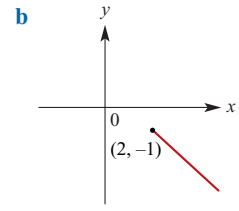


Exercise 6B

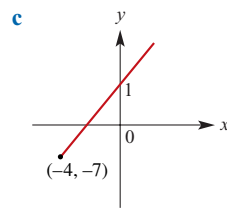
- 1 a Domain = $[-2, 2]$, Range = $[-1, 2]$
 b Domain = $[-2, 2]$, Range = $[-2, 2]$
 c Domain = R , Range = $[-1, \infty)$
 d Domain = R , Range = $(-\infty, 4]$



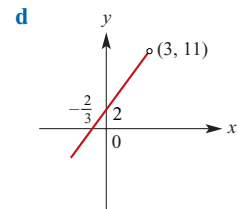
Range = $[3, \infty)$



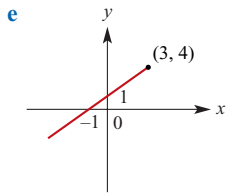
Range = $(-\infty, -1]$



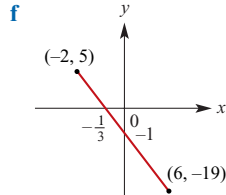
Range = $[-7, \infty)$



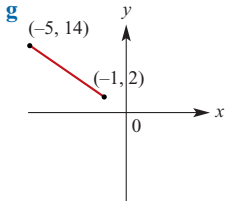
Range = $(-\infty, 11)$



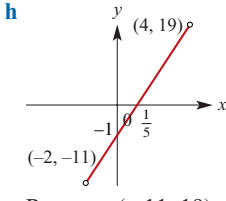
Range = $(-\infty, 4]$



Range = $[-19, 5]$

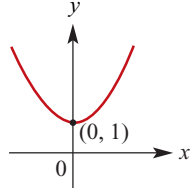


Range = $[2, 14]$

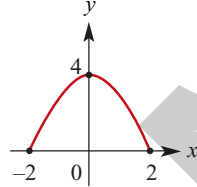


Range = $(-11, 19)$

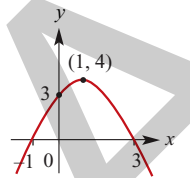
3 a Range = $[1, \infty)$



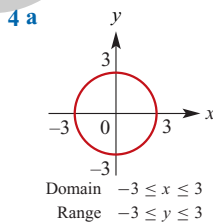
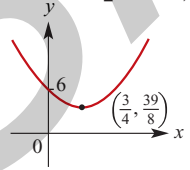
c Range = $[0, 4]$



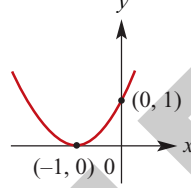
e Range = $(-\infty, 4]$



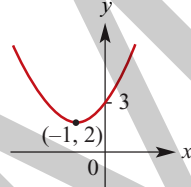
g Range = $\left[\frac{39}{8}, \infty\right)$



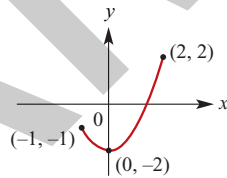
b Range = $[0, \infty)$



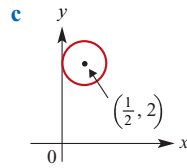
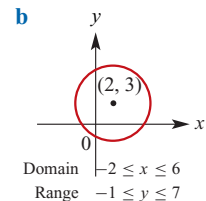
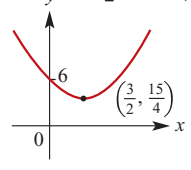
d Range = $[2, \infty)$



f Range = $[-2, 2]$

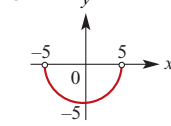


h Range = $\left[\frac{15}{4}, \infty\right)$

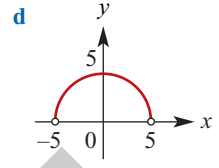


Domain $0 \leq x \leq 1$

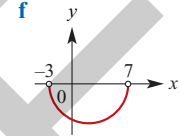
Range $\frac{1}{2} \leq y \leq 2\frac{1}{2}$



Domain $-5 \leq x \leq 5$
Range $-5 \leq y \leq 0$

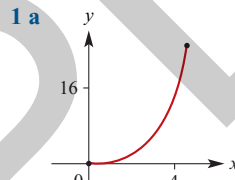


Domain $-5 \leq x \leq 5$
Range $0 \leq y \leq 5$

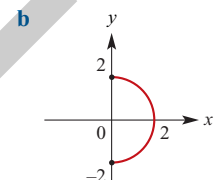


Domain $-3 \leq x \leq 7$
Range $-5 \leq y \leq 0$

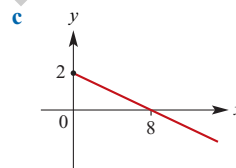
Exercise 6C



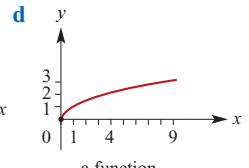
a function
Domain = $[0, 4]$
Range = $[0, 16]$



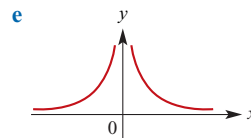
not a function
Domain = $[0, 2]$
Range = $[-2, 2]$



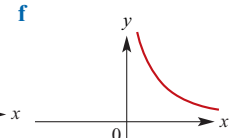
a function
Domain = $[0, \infty)$
Range = $(-\infty, 2]$



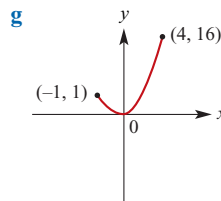
a function
Domain = $\{x : x \geq 0\}$
Range = $\{y : y \geq 0\}$



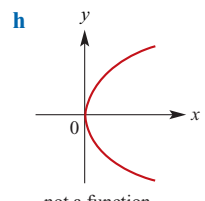
a function
Domain = $\mathbb{R} \setminus \{0\}$
Range = \mathbb{R}^+



a function
Domain = \mathbb{R}^+
Range = \mathbb{R}^+



a function
Domain = $[-1, 4]$
Range = $[0, 16]$



not a function
Domain = $[0, \infty)$
Range = \mathbb{R}

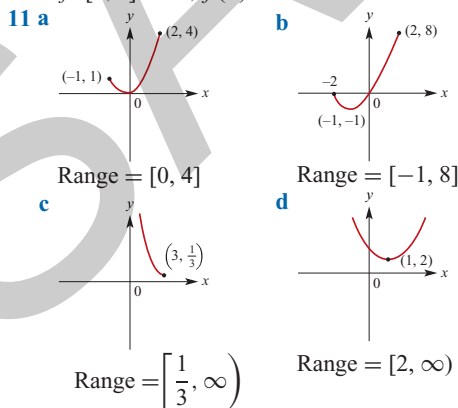
- 2 a Not a function, Domain = $\{0, 1, 2, 3\}$;
Range = $\{1, 2, 3, 4\}$
 b A function, Domain = $\{-2, -1, 0, 1, 2\}$;
Range = $\{-5, -2, -1, 2, 4\}$
 c Not a function, Domain = $\{-1, 0, 3, 5\}$;
Range = $\{1, 2, 4, 6\}$
 d A function, Domain = $\{1, 2, 4, 5, 6\}$;
Range = $\{3\}$
 e A function, Domain = R ; Range = $\{-2\}$
 f Not a function, Domain = $\{3\}$; Range = Z
 g A function, Domain = R ; Range = R
 h A function, Domain = R ; Range = $[5, \infty)$
 i Not a function, Domain = $[-3, 3]$;
Range = $[-3, 3]$

- 3 a i -3 ii 5 iii $\frac{5}{4}$ iv 9
 b i 4 ii -4 iii $\frac{3}{4}$ iv 2
 c i 4 ii 36 iii 36 iv $(a-2)^2$
 d i 0 ii $\frac{a}{1+a}$ iii $\frac{-a}{1-a}$ iv $1-a$

- 4 a 1 b $\frac{1}{6}$ c ± 3 d -1, 4 e -1, 3 f -2, 3
 5 a $g(-1)^6 = -1$, $g(2) = 8$, $g(-2) = 0$
 b $h(-1) = 3$, $h(2) = 18$, $h(-2) = -14$
 c i $g(-3x) = 9x^2 - 6x$
 ii $g(x-5) = x^2 - 8x + 15$
 iii $h(-2x) = -16x^3 - 4x^2 + 6$
 iv $g(x+2) = x^2 + 6x + 8$
 v $h(x^2) = 2x^6 - x^4 + 6$

- 6 a $f(2) = 5$; $f(-4) = 29$ b Range = $[-3, \infty)$
 7 a $f(2) = 7$ b $x = 2$ c $x = -1$
 8 a 2 b ± 1 c $x = \pm\sqrt{3}$
 9 a $x = -1$ b $x > -1$ c $x = -\frac{6}{7}$

- 10 a $f: R \rightarrow R$, $f(x) = 3x + 2$
 b $f: R \rightarrow R$, $f(x) = -\frac{3}{2}x + 6$
 c $f: [0, \infty) \rightarrow R$, $f(x) = 2x + 3$
 d $f: [-1, 2] \rightarrow R$, $f(x) = 5x + 6$
 e $f: [-5, 5] \rightarrow R$, $f(x) = -x^2 + 25$
 f $f: [0, 1] \rightarrow R$, $f(x) = 5x - 7$

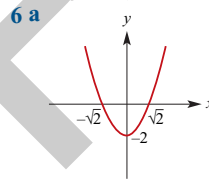


Exercise 6D

- 1 One-to-one functions are **b, d, e** and **g**
 2 Functions are **a, c, d, f** and **g**. One-to-one functions are **c** and **g**.

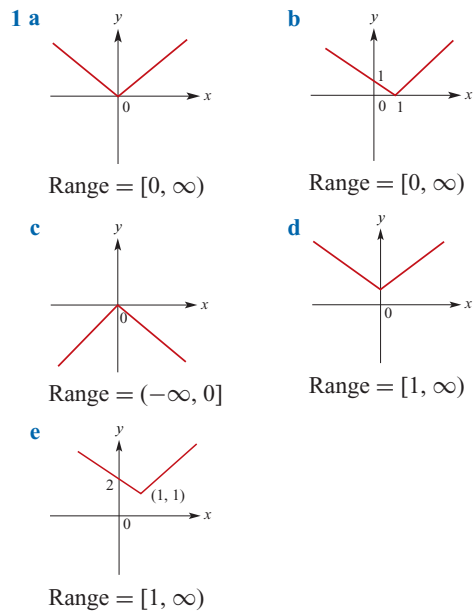
- 3 a Domain = R , Range = R
 b Domain = $R^+ \cup \{0\}$, Range = $R^+ \cup \{0\}$
 c Domain = R , Range = $[1, \infty)$
 d Domain = $[-3, 3]$, Range = $[-3, 0]$
 e Domain = R^+ , Range = R^+
 f Domain = R , Range = $(-\infty, 3]$
 g Domain = $[2, \infty)$, Range = $R^+ \cup \{0\}$
 h Domain = $[\frac{1}{2}, \infty)$, Range = $[0, \infty)$
 i Domain = $(-\infty, \frac{3}{2}]$, Range = $[0, \infty)$
 j Domain = $R \setminus \{\frac{1}{2}\}$, Range = $R \setminus \{0\}$
 k Domain = $R \setminus \{\frac{1}{2}\}$, Range = $(-3, \infty)$
 l Domain = $R \setminus \{\frac{1}{2}\}$, Range = $R \setminus \{2\}$
 4 a Domain = R , Range = R
 b Domain = R , Range = $[2, \infty)$
 c Domain = $[-4, 4]$, Range = $[-4, 0]$
 d Domain = $R \setminus \{-2\}$, Range = $R \setminus \{0\}$

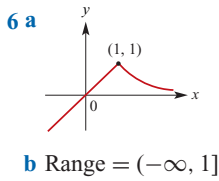
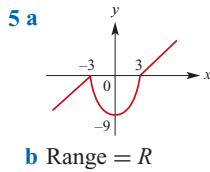
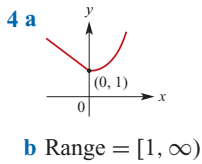
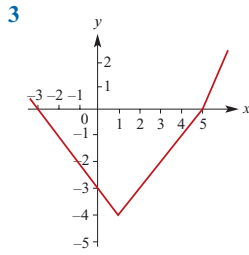
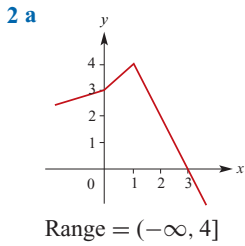
- 5 $y = \sqrt{2-x}$, Domain = $(-\infty, 2]$,
Range = $R^+ \cup \{0\}$
 $y = -\sqrt{2-x}$, Domain = $(-\infty, 2]$,
Range = $(-\infty, 0]$



- b $f_1: [0, \infty) \rightarrow R$, $f_1(x) = x^2 - 2$,
 $f_2: (-\infty, 0] \rightarrow R$, $f_2(x) = x^2 - 2$

Exercise 6E



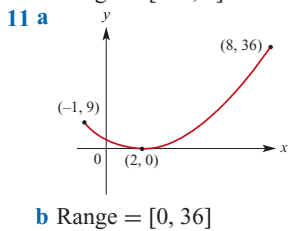
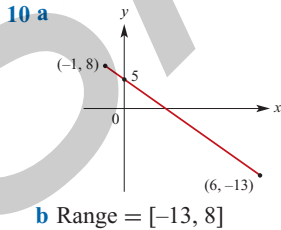


7

$$f(x) = \begin{cases} x + 3, & -3 \leq x \leq -1 \\ -x + 1, & -1 < x \leq 2 \\ -\frac{1}{2}x, & 2 \leq x \leq 4 \end{cases}$$

Exercise 6F

- 1 a** $a = -3, b = \frac{1}{2}$ **b** 6
2 $f(x) = 7 - 5x$
3 a i $f(0) = -\frac{9}{2}$ **ii** $f(1) = -3$
b 3
4 a $f(p) = 2p + 5$ **b** $f(p + h) = 2p + 2h + 5$
c $2h$ **d** 2
5 -2
6 b i 25.06 **ii** 25.032 **iii** 25.2 **iv** 26
7 $f(x) = -7(x - 2)(x - 4)$
8 $f(x) = (x - 3)^2 + 7$, Range = $[7, \infty)$
9 a $(-\infty, -\frac{15}{8}]$ **b** $[\frac{7}{8}, \infty)$
c $(-\infty, 20]$ **d** $(-\infty, 3]$



- 12 a** Domain $-3 \leq x \leq 3$ **b** Domain $1 \leq x \leq 3$
 Range $-3 \leq y \leq 3$ Range $-1 \leq y \leq 1$
c Domain $0 \leq x \leq 1$ **d** Domain $-1 \leq x \leq 9$
 Range $0 \leq y \leq 1$ Range $-5 \leq y \leq 5$
e Domain $-4 \leq x \leq 4$
 Range $-2 \leq y \leq 6$

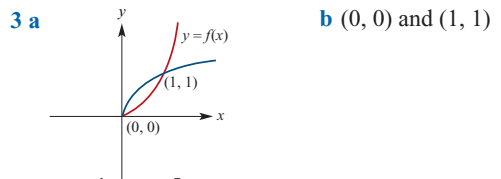
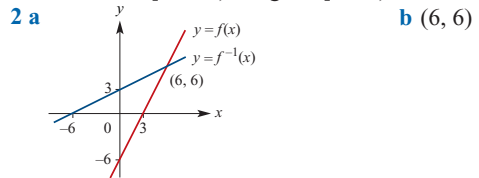
- 13 a** $\{2, 4, 6, 8\}$ **b** $\{4, 3, 2, 1\}$
c $\{-3, 0, 5, 12\}$ **d** $\{1, \sqrt{2}, \sqrt{3}, 2\}$
14 $f(x) = \frac{1}{10}(x - 4)(x - 5)$; $a = \frac{1}{10}, b = -\frac{9}{10}, c = 2$

15 $f(x) = -2(x - 1)(x + 5)$
 $g(x) = -50(x - 1)\left(x + \frac{1}{5}\right)$

16 a $k < \frac{-37}{12}$ **b** $k = -\frac{25}{12}$

Exercise 6G

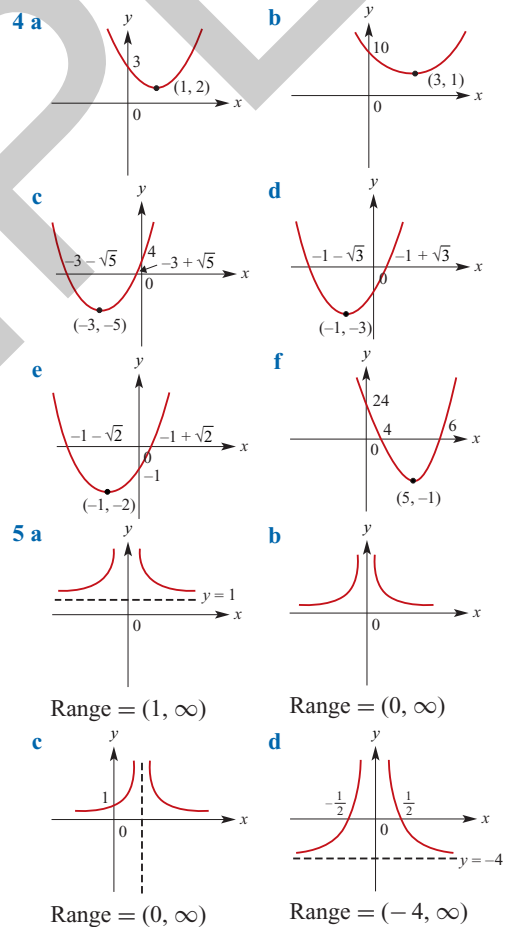
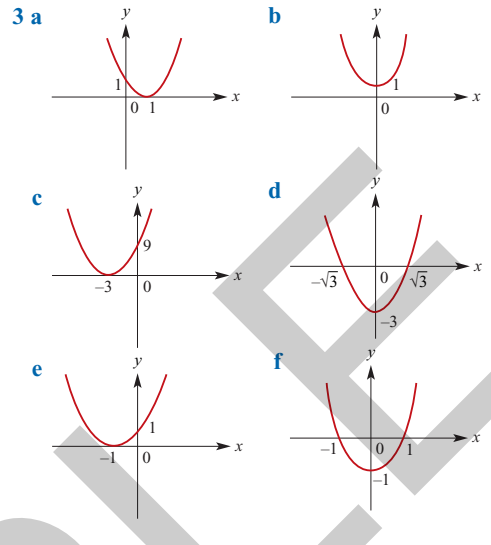
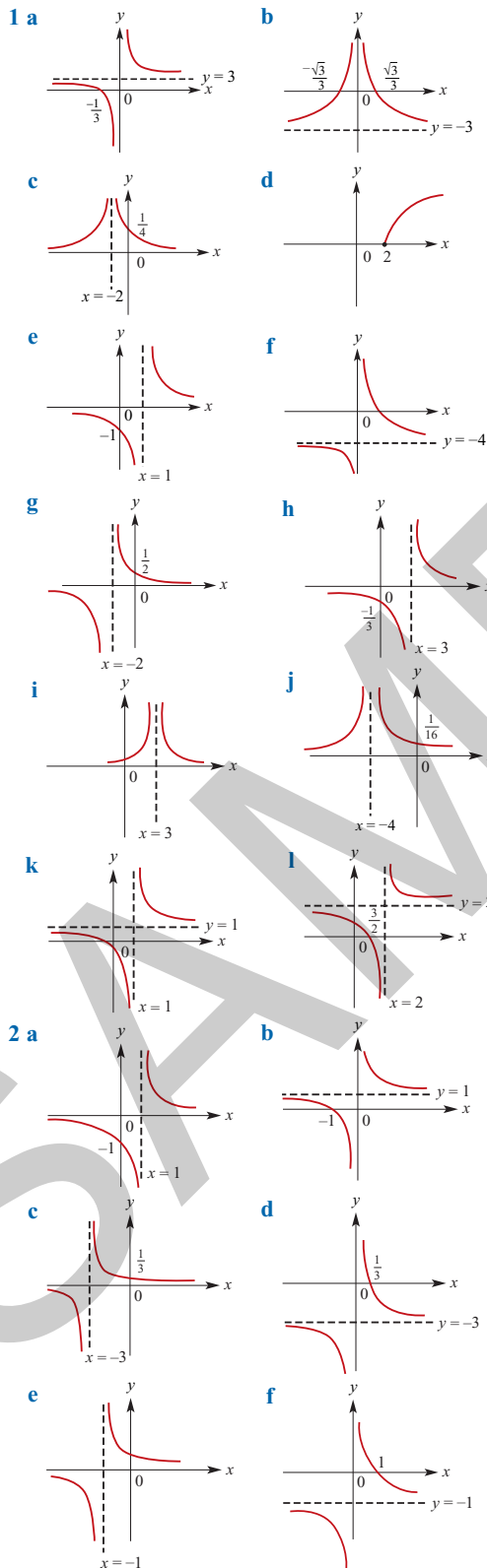
- 1 a** $\{(3, 1)(6, -2)(5, 4)(1, 7)\}$; domain = $\{3, 6, 5, 1\}$; range = $\{1, -2, 4, 7\}$.
b $f^{-1}(x) = \frac{6-x}{2}$; domain = R , range = R
c $f^{-1}(x) = 3 - x$ domain = $[-2, 2]$, range = $[1, 5]$
d $f^{-1}(x) = x - 4$ domain = $[4, \infty)$, range = R^+
e $f^{-1}(x) = x - 4$ domain = $(-\infty, 8]$, range = $(-\infty, 4]$
f $f^{-1}(x) = \sqrt{x}$; domain = $R^+ \cup \{0\}$, range = $R^+ \cup \{0\}$
g $f^{-1}(x) = 2 + \sqrt{x - 3}$; domain = $[3, \infty)$, range = $[2, \infty)$
h $f^{-1}(x) = 4 - \sqrt{x - 6}$; domain = $[6, \infty)$, range = $(-\infty, 4]$
i $f^{-1}(x) = 1 - x^2$; domain = $[0, 1]$, range = $[0, 1]$
j $f^{-1}(x) = \sqrt{16 - x^2}$; domain = $[0, 4]$, range = $[0, 4]$
k $f^{-1}(x) = \frac{16-x}{2}$; domain = $[2, 18]$, range = $[-1, \frac{7}{2}]$
l $f^{-1}(x) = -4 + \sqrt{x - 6}$; domain = $[22, \infty)$, range = $[0, \infty)$



4 $a = \frac{-1}{2}, b = \frac{5}{2}$

5 a $f^{-1}(x) = a - x^2$ **b** $a = 1$ or $a = 2$

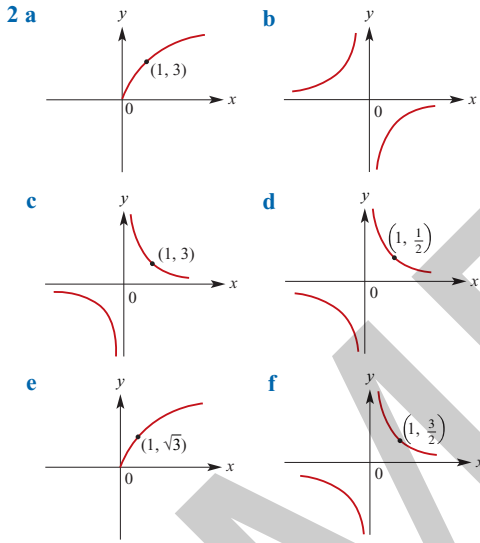
Exercise 6H



Exercise 6I

1 a i $y = 4x^2$ ii $y = \frac{x^2}{25}$ iii $y = \frac{2x^2}{3}$
 iv $y = 4x^2$ v $y = -x^2$ vi $y = x^2$

b i $y = \frac{1}{4x^2}$ **ii** $y = \frac{25}{x^2}$ **iii** $y = \frac{2}{3x^2}$
iv $y = \frac{4}{x^2}$ **v** $y = \frac{-1}{x^2}$ **vi** $y = \frac{1}{x^2}$
c i $y = \frac{1}{2x}$ **ii** $y = \frac{5}{x}$ **iii** $y = \frac{2}{3x}$
iv $y = \frac{4}{x}$ **v** $y = \frac{-1}{x}$ **vi** $y = \frac{-1}{x}$
d i $y = \sqrt{2x}$ **ii** $y = \sqrt{\frac{x}{5}}$ **iii** $y = \frac{2\sqrt{x}}{3}$
iv $y = 4\sqrt{x}$ **v** $y = -\sqrt{x}$ **vi** $y = \sqrt{-x} \quad x \leq 0$



Exercise 6J

1 a i $y = 3\sqrt{x-2}$ **b** $y = -\sqrt{x+3}$
c $y = -3\sqrt{x}$ **d** $y = -\sqrt{\frac{x}{2}}$
e $y = 2\sqrt{x-2} - 3$ **f** $y = \sqrt{\frac{x+2}{2}} - 3$
2 a $y = \frac{3}{x-2}$ **b** $y = \frac{-1}{x+3}$
c $y = -\frac{3}{x}$ **d** $y = -\frac{2}{x}$
e $y = \frac{2}{x-2} - 3$ **f** $y = \frac{2}{x+2} - 3$

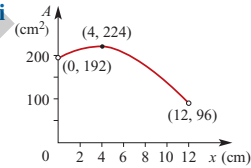
- 3 a i** A dilation of factor 2 from the x -axis followed by a translation of 1 unit in the positive direction of the x -axis and 3 units in the positive direction of the y -axis
ii A reflection in the x -axis followed by a translation of 1 unit in the negative direction of the x -axis and 2 units in the positive direction of the y -axis
iii A dilation of factor $\frac{1}{2}$ from the y -axis followed by a translation of $\frac{1}{2}$ unit in the

negative direction of the x -axis and 2 units in the negative direction of the y -axis

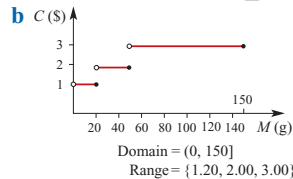
- b i** A dilation of factor 2 from the x -axis followed by a translation of 3 units in the negative direction of the x -axis
ii A translation of 3 units in the negative direction of the x -axis and 2 units in the positive direction of the y -axis
iii A translation of 3 units in the positive direction of the x -axis and 2 units in the negative direction of the y -axis
c i A translation of 3 units in the negative direction of the x -axis and 2 units in the positive direction of the y -axis
ii A dilation of factor $\frac{1}{3}$ from the y -axis followed by a dilation of factor 2 from the x -axis
iii A reflection in the x -axis followed by a translation of 2 units in the positive direction of the y -axis

Exercise 6K

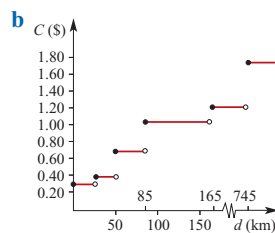
- 1 a i** $A = (8+x)y - x^2$
ii $P = 2x + 2y + 16$
b i $A = 192 + 16x - 2x^2$
ii $0 < x < 12$
iii



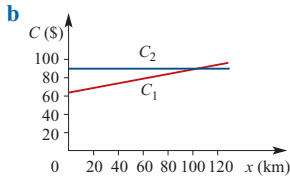
- iv** 224 cm²
2 a $C = 1.20$ for $0 < m \leq 20$
 $C = 2.00$ for $20 < m \leq 50$
 $C = 3.00$ for $50 < m \leq 150$



- 3 a** $C = 0.30$ for $0 \leq d < 25$
 $C = 0.40$ for $25 \leq d < 50$
 $C = 0.70$ for $50 \leq d < 85$
 $C = 1.05$ for $85 \leq d < 165$
 $C = 1.22$ for $165 \leq d < 745$
 $C = 1.77$ for $d \geq 745$



4 a i $C_1 = 64 + 0.25x$ ii $C_2 = 89$



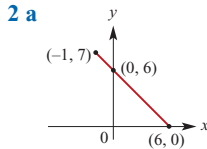
c $x > 100$ km

Multiple-choice questions

- 1 B 2 E 3 D 4 C 5 E
6 B 7 D 8 E 9 C 10 D

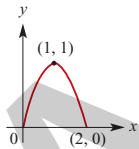
Short-answer questions (technology-free)

1 a -16 b 26 c $-\frac{2}{3}$



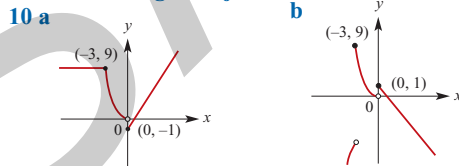
- b Range = $[0, 7]$
3 a Range = R b Range = $[-5, 4]$
c Range = $[0, 4]$ d Range = $(-\infty, 9]$
e Range = $(2, \infty)$ f $\{-6, 2, 4\}$
g Range = $[0, \infty)$ h $R \setminus \{2\}$
i Range = $[-5, 1]$ j Range = $[-1, 3]$

4 a $a = -15, b = \frac{33}{2}$ b Domain = $R \setminus \{0\}$
5 a b $[0, 1]$



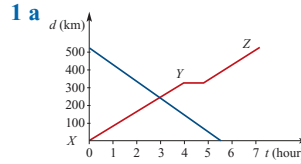
- 6 a $a = 3, b = -5$ 7 a $a = -\frac{1}{2}, b = 2, c = 0$
8 a $R \setminus \{2\}$ b $[2, \infty)$ c $[-5, 5]$
d $R \setminus \left\{\frac{1}{2}\right\}$ e $[-10, 10]$ f $(-\infty, 4]$

9 b, c, d, e, f, g, and j are one-to-one



- 10 a
11 a $f^{-1}(x) = \frac{x+2}{3}$, Domain = $[-5, 13]$
b $f^{-1}(x) = (x-2)^2 - 2$, Domain = $[2, \infty)$
c $f^{-1}(x) = \sqrt{\frac{x}{3}} - 1$, Domain = $[0, \infty)$
d $f^{-1}(x) = -\sqrt{x} + 1$, Domain = $[0, \infty)$
12 a $y = \sqrt{x-2} + 3$ b $y = 2\sqrt{x}$ c $y = -\sqrt{x}$
d $y = \sqrt{-x}$ e $y = \sqrt{\frac{x}{3}}$

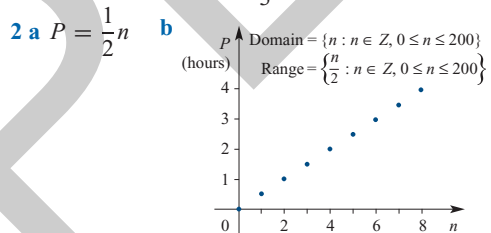
Extended-response questions



Coach starting from X:
 $d = 80t$ for $0 \leq t \leq 4$
 $d = 320$ for $4 < t \leq 4\frac{3}{4}$
 $d = 80t - 60$ for $4\frac{3}{4} < t \leq 7\frac{1}{4}$
Range = $[0, 520]$

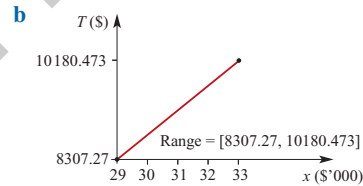
Coach starting from Z:
 $d = 520 - \frac{1040}{11}t$ for $0 \leq t \leq 5\frac{1}{2}$
Range = $[0, 520]$

b The coaches pass $238\frac{1}{3}$ km from X.



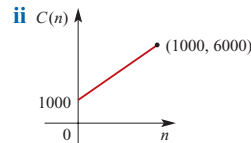
2 a $P = \frac{1}{2}n$

3 a $T = 0.4683x - 5273.4266$

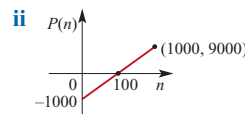


c \$8775.57 (to nearest cent)

4 a i $C(n) = 1000 + 5n, n > 0$

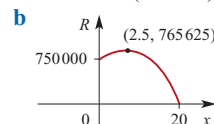


ii $P(n) = 15n - (1000 + 5n) = 10n - 1000$



5 $V = 8000(1 - 0.05n) = 8000 - 400n$

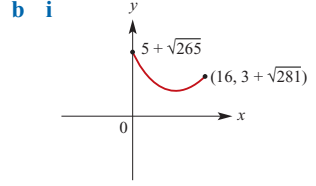
6 a $R = (50000 - 2500x)(15 + x) = 2500(x + 15)(20 - x)$



b c Price for max = \$17.50

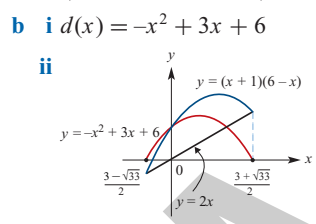
7 a $A(x) = \frac{x}{4}(2a - (6 - \sqrt{3})x)$
 b $0 < x < \frac{a}{3}$ c $\frac{a^2}{4(6 - \sqrt{3})} \text{ cm}^2$

8 a i $d(x) = \sqrt{x^2 + 25} + \sqrt{(16 - x)^2 + 9}$
 ii $0 \leq x \leq 16$



- ii 1.54 iii 3.40 or 15.04
 c i minimum at $x = 10$
 minimum of $d(x) = 8\sqrt{5}$
 ii range = $[8\sqrt{5}, 5 + \sqrt{265}]$

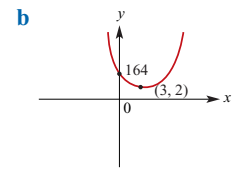
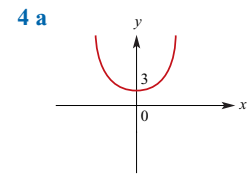
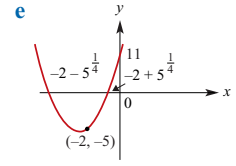
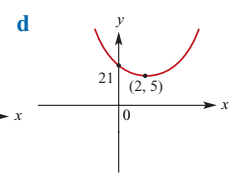
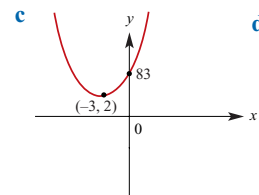
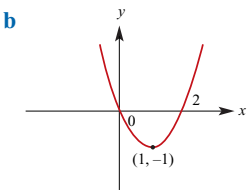
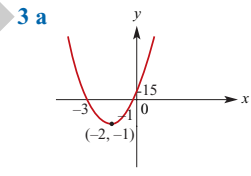
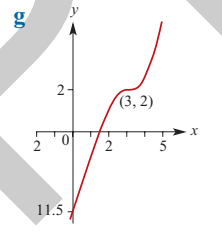
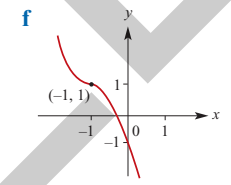
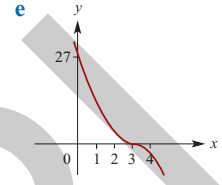
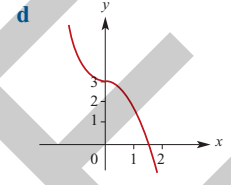
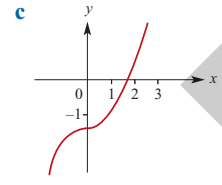
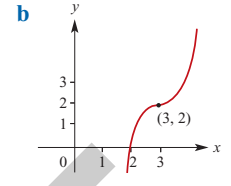
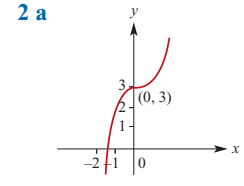
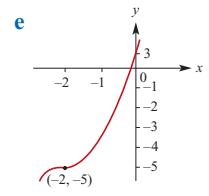
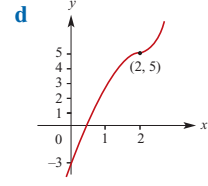
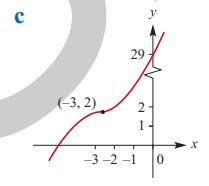
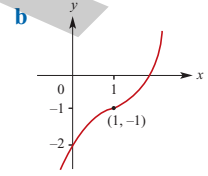
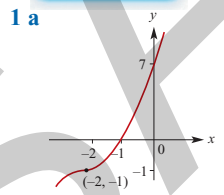
9 a $A\left(\frac{3 + \sqrt{33}}{2}, 3 + \sqrt{33}\right),$
 $B\left(\frac{3 - \sqrt{33}}{2}, 3 - \sqrt{33}\right)$

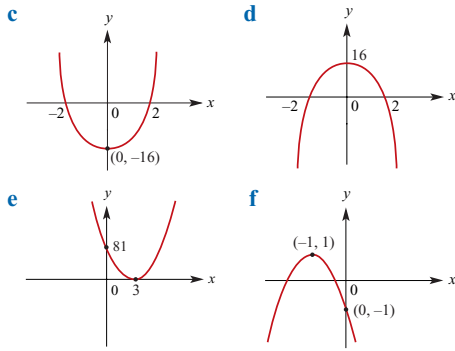


- c i maximum value of $d(x)$ is 8.25 ii $[0, 8.25]$
 d i $A(2.45, 12.25)$ $B(-2.45, -12.25)$
 ii $d(x) = -x^2 + 6$ iii Range = $[0, 6]$
 iv maximum value of $d(x)$ is 6

Chapter 7

Exercise 7A





Exercise 7B

1 a $x^2 + 2x + \frac{3}{x-1}$ b $2x^2 - x - 3 + \frac{6}{x+1}$

c $3x^2 - 10x + 22 - \frac{43}{x+2}$

d $x^2 - x + 4 - \frac{8}{x+1}$

e $2x^2 + 3x + 10 + \frac{28}{x-3}$

f $2x^2 - 5x + 37 - \frac{133}{x+4}$ g $x^2 + x + \frac{2}{x+3}$

2 a $\frac{1}{2}x^2 + \frac{7}{4}x - \frac{3}{8} + \frac{103}{8(2x+5)}$

b $x^2 + 2x - 3 - \frac{2}{2x+1}$

c $\frac{1}{3}x^2 - \frac{8}{9}x - \frac{8}{27} + \frac{19}{27(3x-1)}$

d $x^2 - x + 4 + \frac{13}{x-2}$

e $x^2 + 2x - 15$

f $\frac{1}{2}x^2 + \frac{3}{4}x - \frac{3}{8} - \frac{5}{8(2x+1)}$

3 a $x^2 + 3x + 8 + \frac{9}{x-1}$

b $x^2 - \frac{x}{2} + \frac{9}{4} + \frac{21}{4(2x-1)}$

Exercise 7C

1 a -2 b -29 c 15 d 4 e 7
f -12 g 0 h -5 i -8

2 a $a = -3$ b $a = 2$
c $a = 4$ d $a = -10$

Exercise 7D

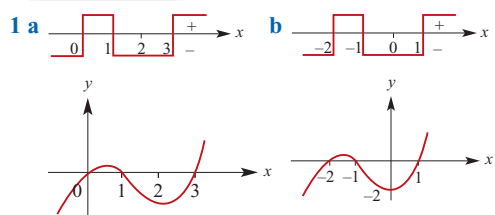
2 a 6 b 28 c $-\frac{1}{3}$
3 a $(x-1)(x+1)(2x+1)$ b $(x+1)^3$
c $(x-1)(6x^2 - 7x + 6)$
d $(x-1)(x+5)(x-4)$
e $(x+1)^2(2x-1)$ f $(x+1)(x-1)^2$

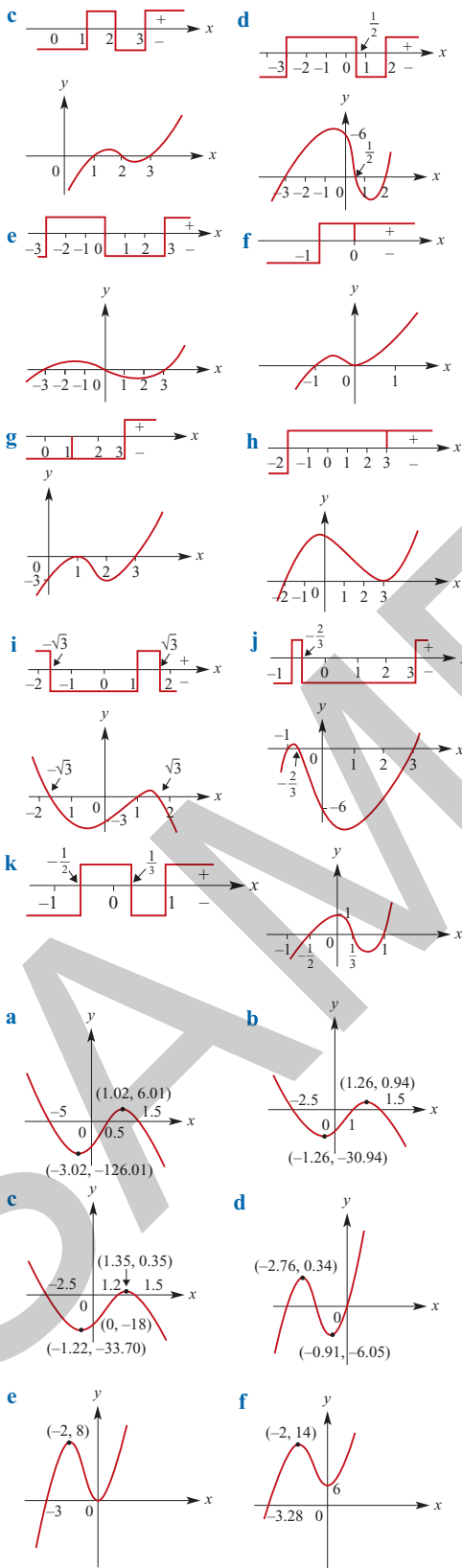
g $(x-2)(4x^2 + 8x + 19)$
h $(x+2)(2x+1)(2x-3)$
4 a $(x-1)(x^2 + x + 1)$
b $(x+4)(x^2 - 4x + 16)$
c $(3x-1)(9x^2 + 3x + 1)$
d $(4x-5)(16x^2 + 20x + 25)$
e $(1-5x)(1+5x+25x^2)$
f $(3x+2)(9x^2 - 6x + 4)$
g $(4m-3n)(16m^2 + 12mn + 9n^2)$
h $(3b+2a)(9b^2 - 6ab + 4a^2)$
5 a $(x+2)(x^2 - x + 1)$
b $(3x+2)(x-1)(x-2)$
c $(x-3)(x+1)(x-2)$
d $(3x+1)(x+3)(2x-1)$
6 a = 3, b = -3, $P(x) = (x-1)(x+3)(x+1)$
7 b i n odd ii n even
8 a a = 1, b = 1 b i $P(x) = x^3 - 2x^2 + 3$

Exercise 7E

1 a 1, -2, 4 b 4, 6 c $\frac{1}{2}, 3, -\frac{2}{3}$
d 1, -1, -2 e 2, 3, -5 f $-1, -\frac{2}{3}, 3$
g $1, -\sqrt{2}, \sqrt{2}$ h $-\frac{2}{5}, -4, 2$
i $-\frac{1}{2}, \frac{1}{3}, 1$ j $-2, -\frac{3}{2}, 5$
2 a -6, 2, 3 b $-2, -\frac{2}{3}, \frac{1}{2}$ c 3
d -1 e -1, 3 f $3, -2 \pm \sqrt{3}$
3 a -2, 0, 4 b $0, -1 \pm 2\sqrt{3}$
c -5, 0, 8 d $0, -1 \pm \sqrt{17}$
4 a $0, \pm 2\sqrt{2}$ b $1 + 2\sqrt[3]{2}$ c -2
d -5 e $\frac{1}{10}$
5 a 1 b -1 c $5, \pm\sqrt{10}$ d $\pm 4, a$
6 a $2(x-9)(x-13)(x+11)$
b $(x+11)(x+3)(2x-1)$
c $(x+11)(2x-9)(x-11)$
d $(2x-1)(x+11)(x+15)$

Exercise 7F





3 $(x + 1)(x + 1)(x - 3) = 0$, \therefore Graph just touches the x -axis at $x = -1$ and cuts it at $x = 3$.

Exercise 7G

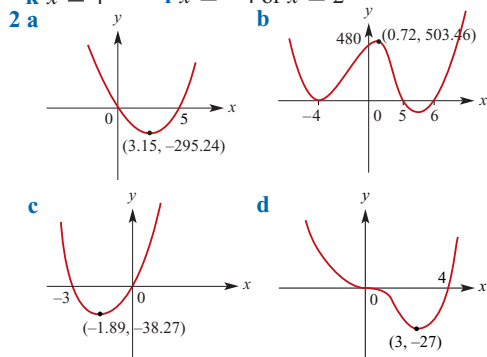
- a $\{x : x \leq -2\} \cup \{x : 1 \leq x \leq 3\}$
- b $\{x : x \geq 4\} \cup \{x : -2 \leq x \leq -1\}$
- c $\{x : x < 1\}$
- d $\{x : -2 < x < 0\} \cup \{x : x > 3\}$
- e $x \leq -1$ f $x \geq 1$ g $x > 4$ h $x \leq -3$

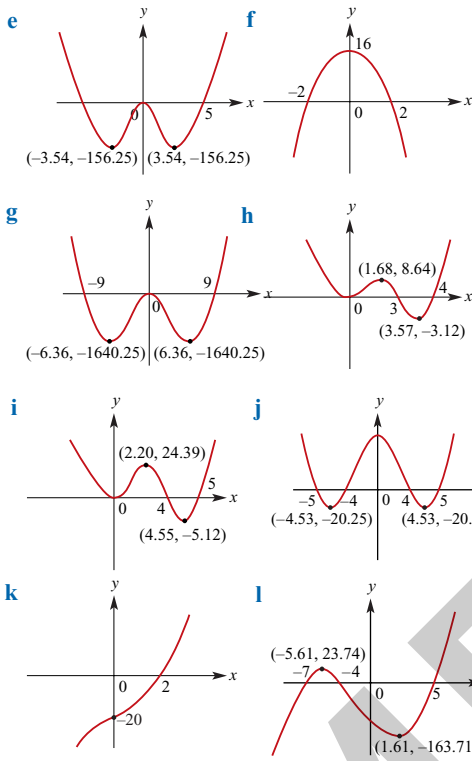
Exercise 7H

- 1 a $y = -\frac{1}{8}(x + 2)^3$ b $y - 2 = -\frac{1}{4}(x - 3)^3$
- 2 $y = 2x(x - 2)^2$
- 3 $y = -2x(x + 4)^2$
- 4 a $y = (x - 3)^3 + 2$
- b $y = \frac{23}{18}x^3 + \frac{67}{18}x^2$ c $y = 5x^3$
- 5 a $y = -\frac{1}{3}x^3 + \frac{4}{3}x$ b $y = \frac{1}{4}x(x^2 + 2)$
- 6 a $y = -4x^3 - 50x^2 + 96x + 270$
- b $y = 4x^3 - 60x^2 + 80x + 26$
- c $y = x^3 - 2x^2 + 6x - 4$
- d $y = 2x^3 - 3x$
- e $y = 2x^3 - 3x^2 - 2x + 1$
- f $y = x^3 - 3x^2 - 2x + 1$
- g $y = -x^3 - 3x^2 - 2x + 1$

Exercise 7I

- 1 a $x = 0$ or $x = 3$
- b $x = 2$ or $x = -1$ or $x = 5$ or $x = -3$
- c $x = 0$ or $x = -2$ d $x = 0$ or $x = 6$
- e $x = 0$ or $x = 3$ or $x = -3$
- f $x = 3$ or $x = -3$
- g $x = 0$ or $x = 4$ or $x = -4$
- h $x = 0$ or $x = 4$ or $x = 3$
- i $x = 0$ or $x = 4$ or $x = 5$
- j $x = 2$ or $x = -2$ or $x = 3$ or $x = -3$
- k $x = 4$ l $x = -4$ or $x = 2$



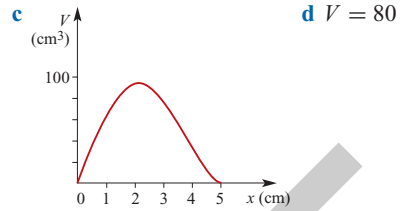


Exercise 7J

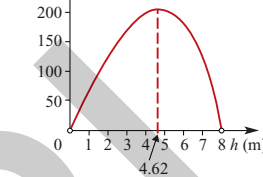
- 1 a** $f(n) = n^2 + 3$ **b** $f(n) = n^2 - 3n + 5$
- c** $f(n) = \frac{1}{6}n^3 + \frac{1}{2}n^2 + \frac{1}{3}n$
- d** $f(n) = \frac{1}{3}n^3 + \frac{1}{2}n^2 + \frac{1}{6}n$
- e** $f(n) = 2n^3 - 5$
- 2 a** $f(n) = n^2$ **b** $f(n) = n(n + 1)$
- c** $f(n) = \frac{1}{3}n^3 + \frac{1}{2}n^2 + \frac{1}{6}n$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

Exercise 7K

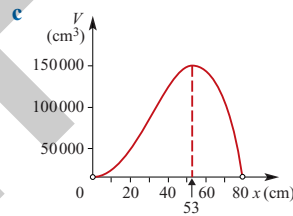
- 1 a** $l = 12 - 2x$, $w = 10 - 2x$
- b** $V = 4x(6 - x)(5 - x)$



- e** $x = 3.56$ or $x = 0.51$
- f** $V \text{ max} = 96.8 \text{ cm}^3$ when $x = 1.81$
- 2 a** $x = \sqrt{64 - h^2}$ **b** $V = \frac{\pi h}{3}(64 - h^2)$
- c**
- d** Domain = $\{h : 0 < h < 8\}$
- e** 64π



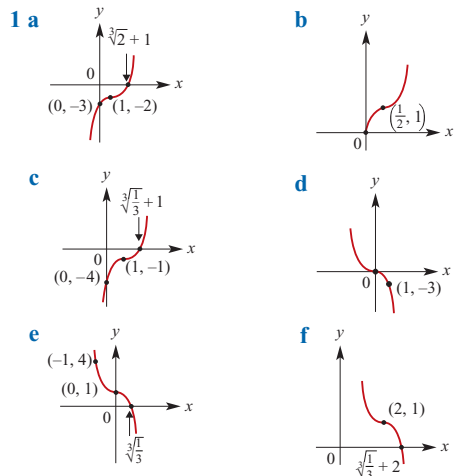
- 3 a** $h = 160 - 2x$
- b** $V = x^2(160 - 2x)$, Domain = $(0, 80)$

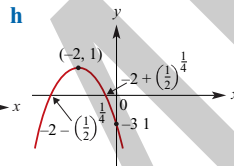
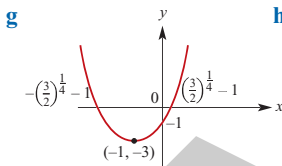
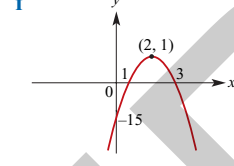
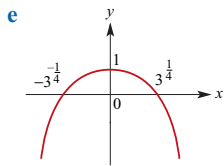
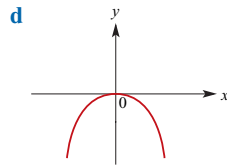
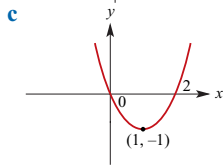
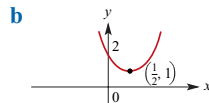
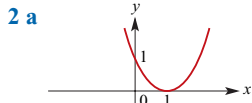
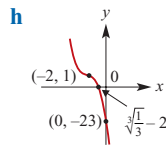
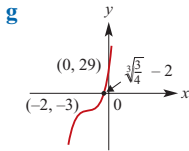


Multiple-choice questions

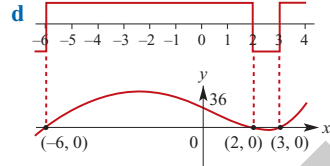
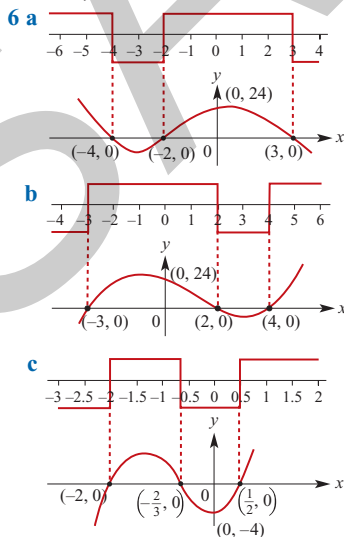
- 1** B **2** D **3** A **4** D **5** A
6 C **7** B **8** B **9** D **10** B

Short-answer questions (technology-free)



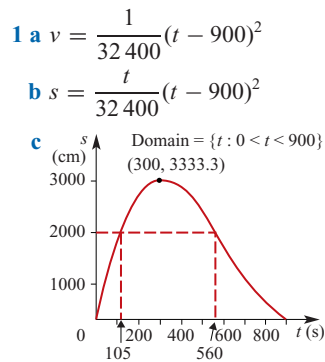


- 3 a** $P\left(\frac{3}{2}\right) = 0$ and $P(-2) = 0$, $(3x + 1)$
b $x = -2, \frac{1}{2}, 3$ **c** $x = -1, -\sqrt{11}, +\sqrt{11}$
d i $P\left(\frac{1}{3}\right) = 0$ **ii** $(3x - 1)(x + 3)(x - 2)$
4 a $f(1) = 0$ **b** $(x - 1)(x^2 + (1 - k)x + k + 1)$
5 a $a = 3, b = -24$



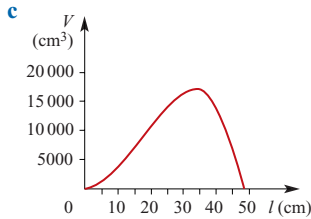
- 7 a** -41 **b** 12 **c** $\frac{43}{9}$
8 $y = -\frac{2}{5}(x + 2)(x - 1)(x - 5)$
9 $y = \frac{2}{81}x(x + 4)^2$
10 a $a = 3, b = 8$ **b** $(x + 3)(2x - 1)(x - 1)$
11 a $y = (x - 2)^3 + 3$ **b** $y = 2x^3$
c $y = -x^3$ **d** $y = (-x)^3 = -x^3$
e $y = \left(\frac{x}{3}\right)^3 = \frac{x^3}{27}$
12 a $y = -(x - 2)^4 + 3$ **b** $y = 2x^4$
c $y = -(x + 2)^4 + 3$
13 a Dilation of factor 2 from the x -axis, translation of 1 unit in the positive direction of the x -axis, then translation of 3 units in the positive direction of the y -axis
b Reflection in the x -axis, translation of 1 unit in the negative direction of the x -axis, then translation of 2 units in the positive direction of the y -axis
c Dilation of factor $\frac{1}{2}$ from the y -axis, translation of $\frac{1}{2}$ unit in the negative direction of the x -axis and translation of 2 units in the negative direction of the y -axis

Extended-response questions



- d** No, it is not feasible since the maximum range of the taxi is less than 3.5 km ($\sim 3-33$ km).
e Maximum speed $\approx \frac{2000}{105} = 19$ m/s
 Minimum speed $\approx \frac{2000}{560} = 3.6$ m/s
2 a $R - 10 = a(x - 5)^3$
b $a = \frac{2}{25}$ **c** $R - 12 = \frac{12}{343}(x - 7)^3$

3 a 4730 cm² b $V = l^2(\sqrt{2365} - l)$



d i $l = 23.69$ or $l = 39.79$

ii $l = 18.1$ or $l = 43.3$

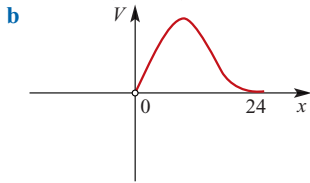
e $V_{\max} \approx 17039 \text{ cm}^3$, $l \approx 32.42 \text{ cm}$

4 a $a = \frac{-43}{15000}$, $b = 0.095$, $c = \frac{-119}{150}$,
d = 15.8

b i Closest to the ground (5.59, 13.83),

ii furthest from the ground (0, 15.8)

5 a $V = (96 - 4x)(48 - 2x)$
 $= 8x(24 - x)^2$



i $0 < x < 24$

ii $V_{\max} = 16384 \text{ cm}^3$ when $x = 8.00$

c 15680 cm³ d 14440 cm³ e 9720 cm³

Chapter 8

Exercise 8A

1 The lines are parallel.

2 $y = \lambda$, $x = 6 - \lambda$ 3 $m = 4$

4 a $m = -5$ b $m = 3$

5 a i $m = -2$ ii $m = 4$

b $x = \frac{m-2}{m+2}$, $y = \frac{2(m+4)}{m+2}$ $m \neq 4$ or $m \neq 2$

6 a $x = 2$, $y = 3$, $z = 1$

b $x = -3$, $y = 5$, $z = 2$

c $x = 5$, $y = 0$, $z = 7$

7 $x = 6$, $y = 5$, $z = 1$

8 $x = \frac{10-3w}{2}$, $y = -\frac{3(w+2)}{2}$, $z = 2w+2$;

if $w = 6$ solution is $(-4, -12, 14)$

9 a = 1, b = -2 and c = 3

10 b = 1, c = 2 and d = 5

11 x = 5, y = -2 and z = 1

12 b = -2, c = 0 and d = 3

Exercise 8B

1 a $\begin{bmatrix} -8 \\ 3 \end{bmatrix}$ b $\begin{bmatrix} -3a-b \\ -a+3b \end{bmatrix}$

2 (1, 0) → (2, -4), (0, 1) → (-1, 3),
(3, 2) → (4, -6)

3 a (2, 1), (-4, 1) b (-2, 0), (2, 2)
c (2, 3), (4, -5)

4 a (6, 21) b (12, 7) c (6, -7)

d (-6, 7) e (7, 6)

5 a $\begin{bmatrix} 2 & 3 \\ 3 & -1 \end{bmatrix}$ c $\begin{bmatrix} 1 & 2 \\ 1 & 2 \end{bmatrix}$

6 $\begin{bmatrix} 1 & 0 \\ 0 & -2 \end{bmatrix}$

7 a $\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$ b $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$ c $\begin{bmatrix} 0 & -1 \\ -1 & 0 \end{bmatrix}$

d $\begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$ e $\begin{bmatrix} 3 & 0 \\ 0 & 3 \end{bmatrix}$ f $\begin{bmatrix} 3 & 0 \\ 0 & 1 \end{bmatrix}$

8 a $T = \begin{bmatrix} 0 & -2 \\ -2 & 0 \end{bmatrix}$ b (-4, -6)

c a = -1 and b = -3.

9 $\begin{bmatrix} 2 & 0 \\ 0 & 1 \end{bmatrix} X + \begin{bmatrix} 3 \\ 4 \end{bmatrix} = X' \Rightarrow$

$X = \frac{1}{2} \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix} \left(X' - \begin{bmatrix} 3 \\ 4 \end{bmatrix} \right)$

$x = \frac{1}{2}(x' - 3)$, $y = y' - 4$

10 $\frac{1}{2} \begin{bmatrix} -1 & -1 \\ -21 & 5 \end{bmatrix}$

Exercise 8C

1 a $\frac{3}{m}$ b $m \geq 3$ c $f^{-1}(x) = \frac{x+3}{m}$

d $\left(\frac{3}{m-1}, \frac{3}{m-1} \right)$ e $my + x = -3m$

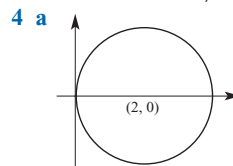
2 a $-\frac{c}{2}$ b $c \geq -2$ c $f^{-1}(x) = \frac{x-c}{2}$

d $(-c, -c)$ e $y = -\frac{1}{2}x + c$

3 a $x = 0$ and $x = -b$ b $\left(\frac{-b}{2}, \frac{-b^2}{4} \right)$

c i (0, 0) and $(1-b, 1-b)$

ii $b = 1$ iii $b \neq 1$



b $y = a$ and $y = -a$

c $\left(\frac{\sqrt{a^2 + 8a - 16} + a + 4}{2}, \frac{\sqrt{a^2 + 8a - 16} + a - 4}{2} \right)$ and
 $\left(-\frac{\sqrt{a^2 + 8a - 16} - a - 4}{2}, -\frac{\sqrt{a^2 + 8a - 16} - a - 4}{2} \right)$

Exercise 8D

1 $y = \frac{-2x^2}{9} - \frac{2x}{3} - 4$ 2 $y = \frac{-x^3}{32} - x$

3 $y = \frac{-3x + 18}{4}$ 4 $y = \frac{x}{4} - 4$

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

7 $y = \frac{-3x^3}{4} - \frac{9x^2}{2} + 14$

8 $y = \frac{-3x^3}{4} - \frac{9x^2}{2} + 8$

9 a $d = -1, a + b + c + d = 1,$
 $8a + 4b + 2c + d = 1,$
 $27a + 9b + 3c + d = 5$

b $\begin{bmatrix} 0 & 0 & 0 & 1 \\ 1 & 1 & 1 & 1 \\ 8 & 4 & 2 & 1 \\ 27 & 9 & 3 & 1 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \\ d \end{bmatrix} = \begin{bmatrix} -1 \\ 1 \\ 1 \\ 5 \end{bmatrix}$

c $a = 1, b = -4, c = 5, d = -1$

d $y = -2x^3 + 8x^2 - 10x + 2$

10 a $a = 2, b = 0, c = -4, d = 0$

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

Multiple-choice questions

- 1 E 2 B 3 B 4 E 5 D
 6 B 7 C 8 C 9 D 10 C

**Short-answer questions
(technology-free)**

1 a $\begin{bmatrix} 1 & 0 \\ 0 & 4 \end{bmatrix} (-1, 12)$ b $\begin{bmatrix} 3 & 0 \\ 0 & 1 \end{bmatrix} (-3, 3)$

c $\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} (-1, -3)$ d $\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix} (1, 3)$

e $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} (3, -1)$

2 $x = 4, y = -1$ and $z = 7$

3 a $y = 2x + 2.$

b i $\frac{-2}{a}$ ii $-2 < a < 0$

c $\left(\frac{1}{a-1}, \frac{1}{a-1} + 3\right)$

4 a $a\left(x + \frac{1}{a}\right)^2 + a - \frac{1}{a}$ b $\left(\frac{-1}{a}, a - \frac{1}{a}\right)$

c $a = \pm 1$ d $-1 < a < 1$

5 $\begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} 2 \\ 3 \end{bmatrix} = \begin{bmatrix} x' \\ y' \end{bmatrix}, x = x' - 2$ and
 $y = \frac{y' - 3}{2}$

6 $\begin{bmatrix} 3 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} -2 \\ 3 \end{bmatrix} = \begin{bmatrix} x' \\ y' \end{bmatrix}, x = \frac{x' + 2}{3}$
 and $y = y' - 3$

Extended-response questions

- 1 a $h = -1 \pm 2\sqrt{2}$ b $a = \pm 2\sqrt{2}$
 c $a = -8, b = 16$

2 a $4b - 5c - d = 41, 2b - 7c - d = 53,$
 $-4b + 3c - d = 25$

b $x^2 + y^2 - 2x - 4y - 29 = 0$

3 a $c = -b - 8$

b $x = 0$ or $x = -b$

c i $y = 0$ or $y = b + 8$ ii $b = -8$

4 a $x \leq a$ b $\left(\frac{\sqrt{4a+1}-1}{2}, \frac{\sqrt{4a+1}-1}{2}\right)$

c $a = 2$ d $a = 6$ e $a = c^2 + c$

5 a $-y + 5z = 15$ and $-y + 5z = 15.$

b This indicates the solution is going to be a straight line.

c $y = 5\lambda - 15$

d $x = 43 - 13\lambda$

6 a $y = -2 + 4z$

b $x = 8 - 5\lambda, y = -2 + 4\lambda, z = \lambda \lambda \in R$

7 $u = \frac{-b}{a}, v = \frac{-c}{a}$

Chapter 9

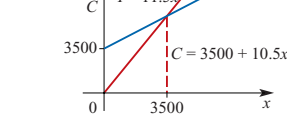
9.1 Multiple-choice questions

- 1 A 2 D 3 D 4 C 5 B
 6 C 7 A 8 E 9 B 10 A
 11 E 12 B 13 D 14 D 15 E
 16 B 17 D 18 E 19 D 20 B
 21 D 22 D 23 A 24 B 25 D
 26 D 27 B 28 C 29 A 30 C
 31 A 32 B 33 C 34 D 35 E
 36 E 37 C 38 C 39 C 40 A
 41 A 42 B 43 E 44 A 45 B
 46 C

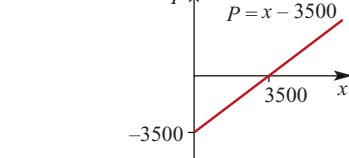
9.2 Extended-response questions

1 a $C = 3500 + 10.5x$ b $I = 11.5x$

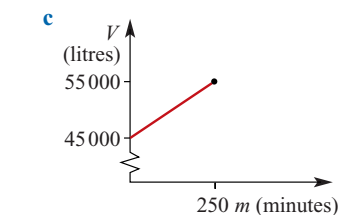
c I and C d 3500



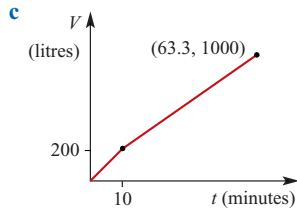
e Profit f 5500



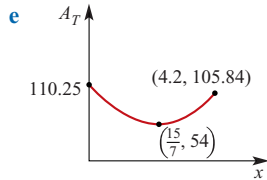
2 a $V = 45000 + 40m$ b 4 hours 10 minutes



3 a 200 L
 b $V = \begin{cases} 20t & 0 \leq t \leq 10 \\ 15t + 50 & 10 < t \leq \frac{190}{3} \end{cases}$



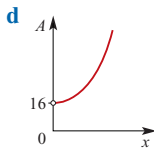
4 a $A_r = 6x^2$ b $A_s = (10.5 - 2.5x)^2$
 c $0 \leq x \leq 4.2$
 d $A_T = 12.25x^2 - 52.5x + 110.25$



f 110.25 cm² (area of rectangle = 0)
 g rectangle: 9 × 6, square: 3 × 3, (x = 3) or
 rectangle: $\frac{27}{7} \times \frac{18}{7}$; square: $\frac{51}{7} \times \frac{51}{7}$

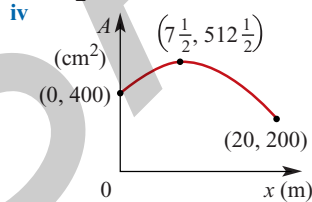
5 a 20 m b 20 m c 22.5 m

6 a $A = 10x^2 + 28x + 16$
 b i 54 cm² ii 112 cm²
 c 3 cm

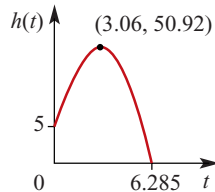


d $V = 2x^3 + 8x^2 + 8x$
 f $x = 3$ g $x = 6.66$

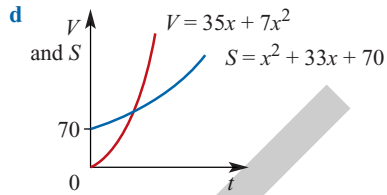
7 a i $A = (10 + x)y - x^2$
 ii $P = 2(y + x + 10)$
 b i $A = 400 + 30x - 2x^2$
 ii $512\frac{1}{2}$ m² iii $0 \leq x \leq 20$



8 a $A = 6x^2 + 7xy + 2y^2$
 c i $x = 0.5$ m ii $y = 0.25$ m
 9 a 50.9 m b $t = 6.12$ seconds
 c $h(t)$ d 6.285 seconds

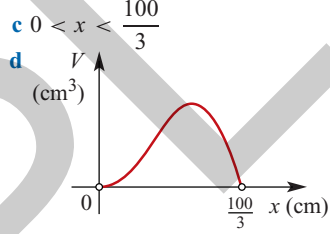


10 a $x + 5$ b $V = 35x + 7x^2$
 c $S = x^2 + 33x + 70$



e 3.25 m f 10 cm
 11 a $2y + 3x = 22$
 b i B(0, 11) ii D(8, -1)
 c 52 units² d 6.45 units

12 a 25 km/h b tap A 60 min; tap B 75 min
 c 4 cm
 13 a $h = 100 - 3x$ b $V = 2x^2(100 - 3x)$

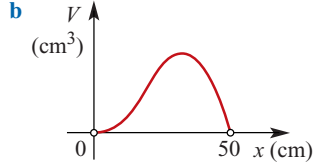


c $0 < x < \frac{100}{3}$
 d V (cm³)
 e i $x = 18.142$ or $x = 25.852$
 ii $x = 12.715$ or $x = 29.504$
 f V max = 32 921.811 cm³ where $x = 22.222$
 g i $S = 600x - 14x^2$
 ii S max = $\frac{45000}{7}$ cm², where $x = \frac{150}{7}$

h $x = 3.068$ or $x = 32.599$
 14 a $y = (7.6 \times 10^{-5})x^3 - 0.0276x^2 + 2.33x$
 b $y = (7.6 \times 10^{-3})x^3 - 0.0276x^2 + 2.33x + 5$
 c 57.31 m

15 a $y = \frac{3}{4}x - 4$ b $y = -\frac{4}{3}x + \frac{38}{3}$
 c D(8, 2) d 5 units e 50 units²

16 a i $y = 250 - 5x$
 ii $V = x^2(250 - 5x) = 5x^2(50 - x)$



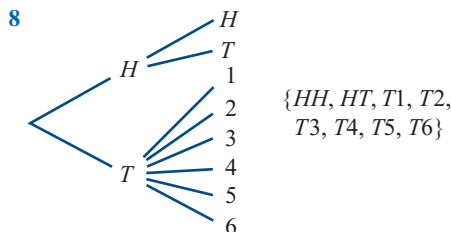
c (0, 50) d $x = 11.378$ or $x = 47.813$
 e V max = 92 592.59 cm³, where $x = 33.33$ and $y = 83.33$

Chapter 10

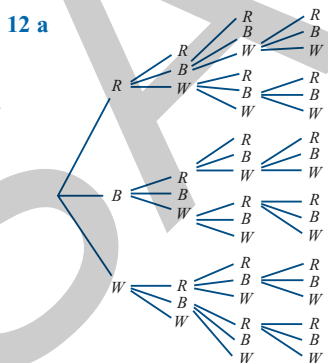
Exercise 10A

- 1 {H, T} 2 {1, 2, 3, 4, 5, 6}
 3 a 52 b 4
 c clubs ♣, hearts ♥, spades ♠, diamonds ♦
 d clubs and spades are black, diamonds and hearts are red

- e 13 f ace, king, queen, jack
 g 4 h 16
 4 a {BB, BR, RB, RR}
 b {H1, H2, H3, H4, H5, H6, T1, T2, T3, T4, T5, T6}
 c {MMM, MMF, MFM, FMM, MFF, FMF, FFM, FFF}
 5 a {0, 1, 2, 3, 4, 5}
 b {0, 1, 2, 3, 4, 5, 6} c {0, 1, 2, 3}
 6 a {0, 1, 2, 3, ...} b {0, 1, 2, 3, ..., 41}
 c {1, 2, 3, ...}
 7 a {2, 4, 6} b {FFF} c \emptyset

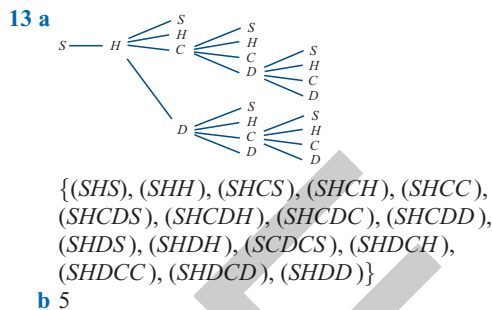


- 9 a {(1, 1), (1, 2), (1, 3), (1, 4), (2, 1), (2, 2), (2, 3), (2, 4), (3, 1), (3, 2), (3, 3), (3, 4), (4, 1), (4, 2), (4, 3), (4, 4)}
 b {(2, 4), (3, 3), (4, 2)}
 10 a {(1, 1), (1, 2), (1, 3), (1, 4), (2, 1), (2, 2), (2, 3), (2, 4), (3, 1), (3, 2), (3, 3), (3, 4)}
 b {(1, 1), (2, 2), (3, 3)}
 11 a {(1, 1), (1, 2), (1, 3), (1, 4), (1, 5), (1, 6), (2, 1), (2, 2), (2, 3), (2, 4), (2, 5), (2, 6), (3, 1), (3, 2), (3, 3), (3, 4), (3, 5), (3, 6), (4, 1), (4, 2), (4, 3), (4, 4), (4, 5), (4, 6), (5, 1), (5, 2), (5, 3), (5, 4), (5, 5), (5, 6), (6, 1), (6, 2), (6, 3), (6, 4), (6, 5), (6, 6)}
 b {(1, 2), (1, 4), (1, 6), (3, 2), (3, 4), (3, 6), (5, 2), (5, 4), (5, 6)}



- {(RR), (RBR), (RBB), (RBWR), (RBWB), (RBWW), (RWR), (RWBR), (RWBB), (RWBW), (RWW), (BRR), (BRB), (BRWR), (BRWB), (BRWW), (BB), (BWRR), (BWRB), (BWRW), (BWB), (BWW), (WRR), (WRBR), (WRBB), (WRBW), (WRW), (WBRR), (WBRRB), (WBRRW), (WBB), (WBW), (WW)}

b 4



Exercise 10B

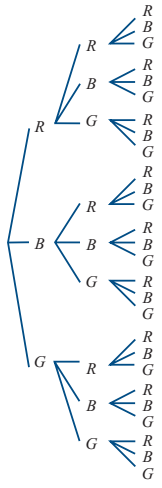
- 1 a $\frac{17}{50}$ b $\frac{1}{10}$ c $\frac{4}{15}$ d $\frac{1}{200}$
 2 a No b answers will vary
 c answers will vary d Yes
 e As the number of trials approaches infinity the relative frequency approaches the value of the probability.
 3 a No b answers will vary
 c answers will vary d Yes
 e As the number of trials approaches infinity the relative frequency approaches the value of the probability.
 4 $\text{Pr}(a \text{ 6 from first die}) \approx \frac{78}{500} = 0.156$
 $\text{Pr}(a \text{ 6 from second die}) \approx \frac{102}{700} \approx 0.146$
 \therefore choose the first die.
 5 a 0.702 b 0.722
 c The above estimates for the probability should be recalculated.
 d 0.706
 6 $\text{Pr}(4) = \frac{1}{3}$
 7 $\text{Pr}(2) = \text{Pr}(3) = \text{Pr}(4) = \text{Pr}(5) = \frac{2}{13}$,
 $\text{Pr}(6) = \frac{4}{13}$, $\text{Pr}(1) = \frac{1}{13}$
 8 $\text{Pr}(A) = 0.225$ 9 $\text{Pr}(A') = 0.775$

Exercise 10C

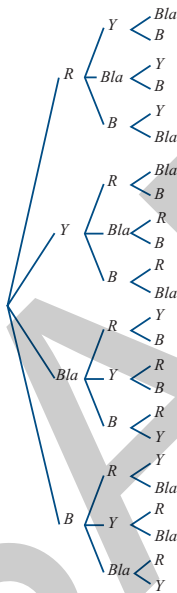
- 1 a $\frac{1}{3}$ b $\frac{1}{8}$ c $\frac{1}{4}$ d $\frac{5}{18}$
 2 a 0.141 b $\frac{0.628}{30}$ c 0.769
 3 a $\frac{1}{365}$ b $\frac{30}{365}$ c $\frac{30}{365}$ d $\frac{90}{365}$
 e $\frac{364}{365}$ f $\frac{334}{365}$
 4 a $\frac{1}{4}$ b $\frac{1}{2}$ c $\frac{4}{13}$ d $\frac{3}{4}$
 5 a $\frac{9}{13}$ b $\frac{10}{13}$ c $\frac{5}{13}$ d $\frac{1}{13}$
 6 a $\frac{1}{2}$ b $\frac{1}{18}$ c $\frac{5}{18}$

7 a $\frac{1}{12}$ b $\frac{1}{2}$ c $\frac{7}{12}$

8 $\frac{1}{4}$
9 a



10 a b i $\frac{1}{27}$ ii $\frac{2}{9}$ iii $\frac{1}{3}$ iv $\frac{2}{9}$



b i 0.25 ii $\frac{12}{24} = 0.5$ iii $\frac{1}{12}$

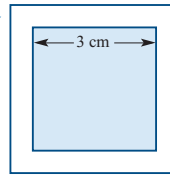
11 a $\frac{5}{13}$ b $\frac{11}{13}$

12 a

2nd ball \ 1st ball	1	2	3	4	5
1	(1, 1)	(1, 2)	(1, 3)	(1, 4)	(1, 5)
2	(2, 1)	(2, 2)	(2, 3)	(2, 4)	(2, 5)
3	(3, 1)	(3, 2)	(3, 3)	(3, 4)	(3, 5)
4	(4, 1)	(4, 2)	(4, 3)	(4, 4)	(4, 5)
5	(5, 1)	(5, 2)	(5, 3)	(5, 4)	(5, 5)

b i $\frac{4}{25}$ ii $\frac{4}{5}$ iii $\frac{3}{25}$

13 a b $\frac{9}{25}$



14 $\frac{\pi}{4}$
15 a $\frac{4\pi}{25}$ b $1 - \frac{4\pi}{25}$

Exercise 10D

- 1 a {1, 2, 3, 4, 6} b {2, 4}
 c {5, 6, 7, 8, 9, 10} d {1, 3}
 e {1, 3, 5, 6, 7, 8, 9, 10} f {5, 7, 8, 9, 10}
- 2 a {1, 2, 3, 5, 6, 7, 9, 10, 11}
 b {1, 3, 5, 7, 9, 11} c {2, 4, 6, 8, 10, 12}
 d {1, 3, 5, 7, 9, 11} e {1, 3, 5, 7, 9, 11}
- 3 a {E, H, M, S} b {C, H, I, M}
 c {A, C, E, I, S, T} d {H, M}
 e {C, E, H, I, M, S} f {H, M}

- 4 a 20 b 45
 5 a 6 b 1 c 18 d 2
 6 a $\frac{2}{3}$ b 0 c $\frac{1}{2}$ d $\frac{5}{6}$
 7 a $\frac{1}{2}$ b $\frac{1}{3}$ c $\frac{1}{6}; \frac{2}{3}$
 8 a 1 b $\frac{4}{11}$ c $\frac{9}{11}$ d $\frac{6}{11}$ e $\frac{7}{11}$ f $\frac{4}{11}$

Exercise 10E

- 1 a 0.2 b 0.5 c 0.3 d 0.7
 2 a 0.75 b 0.4 c 0.87 d 0.48
 3 a 0.63 b 0.23 c 0.22 d 0.77
 4 a 0.45 b 0.40 c 0.25 d 0.70
 5 a 0.9 b 0.6 c 0.1 d 0.9
 6 a 95% b 5%
- 7 a $A = \{J♥, Q♥, K♥, A♥, J♠, Q♠, K♠, A♠, J♦, Q♦, K♦, A♦, J♣, Q♣, K♣, A♣\}$
 $C = \{2♥, 3♥, 4♥, 5♥, 6♥, 7♥, 8♥, 9♥, 10♥, J♥, Q♥, K♥, A♥\}$
- b i $\Pr(\text{a picture card}) = \frac{4}{13}$
 ii $\Pr(\text{a heart}) = \frac{1}{4}$
 iii $\Pr(\text{a heart picture card}) = \frac{1}{13}$
 iv $\Pr(\text{a picture card or a heart}) = \frac{25}{52}$
 v $\Pr(\text{a picture card or a club, diamond or spade}) = \frac{43}{52}$
- 8 a $\frac{8}{15}$ b $\frac{7}{10}$ c $\frac{2}{15}$ d $\frac{1}{3}$
 9 a 0.8 b 0.57 c 0.28 d 0.08
 10 a 0.81 b 0.69 c 0.74 d 0.86

- 11 a 0 b 1 c $\frac{1}{5}$ d $\frac{1}{3}$
 12 a 0.88 b 0.58 c 0.30 d 0.12

Multiple-choice questions

- 1 B 2 C 3 A 4 C 5 D
 6 E 7 E 8 D 9 A 10 B

**Short-answer questions
(technology-free)**

- 1 a $\frac{1}{6}$ b $\frac{5}{6}$ 2 0.007
 3 a $\frac{1}{3}$ b $\frac{1}{4}$ c $\frac{1}{2}$
 4 a 0.36 b $\frac{87}{245}$ 5 $\frac{4}{15}$
 6 a {156, 165, 516, 561, 615, 651}
 b $\frac{2}{3}$ c $\frac{1}{3}$
 7 a $\frac{5}{12}$ b $\frac{1}{4}$
 8 No
 9 a 0.036 b 0.027 c 0.189 d 0.729
 10 a $\frac{1}{27}$ b $\frac{4}{27}$ c $\frac{4}{9}$ d $\frac{20}{27}$ e $\frac{2}{5}$

Extended-response questions

- 1 a $\beta - \gamma$ b $\alpha - \gamma$ c $1 - \alpha - \beta + \gamma$
 d $1 - \gamma$ e $1 - \alpha - \beta + \gamma$ f $1 - \gamma$
 2 a 0.15 b 0.148

T	18	19	20	21	22	23	24
Pr	0.072	0.180	0.288	0.258	0.148	0.046	0.008

- 3 a 0.204 b $0.071 \leq p \leq 0.214$ c 0.022
 4 a 0.6 b $\frac{1}{3}$ c $\frac{2}{7}$ d 0.108
 e $\frac{3}{20}$

Chapter 11

Exercise 11A

- 1 $\frac{1}{4}$
 2 a $\frac{65}{284}$ b $\frac{137}{568}$ c $\frac{21}{65}$ d $\frac{61}{246}$
 3 a 0.06 b 0.2
 4 a $\frac{4}{7}$ b 0.3 c $\frac{15}{22}$
 5 a 0.2 b 0.5 c 0.4
 6 a 0.2 b $\frac{10}{27}$ c $\frac{1}{3}$
 7 a 0.3 b 0.75
 8 a $\frac{1}{2}$ b $\frac{3}{4}$ c $\frac{1}{2}$ d 1 e $\frac{2}{3}$ f $\frac{1}{2}$

- 9 16% 10 $\frac{1}{5}$
 11 a $\frac{1}{16}$ b $\frac{1}{169}$ c $\frac{1}{4}$ d $\frac{16}{169}$
 12 a $\frac{1}{17}$ b $\frac{1}{221}$ c $\frac{25}{102}$ d $\frac{20}{221}$
 13 $0.230808 \approx 0.231$
 14 a $\frac{15}{28}$ b $\frac{1}{2}$ c $\frac{1}{2}$ d $\frac{2}{5}$
 e $\frac{3}{7}$ f $\frac{8}{13}$ g $\frac{5}{28}$ h $\frac{3}{14}$
 15 a 0.85 b 0.6 c 0.51 d 0.51
 16 0.4; 68%
 17 a i 0.444 ii 0.4 iii 0.35 iv 0.178 v 0.194
 b 0.372 c i 0.478 ii 0.425
 18 a i 0.564 ii 0.05 iii 0.12 iv 0.0282 v 0.052
 b 0.081 c 0.35
 19 a $\frac{1}{6}$ b $\frac{53}{90}$ c $\frac{15}{53}$
 20 a $B \subseteq A$ b $A \cap B = \emptyset$ c $A \subseteq B$

Exercise 11B

- 1 a Yes b Yes c No
 2 0.6 4 No
 5 a 0.6 b 0.42 c 0.88
 6 a 0.35 b 0.035 c 0.1225 d 0.025
 7 a $\frac{4}{15}$ b $\frac{1}{15}$ c $\frac{133}{165}$ d $\frac{6}{11}$ e $\frac{4}{15}$; No
 9 a 0.35 b 0.875
 10 a $\frac{18}{65}$ b $\frac{12}{65}$ c $\frac{23}{65}$ d $\frac{21}{65}$
 e $\frac{4}{65}$ f $\frac{8}{65}$ g $\frac{2}{15}$ h $\frac{8}{21}$; No
 11 a i 0.75 ii 0.32 iii 0.59
 b No c No
 12 b i $\frac{1}{8}$ ii $\frac{3}{8}$ iii $\frac{7}{8}$
 13 b i 0.09 ii 0.38 iii 0.29 iv 0.31
 14 a $\frac{1}{216}$ b $\frac{1}{8}$ c $\frac{1}{2}$ d $\frac{1}{36}$
 15 a $\frac{1}{32}$ b $\frac{1}{32}$ c $\frac{1}{2}$ d $\frac{1}{16}$
 16 a $\frac{1}{6}$ b $\frac{1}{30}$ c $\frac{1}{6}$ d $\frac{5}{6}$ e $\frac{1}{6}$
 17 a $\frac{1}{2}$ b $\frac{1}{8}$ c $\frac{1}{2}$

Exercise 11C

- 1 a $\begin{bmatrix} 0.6 & 0.45 \\ 0.4 & 0.55 \end{bmatrix}$ b 0.525
 2 a $\begin{bmatrix} 3 & 1 \\ 5 & 3 \end{bmatrix}$ b $\frac{7}{15}$

- 3 a $\begin{bmatrix} 0.43 & 0.33 \\ 0.57 & 0.67 \end{bmatrix}$ b 0.385
- 4 a $\begin{bmatrix} \Pr(W_{i+1}) \\ \Pr(L_{i+1}) \end{bmatrix} = \begin{bmatrix} 0.6 & 0.5 \\ 0.4 & 0.5 \end{bmatrix} \begin{bmatrix} \Pr(W_i) \\ \Pr(L_i) \end{bmatrix}$
 b 0.552
- 5 a $\begin{bmatrix} \Pr(L_{i+1}) \\ \Pr(T_{i+1}) \end{bmatrix} = \begin{bmatrix} 0.25 & 0.10 \\ 0.75 & 0.90 \end{bmatrix} \begin{bmatrix} \Pr(L_i) \\ \Pr(T_i) \end{bmatrix}$
 b 0.84
- 6 $\begin{bmatrix} \Pr(A_{i+1}) \\ \Pr(E_{i+1}) \end{bmatrix} = \begin{bmatrix} 0.7 & 0.5 \\ 0.3 & 0.5 \end{bmatrix}^i \begin{bmatrix} 0.6 \\ 0.4 \end{bmatrix}$ a 0.620
 b 0.624 c 0.625
- 7 a 0.762 b 0.7963 c 0.2033 8 $\frac{3}{7}$

Exercise 11D

- 1 a i $\begin{bmatrix} 62 \\ 38 \end{bmatrix}$ ii $\begin{bmatrix} 68.6 \\ 31.4 \end{bmatrix}$ iii $\begin{bmatrix} 70.6 \\ 29.4 \end{bmatrix}$
 b $\begin{bmatrix} 0.71498 & 0.71255 \\ 0.28502 & 0.28745 \end{bmatrix}$
 c i $\begin{bmatrix} 68.6 \\ 31.4 \end{bmatrix}$ ii $\begin{bmatrix} 70.6 \\ 29.4 \end{bmatrix}$ iii $\begin{bmatrix} 71.4217 \\ 28.5783 \end{bmatrix}$
- 2 a i $\begin{bmatrix} 187.5 \\ 202.5 \end{bmatrix}$ ii $\begin{bmatrix} 210 \\ 180 \end{bmatrix}$ iii $\begin{bmatrix} 223.5 \\ 166.5 \end{bmatrix}$
 b $\begin{bmatrix} 0.6425 & 0.5958 \\ 0.3575 & 0.4042 \end{bmatrix}$
 c i $\begin{bmatrix} 210 \\ 180 \end{bmatrix}$ ii $\begin{bmatrix} 223.5 \\ 166.5 \end{bmatrix}$ iii $\begin{bmatrix} 236.5 \\ 153.5 \end{bmatrix}$
- 3 a i $\begin{bmatrix} 0.39 \\ 0.61 \end{bmatrix}$ ii $\begin{bmatrix} 0.4563 \\ 0.5437 \end{bmatrix}$ iii $\begin{bmatrix} 0.4698 \\ 0.5302 \end{bmatrix}$
 b i $\begin{bmatrix} 0.56 \\ 0.44 \end{bmatrix}$ ii $\begin{bmatrix} 0.4852 \\ 0.5148 \end{bmatrix}$ iii $\begin{bmatrix} 0.4700 \\ 0.5300 \end{bmatrix}$
- 4 a i $\begin{bmatrix} 0.125 \\ 0.875 \end{bmatrix}$ ii $\begin{bmatrix} 0.1629 \\ 0.8371 \end{bmatrix}$ iii $\begin{bmatrix} 0.1794 \\ 0.8206 \end{bmatrix}$
 b i $\begin{bmatrix} 0.4286 \\ 0.5714 \end{bmatrix}$ ii $\begin{bmatrix} 0.2551 \\ 0.7449 \end{bmatrix}$ iii $\begin{bmatrix} 0.1797 \\ 0.8203 \end{bmatrix}$
- 5 a $\begin{bmatrix} 0.87 & 0.23 \\ 0.13 & 0.77 \end{bmatrix}$
 b 63.1% at the indoor pool, 36.9% at the outdoor pool
- 6 a $\begin{bmatrix} 0.96 & 0.98 \\ 0.04 & 0.02 \end{bmatrix}$ b 96.1%
- 7 $\begin{bmatrix} 71.4286 \\ 28.5714 \end{bmatrix}$ 8 $\begin{bmatrix} 237.5 \\ 142.5 \end{bmatrix}$
- 9 a $\begin{bmatrix} 0.8 & 0.14 \\ 0.2 & 0.86 \end{bmatrix}$ b 675 people
- 10 a $\begin{bmatrix} 0.93 & 0.11 \\ 0.07 & 0.89 \end{bmatrix}$
 b 44.0% school A, 56.0% school B
 c 61.0% school A, 39.0% school B
- 11 a $\begin{bmatrix} 0.5 & 0.37 \\ 0.5 & 0.63 \end{bmatrix}$ b i 0.4266 ii 0.4244
 c 0.4253

- 12 a $\begin{bmatrix} 0.25 & 0.65 \\ 0.75 & 0.35 \end{bmatrix}$ b i 0.45 ii 0.61
 c 0.536
- 13 a 51.8% to Dr Black, 48.2% to Dr White
- 14 a $\begin{bmatrix} 0.74 & 0.14 \\ 0.26 & 0.86 \end{bmatrix}$
 b 530 garage A, 959 garage B
 c 521 garage A, 968 garage B

Multiple-choice questions

- 1 E 2 C 3 A 4 B 5 C
 6 D 7 E 8 D 9 E 10 C

Short-answer questions (technology-free)

- 1 a $\frac{2}{7}$ b $\frac{32}{63}$ c $\frac{9}{16}$
- 2 a 0.65 b No
- 3 0.99989
- 4 a 0.2 b 0.4
 5 a 0.7 b 0.3 c $\frac{1}{3}$ d $\frac{2}{3}$
- 6 a $\begin{bmatrix} 0.9 \\ 0.1 \end{bmatrix}$ b $\begin{bmatrix} 0.83 \\ 0.17 \end{bmatrix}$
- 7 0.4888

Extended-response questions

- 1 a A: $\frac{3}{28}$ B: $\frac{3}{4}$ b A: $\frac{9}{64}$ B: $\frac{49}{64}$
 c 0.125 d 0.155
- 2 a B is a subset of A
 b A and B are mutually exclusive
 c A and B are independent
- 3 a $\frac{1}{4}$ b $\frac{1}{3}$
 c i $\frac{1}{16}$ ii $\frac{1}{4^n}$
 d $\frac{1}{4}$
- 4 a $\begin{bmatrix} 0.9 & 0.2 \\ 0.1 & 0.8 \end{bmatrix}$ b $\begin{bmatrix} 122 \text{ Melbourne} \\ 78 \text{ Tullamarine} \end{bmatrix}$
 c $\begin{bmatrix} 133 \text{ Melbourne} \\ 67 \text{ Tullamarine} \end{bmatrix}$
- 5 a $\begin{bmatrix} 0.25 & 0.2 \\ 0.75 & 0.8 \end{bmatrix}$
 b i $\begin{bmatrix} 0.2105 \\ 0.7895 \end{bmatrix}$ ii $\begin{bmatrix} 0.2105 \\ 0.7895 \end{bmatrix}$ c $\begin{bmatrix} 0.2105 \\ 0.7895 \end{bmatrix}$

Chapter 12

Exercise 12A

- 1 a 11 b 12 c 37 d 29
 2 a 60 b 500 c 350 d 512
 3 a 128 b 160
 4 20 5 63 6 26 7 240
 8 260 000 9 17 576 000 10 30

Exercise 12B

- 1 a 6 b 120 c 5040 d 2 e 1 f 1
 2 a 20 b 72 c 6 d 56 e 120 f 720
 3 120 4 5040 5 24 6 720
 7 720 8 336
 9 a 5040 b 210 10 a 120 b 120
 11 a 840 b 2401 12 a 480 b 1512
 13 a 60 b 24 c 252
 14 a 150 b 360 c 1560
 15 a 720 b 48

Exercise 12C

- 1 a 3 b 3 c 6 d 4
 2 a 10 b 10 c 35 d 35
 3 a 190 b 100 c 4950 d 31125
 4 a 20 b 7 c 28 d 1225
 5 1716 6 2300 7 133 784 560
 8 8 145 060 9 18
 10 a 5 852 925 b 1 744 200
 11 100 386 12 a 792 b 336
 13 a 150 b 75 c 6 d 462 e 81
 14 a 8 436 285 b 3003 c 66 d 2 378 376
 15 186 16 32 17 256 18 31 19 57
 20 a 20 b 21

Exercise 12D

- 1 a 0.5 b 0.5 2 0.375
 3 a 0.2 b 0.6 c 0.3
 4 0.2 5 $\frac{329}{858}$
 6 a $\frac{2^7}{2^8 - 1} \approx 0.502$ b $\frac{56}{255}$ c $\frac{73}{85}$
 7 a $\frac{5}{204}$ b $\frac{35}{136}$
 8 a $\frac{25}{49}$ b $\frac{24}{49}$ c $\frac{3}{7}$ d 0.2
 9 a $\frac{1}{6}$ b $\frac{5}{6}$ c $\frac{17}{21}$ d $\frac{34}{35}$
 10 a 0.659 b 0.341 c 0.096 d 0.282
 11 a $\frac{5}{42}$ b $\frac{20}{21}$ c $\frac{15}{37}$

Multiple-choice questions

- 1 E 2 D 3 A 4 D 5 C
 6 B 7 C 8 A 9 E 10 E

- 9 a {2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12} b $\frac{1}{6}$

c

y	2	3	4	5	6	7	8	9	10	11	12
p(y)	$\frac{1}{36}$	$\frac{2}{36}$	$\frac{3}{36}$	$\frac{4}{36}$	$\frac{5}{36}$	$\frac{6}{36}$	$\frac{5}{36}$	$\frac{4}{36}$	$\frac{3}{36}$	$\frac{2}{36}$	$\frac{1}{36}$

Short-answer questions (technology-free)

- 1 a 499 500 b 1 000 000 c 1 000 000
 2 648 3 120 4 8n 5 5416
 6 36 750 7 11 025
 8 a 10 b 32 9 1200
 10 a $\frac{1}{8}$ b $\frac{3}{8}$ c $\frac{3}{28}$

Extended-response questions

- 1 a 2880 b 80 640 c 336
 2 a 720 b 48 c 336
 3 a 60 b 36
 4 a 210 b 100 c 80
 5 a 1365 b 210 c 1155
 6 a 3060 b 330 c 1155
 7 Division 1: 1.228×10^{-7}
 Division 2: 1.473×10^{-6}
 Division 3: 2.726×10^{-5}
 Division 4: 1.365×10^{-3}
 Division 5: 3.362×10^{-3}
 8 a 1.290×10^{-4}
 b 6.449×10^{-4}

Chapter 13

Exercise 13A

- 1 a no b no c yes d no e no
 2 a $\Pr(X = 2)$ b $\Pr(X > 2)$ c $\Pr(X \geq 2)$
 d $\Pr(X < 2)$ e $\Pr(X \geq 2)$ f $\Pr(X > 2)$
 g $\Pr(X \leq 2)$ h $\Pr(X \geq 2)$ i $\Pr(X \leq 2)$
 j $\Pr(X \geq 2)$ k $\Pr(2 < X < 5)$
 3 a {2} b {3, 4, 5} c {2, 3, 4, 5}
 d {0, 1} e {0, 1, 2} f {2, 3, 4, 5}
 g {3, 4, 5} h {2, 3, 4} i {3, 4}
 4 a $\frac{1}{15}$ b $\frac{3}{5}$
 5 a 0.09 b 0.69
 6 a 0.49 b 0.51 c 0.74
 7 a 0.6 b 0.47 c $\frac{2}{3}$

- 8 a {HHH, HTH, HHT, HTT, THH, TTH, THT, TTT}

b $\frac{3}{8}$ c

x	0	1	2	3
p(x)	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{8}$

- d $\frac{7}{8}$ e $\frac{4}{7}$

10 a {1, 2, 3, 4, 5, 6} b $\frac{7}{36}$

c

1	2	3	4	5	6
$\frac{1}{36}$	$\frac{3}{36}$	$\frac{5}{36}$	$\frac{7}{36}$	$\frac{9}{36}$	$\frac{11}{36}$

11 a 0.09 b 0.4 c 0.51

12 a

y	-3	-2	1	3
p(y)	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{8}$

b $\frac{7}{8}$

Exercise 13B

1 0.378 2 $\frac{28}{57} \approx 0.491$ 3 $\frac{12}{13} \approx 0.923$

4 $\frac{60}{253} \approx 0.237$ 5 0.930 6 0.109

Exercise 13C

1 a 0.185 b 0.060 2 a 0.194 b 0.930

3 a 0.137 b 0.446 c 0.554

4 a 0.008 b 0.268 c 0.468

5 a 0.056 b 0.391 6 0.018

7 a $\Pr(X = x) = \binom{5}{x} (0.1)^x (0.9)^{5-x}$
 $x = 0, 1, 2, 3, 4, 5$ or

x	0	1	2	3	4	5
p(x)	0.591	0.328	0.073	0.008	0.000	0.000

b Most probable number is 0

8 0.749 9 0.021 10 0.5398 11 $\frac{175}{256}$

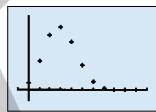
12 a 0.988 b 0.9999 c 8.1×10^{-11}

13 a 0.151 b 0.302 14 5.8%

15 a i 0.474 ii 0.224 iii 0.078

b Answers will vary – about 5 or more.

16 0.014 17



18

19 a 5 b 8

20 a 13 b 22

21 a 16 b 29

22 a 45 b 59

23 a 0.3087 b $\frac{0.3087}{1 - (0.3)^5} \approx 0.3095$

24 a 0.3020 b 0.6242 c 0.3225

Exercise 13D

1 Exact answer 0.172

2 a About 50 : 50

b One set of simulations gave the answer 1.9

Exercise 13E

- 2 Exact answer 29.29
- 3 a One set of simulations gave the answer 8.3.
 b One set of simulations gave the answer 10.7.
- 4 Exact answer is 0.0009.
- 5 a One set of simulations gave the answer 3.5.

Multiple-choice question

- 1 B 2 A 3 C 4 A 5 E
 6 C 7 A 8 D 9 B 10 E

Short-answer questions (technology-free)

- 1 a 0.92 b 0.63 c 0.8

2

x	1	2	3	4
p(x)	0.25	0.28	0.30	0.17

3

x	2	3	4
p(x)	$\frac{2}{5}$	$\frac{8}{15}$	$\frac{1}{15}$

4 a

	1st choice						
2nd choice		1	2	3	6	7	9
1		2	3	4	7	8	10
2		3	4	5	8	9	11
3		4	5	6	9	10	12
6		7	8	9	12	13	15
7		8	9	10	13	14	16
9		10	11	12	15	16	18

- b {2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18}

c

x	2	3	4	5	6	7
Pr(X = x)	$\frac{1}{36}$	$\frac{2}{36}$	$\frac{3}{36}$	$\frac{2}{36}$	$\frac{1}{36}$	$\frac{2}{36}$
x	8	9	10	11	12	13
Pr(X = x)	$\frac{4}{36}$	$\frac{4}{36}$	$\frac{4}{36}$	$\frac{2}{36}$	$\frac{3}{36}$	$\frac{2}{36}$
x	14	15	16	18		
Pr(X = x)	$\frac{1}{36}$	$\frac{2}{36}$	$\frac{2}{36}$	$\frac{1}{36}$		

5 a 0.051 b 0.996 c $\frac{243}{256} \approx 0.949$

6 a $\frac{9}{64}$ b $\frac{37}{64}$

7 a 0.282 b 0.377 c 0.341

8 a 0.173 b 0.756 c 0.071

9 a $(\frac{p}{100})^{15}$ b $15(\frac{p}{100})^{14}(1 - \frac{p}{100})$

$$c \left(\frac{p}{100}\right)^{15} + 15\left(\frac{p}{100}\right)^{14}\left(1 - \frac{p}{100}\right) + 105\left(1 - \frac{p}{100}\right)^2\left(\frac{p}{100}\right)^{13}$$

10 a $\frac{117}{125}$ b $m = 5$

Extended-response questions

1 a

x	1	2	3	4
$p(x)$	0.54	0.16	0.06	0.24

- b 0.46
- 2 a i 0.1 ii 0.6 iii $\frac{2}{3}$
- b i 0.0012 ii 0.2508
- 3 a $\frac{3}{5}$
- b i $\frac{7}{40}$ ii $\frac{3}{10}$
- c i $\frac{11}{40}$ ii $\frac{11}{17}$
- 4 a 0.003 b 5.320×10^{-6}
- 5 0.8 6 0.969
- 7 a 0.401 b $n \geq 45$
- 8 a $1 - q^2$ b $1 - 4q^3 + 3q^4$ c $\frac{1}{3} < q < 1$
- 9 0.966 (exact answer)
- 10 a 0.734 (exact answer)
- b About 7 (by simulation)
- 11 a $\frac{13}{8}$ b 3.7
- 12 b $\Pr(A) = 0.375, \Pr(B) = 0.375,$
 $\Pr(C) = 0.125, \Pr(D) = 0.125$
 (exact answer)

Chapter 14

14.1 Multiple-choice questions

- 1 E 2 C 3 E 4 B 5 E
 6 E 7 C 8 C 9 B 10 D
 11 D 12 D 13 E 14 A 15 E
 16 E 17 B 18 C 19 C 20 A
 21 E 22 E 23 C 24 D 25 D
 26 D 27 A 28 E 29 C

14.2 Extended-response questions

- 1 a i $\frac{15}{28}$ ii $\frac{37}{56}$ iii $\frac{43}{49}$
- b i $\frac{9}{14}$ ii $\frac{135}{392}$
- 2 a $\frac{1}{2}$ b $\frac{13}{36}$
- 3 a $\frac{3}{8}$ b $\frac{1}{56}$ c $\frac{3}{28}$ d $\frac{6}{7}$
- 4 a 0.0027 b 0.12 c 0.17 d 0.72
- 5 a $\frac{59}{120}$ b $\frac{45}{59}$

6 a $\frac{167}{360}$ b i $\frac{108}{193}$ ii $\frac{45}{193}$

7 a i $\frac{1}{9}$ ii $\frac{5}{18}$

b i $\frac{1}{81}$ ii $\frac{13}{324}$

8 a i $m = 30, q = 35, s = 25$
 ii $m + q = 65$

b $\frac{3}{10}$ c $\frac{7}{12}$

9 a 0.084 b 0.52 c 0.68

10 a 60 b 8 c 0.1

11 a $\frac{1}{60}$ b $\frac{1}{5}$ c $\frac{3}{5}$ d $\frac{6}{13}$

12 a i 10 000 cm² ii 400 cm² iii 6400 cm²
 b i 0.04 ii 0.12 iii 0.64
 c i 0.0016 ii 0.000 64

13 a $\frac{7}{18}$ b $\frac{13}{36}$ c $\frac{23}{108}$

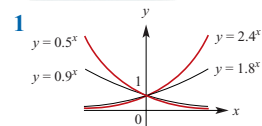
14 a i 0.328 ii 0.205 iii 0.672
 b i 11 ii 18

15 a i 0.121 ii 0.851 iii 0.383
 b i 9 ii 14

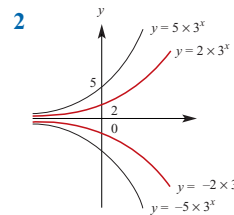
16 a $\frac{20}{81}$ b $\frac{1}{9}$ c i $\frac{5}{12}$ ii $\frac{7}{18}$ d 0.6

Chapter 15

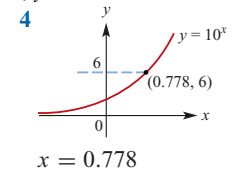
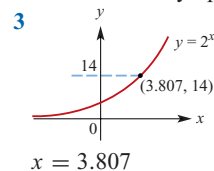
Exercise 15A

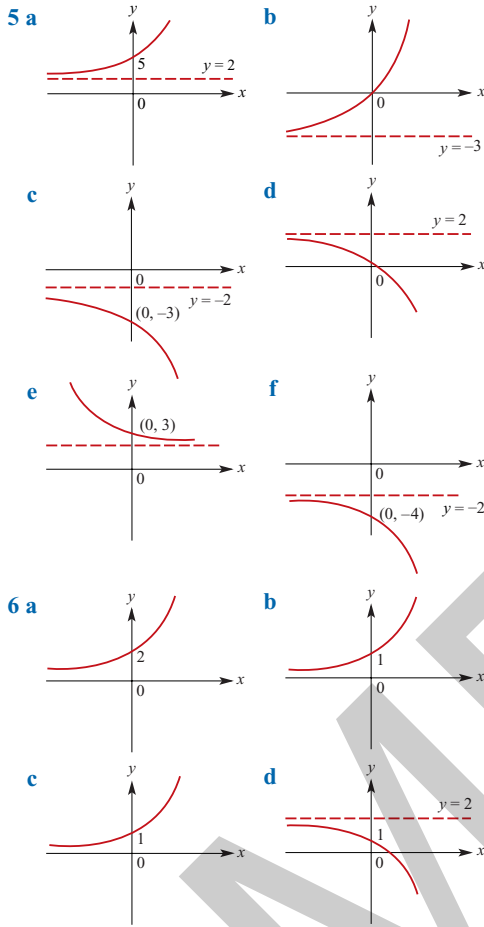


- All pass through (0, 1)
- base > 1, increasing
- base < 1, decreasing
- horizontal asymptote, $y = 0$



- For $y = a \times b^x$
- y -axis intercept (0, a)
 - c and d are reflections of a and b in the x -axis
 - horizontal asymptote, $y = 0$





Exercise 15B

- 1 a x^5 b $8x^7$ c x^2 d $2x^3$ e a^6 f 2^6
 g x^2y^2 h x^4y^6 i $\frac{x^3}{y^3}$ j $\frac{x^6}{y^4}$
 2 a x^9 b 2^{16} c 3^{17} d q^8p^9
 e $a^{11}b^3$ f 2^8x^{18} g $m^{11}n^{12}p^{-2}$ h $2a^5b^{-2}$
 3 a x^2y^3 b $8a^8b^3$ c x^5y^2 d $\frac{9}{2}x^2y^3$
 4 a $\frac{1}{n^4p^5}$ b $\frac{2x^8z}{y^4}$ c $\frac{b^5}{a^5}$ d $\frac{a^3b}{c}$
 e $a^{n+2}b^{n+1}c^{n-1}$
 5 a 3^{17n} b 2^{3-n} c $\frac{3^{4n-11}}{2^2}$
 d $2^{n+1}3^{3n-1}$ e 5^{3n-2} f $2^{3n-3} \times 3^{-4}$
 g $3^{6-n} \times 2^{-5n}$ h $3^3 = 27$ i 6
 6 a $2^{12} = 4096$ b $5^5 = 3125$ c $3^3 = 27$

Exercise 15C

- 1 a 25 b 27 c $\frac{1}{9}$ d 16 e $\frac{1}{2}$ f $\frac{1}{4}$ g $\frac{1}{25}$
 h 16 i $\frac{1}{10000}$ j 1000 k 27 l $\frac{3}{5}$

- 2 a $\frac{1}{6}b^{-\frac{7}{6}}$ b $a^{-6}b^{\frac{9}{2}}$ c $3^{-\frac{7}{3}} \times 5^{-\frac{7}{6}}$
 d $\frac{1}{4}$ e x^6y^{-8} f $a^{\frac{14}{15}}$
 3 a $(2x-1)^{3/2}$ b $(x-1)^{5/2}$ c $(x^2+1)^{3/2}$
 d $(x-1)^{4/3}$ e $x(x-1)^{-\frac{1}{2}}$ f $(5x^2+1)^{4/3}$

Exercise 15D

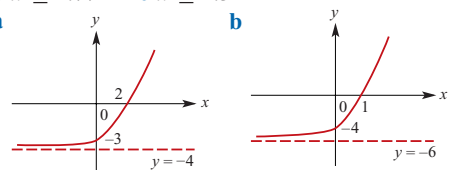
- 1 a 3 b 3 c $\frac{1}{2}$ d $\frac{3}{4}$ e $\frac{1}{3}$ f 4 g 2 h 3 i 3
 2 a 1 b 2 c $-\frac{3}{2}$ d $\frac{4}{3}$ e -1 f 8 g 3
 h -4 i 8 j 4 k $3\frac{1}{2}$ l 6 m $7\frac{1}{2}$
 3 a $\frac{4}{5}$ b $\frac{3}{2}$ c $5\frac{1}{2}$
 4 a 0 b 0, -2 c 1, 2 d 0, 1
 5 a 2.32 b 1.29 c 1.26 d 1.75
 6 a $x > 2$ b $x > \frac{1}{3}$ c $x \leq \frac{1}{2}$ d $x < 3$
 e $x < \frac{3}{4}$ f $x > 1$ g $x \leq 3$

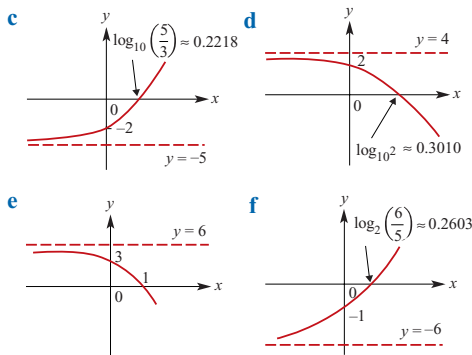
Exercise 15E

- 1 a $\log_2(10a)$ b 1 c $\log_2\left(\frac{9}{4}\right)$ d 1
 e $-\log_5 6$ f -2 g $3 \log_2 a$ h 9
 2 a 3 b 4 c -7 d -3 e 4 f -3 g 4
 h -6 i -9 j -1 k 4 l -2
 3 a 2 b 7 c 9 d 1 e $\frac{5}{2}$
 f $\log_x a^5$ g 3 h 1
 4 a 2 b 27 c $\frac{1}{125}$ d 8 e 30
 f $\frac{2}{3}$ g 8 h 64 i 4 j 10
 5 a 5 b 32.5 c 22 d 20
 e $\frac{3 + \sqrt{17}}{2}$ f 3 or 0
 6 $2 + 3a - \frac{5c}{2}$ 8 10
 9 a 4 b $\frac{6}{5}$ c 3 d 10 e 9 f 2

Exercise 15F

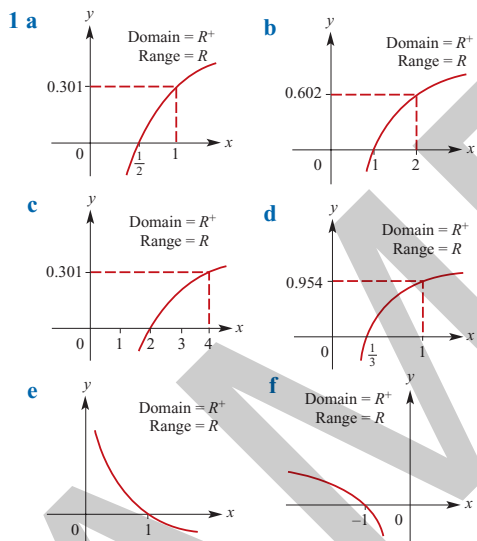
- 1 a 2.81 b -1.32 c 2.40 d 0.79 e -2.58
 f -0.58 g -4.30 h -1.38 i 3.10 j -0.68
 2 a $x > 3$ b $x < 1.46$ c $x < -1.15$
 d $x \leq 2.77$ e $x \geq 1.31$
 3 a



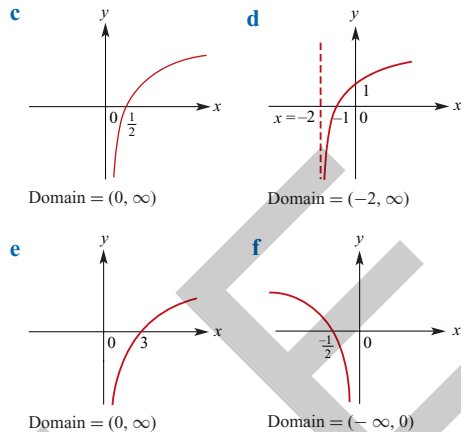
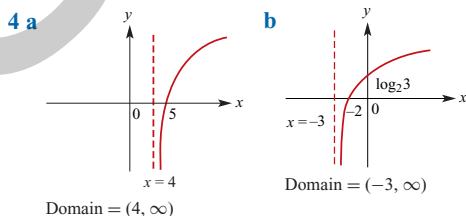


4 $d_0 = 41.88, m = 0.094$

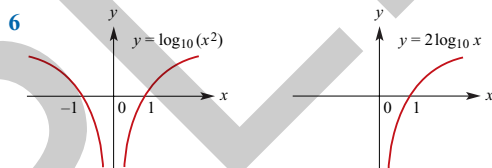
Exercise 15G



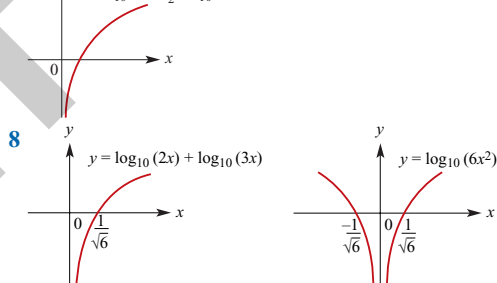
2 a $y = 2 \log_{10} x$ b $y = 10^{\frac{1}{3}x}$
 c $y = \frac{1}{3} \log_{10} x$ d $y = \frac{1}{3} 10^{\frac{1}{2}x}$
 3 a $y = \log_3(x - 2)$ b $y = 2^x + 3$
 c $y = \log_3\left(\frac{x - 2}{4}\right)$ d $y = \log_5(x + 2)$
 e $y = \frac{1}{3} \times 2^x$ f $y = 3 \times 2^x$
 g $y = 2^x - 3$ h $y = \log_3\left(\frac{x + 2}{5}\right)$



5 a 0.64 b 0.40



7 $y = \log_{10} \sqrt{x} = \frac{1}{2} \log_{10} x$ for $x \in (0, 10]$



9 a $\frac{6}{\left(\frac{10}{3}\right)^{\frac{2}{3}}}$ and $k = \frac{1}{3} \log_{10}\left(\frac{10}{3}\right)$

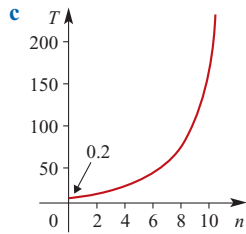
Exercise 15H

1 $y = 1.5 \times 0.575^x$ 2 $p = 2.5 \times 1.35^t$

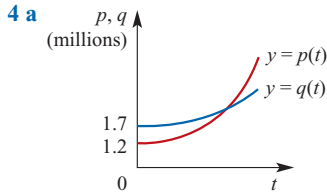
3 a

Cuts, n	Sheets	Total thickness, T (mm)
0	1	0.2
1	2	0.4
2	4	0.8
3	8	1.6
4	16	3.2
5	32	6.4
6	64	12.8
7	128	25.6
8	256	51.2
9	512	102.4
10	1024	204.8

b $T = 0.2(2)^n$



d 214 748.4 m



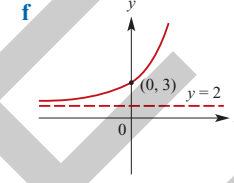
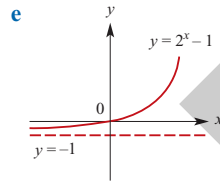
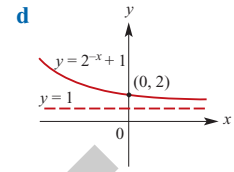
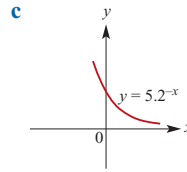
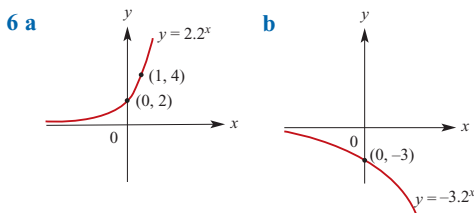
- b i $t = 12.56 \dots$ (mid 1962)
 ii $t = 37.56 \dots$ (mid 1987)

Multiple-choice questions

- 1 C 2 A 3 C 4 C 5 A
 6 B 7 A 8 A 9 A 10 A

Short-answer questions
 (technology-free)

- 1 a a^4 b $\frac{1}{b^2}$ c $\frac{1}{m^2n^2}$
 d $\frac{1}{ab^6}$ e $\frac{3a^6}{2}$ f $\frac{5}{3a^2}$
 g a^3 h $\frac{n^8}{m^4}$ i $\frac{1}{p^2q^4}$
 j $\frac{8}{5a^{11}}$ k $2a$ l $a^2 + a^6$
 2 a $\log_2 7$ b $\frac{1}{2} \log_2 7$ c $\log_{10} 2$
 d $\log_{10} \left(\frac{7}{2}\right)$ e $1 + \log_{10} 11$ f $1 + \log_{10} 101$
 g $\frac{1}{5} \log_2 100$ h $-\log_2 10$
 3 a 6 b 7 c 2 d 0
 e 3 f -2 g -3 h 4
 4 a $\log_{10} 6$ b $\log_{10} 6$ c $\log_{10} \left(\frac{a^2}{b}\right)$
 d $\log_{10} \left(\frac{a^2}{25000}\right)$ e $\log_{10} y$ f $\log_{10} \left(\frac{a^2b^3}{c}\right)$
 5 a $x = 3$ b $x = 3$ or $x = 0$
 c $x = 1$ d $x = 2$ or $x = 3$



- 7 a $x = 1$
 9 $x = 3$ 10 a $k = \frac{1}{7}$ b $q = \frac{3}{2}$
 11 a $a = \frac{1}{2}$ b $y = -4$ or $y = 20$

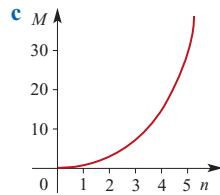
Extended-response questions

1 a

n	0	1	2	3	4
M	0	1	3	7	15

b $M = 2^n - 1$

n	5	6	7
M	31	63	127



d

Three discs	1	2	3
Times moved	4	2	1

Four discs	1	2	3	4
Times moved	8	4	2	1

- 2 $n = 2$
 3 a $\left(\frac{1}{2}\right)^{3n}$ b $\left(\frac{1}{2}\right)^{5n-2}$ c $n = 3$
 4 a $729 \left(\frac{1}{4}\right)^n$ b $128 \left(\frac{1}{2}\right)^n$ c 4 times
 5 a Batch 1 = $15(0.95)^n$ Batch 2 = $20(0.94)^n$
 b 32 years
 6 a X \$1.82 Y \$1.51 Z \$2.62
 b X \$4.37 Y \$4.27 Z \$3.47
 c Intersect at $t = 21.784 \dots$ and
 $t = 2.090 \dots$ therefore February 1997
 until September 1998

- d February 1998 until September 1998, approximately 8 months.
- 7 a 13.81 years b 7.38 years
- 8 a temperature = 87.065×0.94^t
- b i 87.1° ii 18.56°
- c temperature = 85.724×0.94^t
- d i 85.72° ii 40.82°
- e 28.19 minutes
- 9 a $a = 0.2$ and $b = 5$
- b i $z = x \log_{10} b$ ii $a = 0.2$ and $k = \log_{10} 5$
- 10 a $y = 2 \times 1.585^x$ b $y = 2 \times 10^{0.2x}$
- c $x = 5 \log_{10} \left(\frac{y}{2}\right)$

Chapter 16

Exercise 16A

- 1 a $\frac{\pi}{3}$ b $\frac{4\pi}{5}$ c $\frac{4\pi}{3}$ d $\frac{11\pi}{6}$ e $\frac{7\pi}{3}$ f $\frac{8\pi}{3}$
- 2 a 120° b 150° c 210° d 162°
- e 100° f 324° g 220° h 324°
- 3 a 34.38° b 108.29° c 166.16° d 246.94°
- e 213.14° f 296.79° g 271.01° h 343.77°
- 4 a 0.66 b 1.27 c 1.87 d 2.81
- e 1.47 f 3.98 g 2.39 h 5.74
- 5 a -60° b -720° c -540° d -180°
- e 300° f -330° g 690° h -690°
- 6 a -2π b -3π c $-\frac{4\pi}{3}$
- d -4π e $-\frac{11\pi}{6}$ f $-\frac{7\pi}{6}$

Exercise 16B

- 1 a 0, 1 b -1, 0 c 1, 0 d 1, 0
- e 0, -1 f 1, 0 g -1, 0 h 0, 1
- 2 a 0.95 b 0.75 c -0.82 d 0.96
- e -0.5 f -0.03 g -0.86 h 0.61
- 3 a 0; -1 b -1; 0 c -1; 0 d -1; 0
- e -1; 0 f 0; -1 g 0; -1 h 0; -1

Exercise 16C

- 1 a 0 b 0 c undefined
- d 0 e undefined f undefined
- 2 a -34.23 b -2.57 c -0.97
- d -1.38 e 0.95 f 0.75 g 1.66
- 3 a 0 b 0 c 0 d 0 e 0 f 0

Exercise 16D

- 1 a $67^\circ 59'$ b 4.5315 c 2.5357
- d 6.4279 e $50^\circ 12'$ f 3.4202
- g 2.3315 h 6.5778 i 6.5270
- 2 a $a = 0.7660, b = 0.6428$
- b $c = -0.7660, d = 0.6428$
- c i $\cos 140^\circ = -0.76604, \sin 140^\circ = 0.6428$
- ii $\cos 140^\circ = -\cos 40^\circ$

Exercise 16E

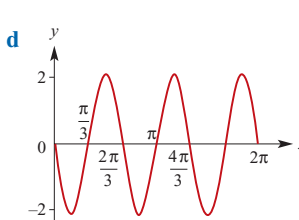
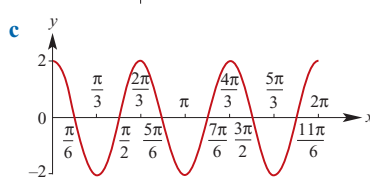
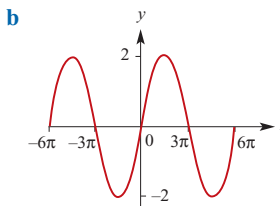
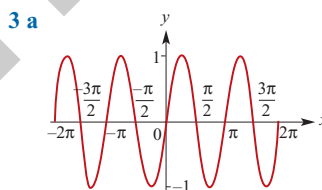
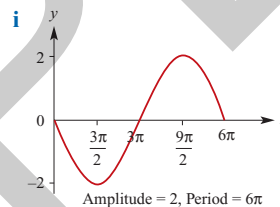
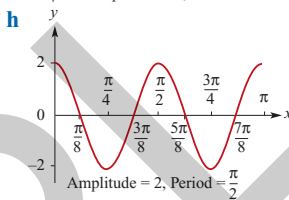
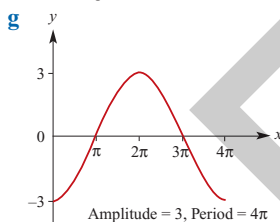
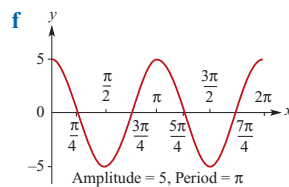
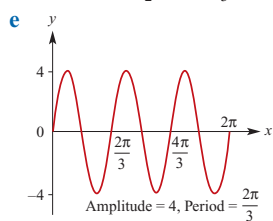
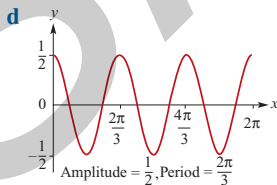
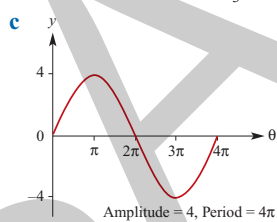
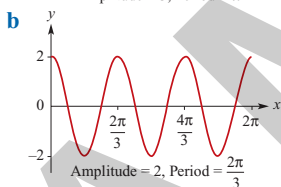
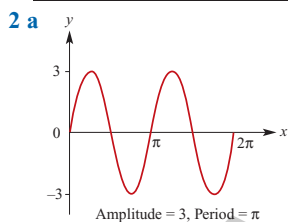
- 1 a -0.42 b -0.7 c -0.42 d -0.38
- e 0.42 f -0.38 g -0.7 h 0.7
- 2 a 120° b 240° c -60°
- d 120° e 240° f 300°
- 3 a $\frac{5\pi}{6}$ b $\frac{7\pi}{6}$ c $\frac{11\pi}{6}$
- 4 a $a = -\frac{1}{2}$ b $b = \frac{\sqrt{3}}{2}$ c $c = \frac{1}{2}$
- d $d = \frac{-\sqrt{3}}{2}$ e $\tan(\pi - \theta) = -\sqrt{3}$
- f $\tan(-\theta) = -\sqrt{3}$
- 5 a $-\frac{\sqrt{3}}{2}$ b $\frac{1}{2}$ c $-\sqrt{3}$ d $-\frac{\sqrt{3}}{2}$ e $-\frac{1}{2}$
- 6 a -0.7 b -0.6 c -0.4 d -0.6
- e -0.7 f -0.7 g 0.4 h 0.6

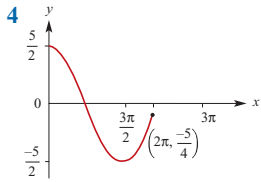
Exercise 16F

- 1 a $\sin = \frac{\sqrt{3}}{2}, \cos = -\frac{1}{2}, \tan = -\sqrt{3}$
- b $\sin = \frac{1}{\sqrt{2}}, \cos = -\frac{1}{\sqrt{2}}, \tan = -1$
- c $\sin = -\frac{1}{2}, \cos = -\frac{\sqrt{3}}{2}, \tan = \frac{1}{\sqrt{3}}$
- d $\sin = -\frac{\sqrt{3}}{2}, \cos = -\frac{1}{2}, \tan = \sqrt{3}$
- e $\sin = -\frac{1}{\sqrt{2}}, \cos = \frac{1}{\sqrt{2}}, \tan = -1$
- f $\sin = \frac{1}{2}, \cos = \frac{\sqrt{3}}{2}, \tan = \frac{1}{\sqrt{3}}$
- g $\sin = \frac{\sqrt{3}}{2}, \cos = \frac{1}{2}, \tan = \sqrt{3}$
- h $\sin = -\frac{1}{\sqrt{2}}, \cos = -\frac{1}{\sqrt{2}}, \tan = 1$
- i $\sin = \frac{\sqrt{3}}{2}, \cos = \frac{1}{2}, \tan = \sqrt{3}$
- j $\sin = -\frac{\sqrt{3}}{2}, \cos = \frac{1}{2}, \tan = -\sqrt{3}$
- 2 a $\frac{\sqrt{3}}{2}$ b $-\frac{1}{\sqrt{2}}$ c $-\frac{1}{\sqrt{3}}$ d $-\frac{1}{2}$ e $-\frac{1}{\sqrt{2}}$
- f $\sqrt{3}$ g $-\frac{\sqrt{3}}{2}$ h $\frac{1}{\sqrt{2}}$ i $-\frac{1}{\sqrt{3}}$
- 3 a $-\frac{\sqrt{3}}{2}$ b $-\frac{1}{\sqrt{2}}$ c $\frac{1}{\sqrt{3}}$ d not defined
- e 0 f $-\frac{1}{\sqrt{2}}$ g $\frac{1}{\sqrt{2}}$ h -1

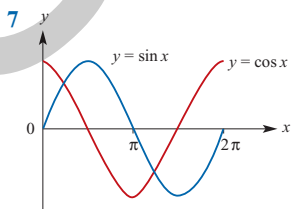
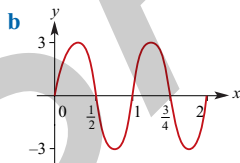
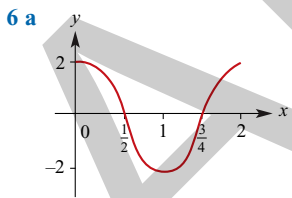
Exercise 16G

1	Period	Amplitude
a	2π	2
b	π	3
c	$\frac{2\pi}{3}$	$\frac{1}{2}$
d	4π	3
e	$\frac{2\pi}{3}$	4
f	$\frac{\pi}{2}$	$\frac{1}{2}$
g	4π	2
h	2	2
i	4	3



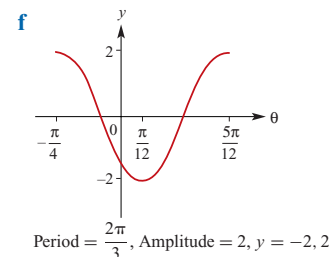
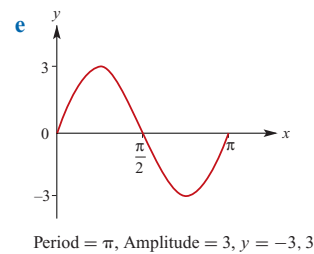
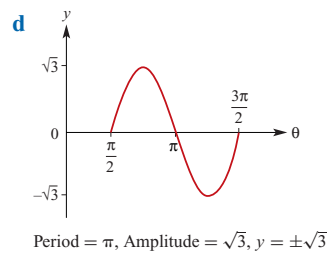
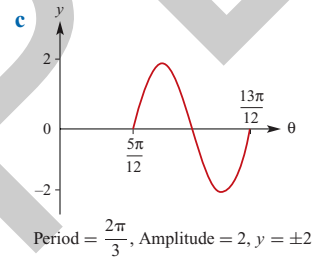
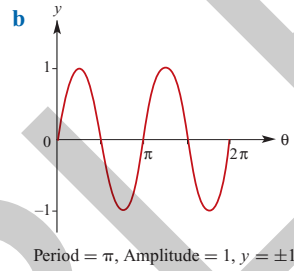
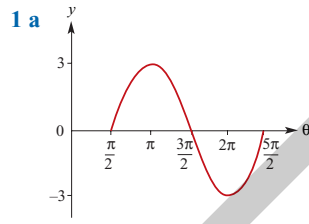


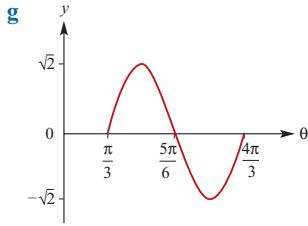
- 4**
- 5 a** dilation of factor 3 from the x -axis
amplitude = 3, period = 2π
- b** dilation of factor $\frac{1}{5}$ from the y -axis
amplitude = 1, period = $\frac{2\pi}{5}$
- c** dilation of factor 3 from the y -axis
amplitude = 1, period = 6π
- d** dilation of factor 2 from the x -axis
dilation of factor $\frac{1}{5}$ from the y -axis
amplitude = 2, period = $\frac{2\pi}{5}$
- e** dilation of factor $\frac{1}{5}$ from the y -axis
reflection in the x -axis
amplitude = 1, period = $\frac{2\pi}{5}$
- f** reflection in the y -axis
amplitude = 1, period = 2π
- g** dilation of factor 3 from the y -axis
dilation of factor 2 from the x -axis
amplitude = 2, period = 6π
- h** dilation of factor 2 from the y -axis
dilation of factor 4 from the x -axis
reflection in the x -axis
amplitude = 4, period = 4π
- i** dilation of factor 3 from the y -axis
dilation of factor 2 from the x -axis
reflection in the y -axis
amplitude = 2, period = 6π



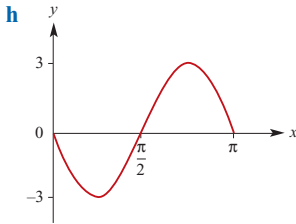
b $\frac{\pi}{4}, \frac{5\pi}{4}$

Exercise 16H

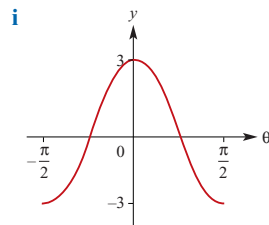




Period = π , Amplitude = $\sqrt{2}$, $y = -\sqrt{2}, \sqrt{2}$

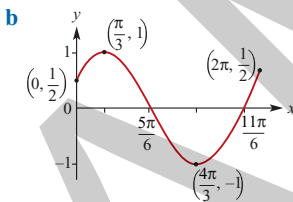


Period = π , Amplitude = 3, $y = -3, 3$

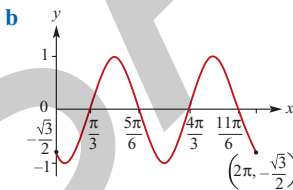


Period = π , Amplitude = 3, $y = 3, -3$

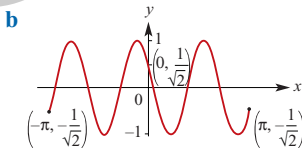
2 a $f(0) = \frac{1}{2}$ $f(2\pi) = \frac{1}{2}$



3 a $f(0) = -\frac{\sqrt{3}}{2}$ $f(2\pi) = -\frac{\sqrt{3}}{2}$



4 a $f(-\pi) = -\frac{1}{\sqrt{2}}$ $f(\pi) = -\frac{1}{\sqrt{2}}$



5 a $y = 3 \sin \frac{x}{2}$ **b** $y = 3 \sin 2x$

c $y = 2 \sin \frac{x}{3}$ **d** $y = \sin 2 \left(x - \frac{\pi}{3} \right)$

e $y = \sin \frac{1}{2} \left(x + \frac{\pi}{3} \right)$

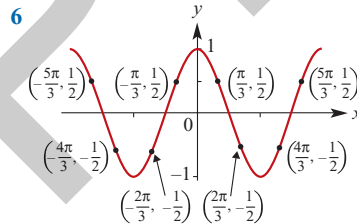
Exercise 16I

- 1 a** $\frac{5\pi}{4}$ and $\frac{7\pi}{4}$ **b** $\frac{\pi}{4}$ and $\frac{7\pi}{4}$
2 a 0.93 and 2.21 **b** 4.30 and 1.98
c 3.50 and 5.93 **d** 0.41 and 2.73
e 2.35 and 3.94 **f** 1.77 and 4.51
3 a 150 and 210 **b** 30 and 150 **c** 120 and 240
d 120 and 240 **e** 60 and 120 **f** 45 and 135
4 a 0.64, 2.498, 6.93, 8.781

b $\frac{5\pi}{4}, \frac{7\pi}{4}, \frac{13\pi}{4}, \frac{15\pi}{4}$

c $\frac{\pi}{3}, \frac{2\pi}{3}, \frac{7\pi}{3}, \frac{8\pi}{3}$

5 a $\frac{3\pi}{4}, -\frac{3\pi}{4}$ **b** $\frac{\pi}{3}, \frac{2\pi}{3}$ **c** $\frac{2\pi}{3}, -\frac{2\pi}{3}$



7 a $\frac{7\pi}{12}, \frac{11\pi}{12}, \frac{19\pi}{12}, \frac{23\pi}{12}$

b $\frac{\pi}{12}, \frac{11\pi}{12}, \frac{13\pi}{12}, \frac{23\pi}{12}$

c $\frac{\pi}{12}, \frac{5\pi}{12}, \frac{13\pi}{12}, \frac{17\pi}{12}$

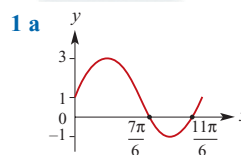
d $\frac{5\pi}{12}, \frac{7\pi}{12}, \frac{13\pi}{12}, \frac{15\pi}{12}, \frac{21\pi}{12}, \frac{23\pi}{12}$

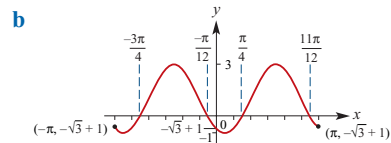
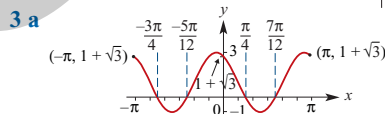
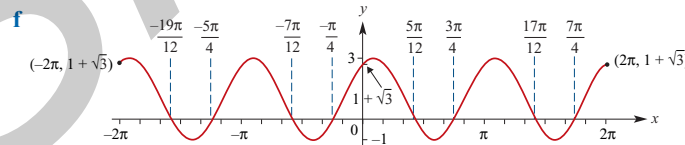
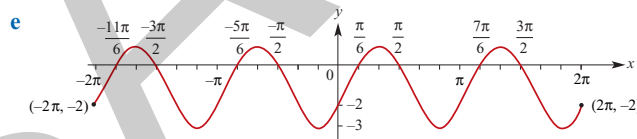
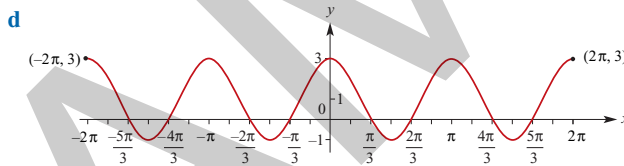
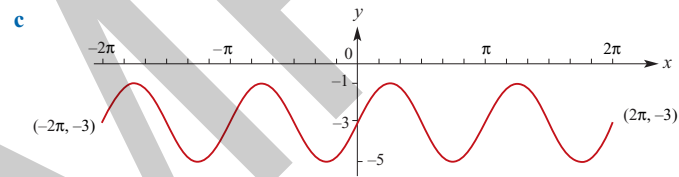
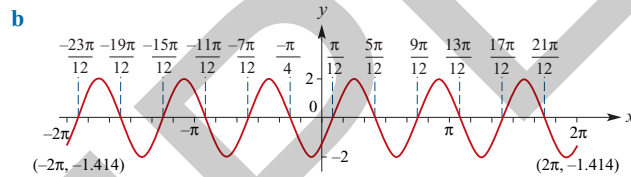
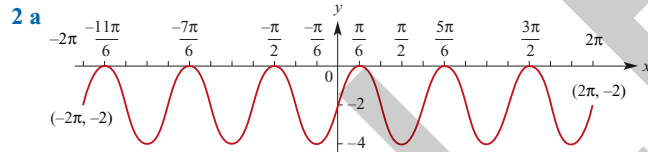
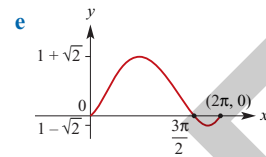
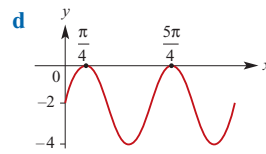
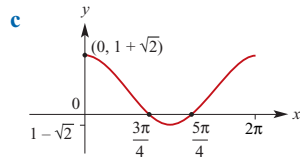
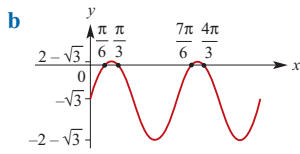
e $\frac{5\pi}{12}, \frac{7\pi}{12}, \frac{17\pi}{12}, \frac{19\pi}{12}$

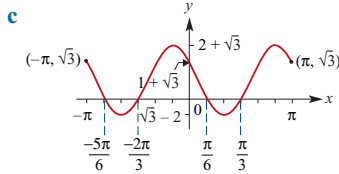
f $\frac{5\pi}{8}, \frac{7\pi}{8}, \frac{13\pi}{8}, \frac{15\pi}{8}$

- 8 a** 2.034, 2.678, 5.176, 5.820
b 1.892, 2.820, 5.034, 5.961
c 0.580, 2.562, 3.721, 5.704
d 0.309, 1.785, 2.403, 3.880, 4.498, 5.974

Exercise 16J







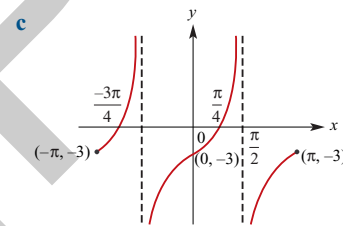
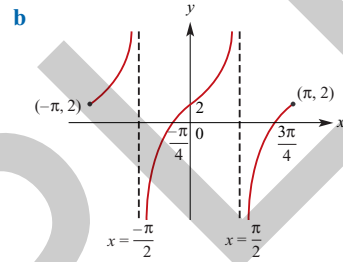
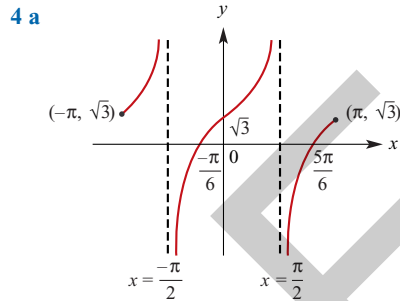
Exercise 16K

- 1 **a** 0.6 **b** 0.6 **c** -0.7 **d** 0.3 **e** -0.3
f $\frac{10}{7}$ (1.49) **g** -0.3 **h** 0.6 **i** -0.6 **j** -0.3
- 2 **a** $\frac{\pi}{3}$ **b** $\frac{\pi}{3}$ **c** $\frac{5\pi}{12}$ **d** $\frac{\pi}{14}$
- 3 $\sin x = \frac{-4}{5}$ and $\tan x = \frac{-4}{3}$
- 4 $\cos x = \frac{-12}{13}$ and $\tan x = \frac{-5}{12}$
- 5 $\sin x = \frac{-2\sqrt{6}}{5}$ and $\tan x = -2\sqrt{6}$

Exercise 16L

- 1 **a** $\frac{\pi}{4}$ **b** $\frac{3\pi}{2}$ **c** $\frac{\pi}{2}$
- 2 **a**
-
- b**
-
- c**
-
- 3 **a** $\frac{-7\pi}{8}, \frac{-3\pi}{8}, \frac{\pi}{8}, \frac{5\pi}{8}$
b $\frac{-17\pi}{18}, \frac{-11\pi}{18}, \frac{-5\pi}{18}, \frac{\pi}{18}, \frac{7\pi}{18}, \frac{13\pi}{18}$
c $\frac{-5\pi}{6}, \frac{-\pi}{3}, \frac{\pi}{6}, \frac{2\pi}{3}$

d $\frac{-13\pi}{18}, \frac{-7\pi}{18}, \frac{-\pi}{18}, \frac{5\pi}{18}, \frac{11\pi}{18}, \frac{17\pi}{18}$



Exercise 16M

- 1 **a** 0.74 **b** 0.51
c 0.82 or -0.82 **d** 0 or 0.88
- 2 $y = a \sin(b\theta + c) + d$
a $a = 1.993$ $b = 2.998$ $c = 0.003$
 $d = 0.993$
b $a = 3.136$ $b = 3.051$ $c = 0.044$
 $d = -0.140$
c $a = 4.971$ $b = 3.010$ $c = 3.136$
 $d = 4.971$

Exercise 16N

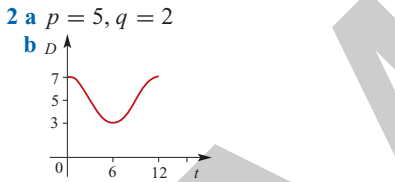
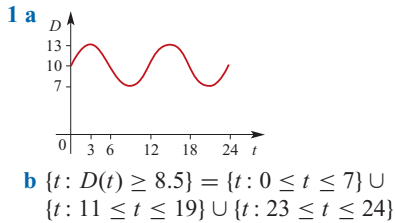
- 1 **a** $x = \frac{(12n+1)\pi}{6}$ or $x = \frac{(12n+5)\pi}{6}$
b $x = \frac{(12n \pm 1)\pi}{18}$ **c** $x = \frac{(3n+2)\pi}{3}$
- 2 **a** $x = \frac{\pi}{6}$ or $x = \frac{5\pi}{6}$
b $x = \frac{\pi}{18}$ or $x = \frac{11\pi}{18}$
c $x = \frac{2\pi}{3}$ or $x = \frac{5\pi}{3}$

3 $x = n\pi$ or $x = \frac{(4n-1)\pi}{4}$;
 $x = -\frac{5\pi}{4}, -\pi, -\frac{\pi}{4}, 0, \frac{3\pi}{4}, \pi$ or $\frac{7\pi}{4}$

4 $x = \frac{n\pi}{3}$; $x = -\pi, -\frac{2\pi}{3}, -\frac{\pi}{3}, 0$

5 $x = \frac{6n-1}{12}$ or $x = \frac{3n+2}{6}$;
 $x = -\frac{2}{3}, -\frac{7}{12}, -\frac{1}{6}, -\frac{1}{12}, \frac{1}{3}, \frac{5}{12}, \frac{5}{6}, \frac{11}{12}$

Exercise 160



- c A ship can enter 2 hours after low tide.
- 3 a 5 b 1
- c $t = 0.524$ s, 2.618 s, 4.712 s
- d $t = 0$ s, 1.047 s, 2.094 s
- e Particle oscillates about the point $x = 3$ from $x = 1$ to $x = 5$.

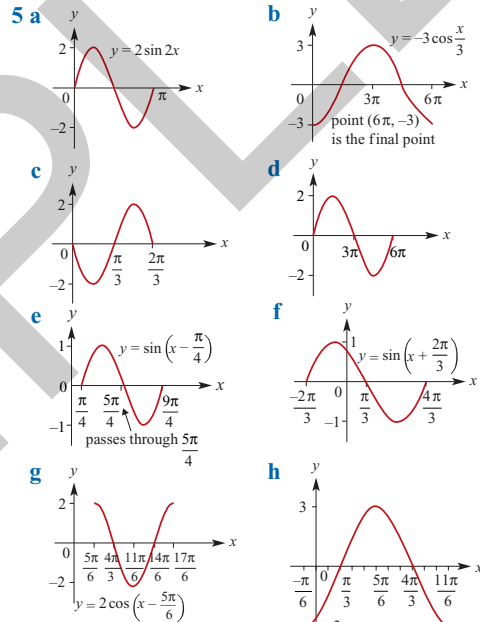
Multiple-choice questions

- 1 C 2 D 3 E 4 C 5 E
 6 D 7 E 8 E 9 C 10 B

Short-answer questions (technology-free)

- 1 a $\frac{11\pi}{6}$ b $\frac{9\pi}{2}$ c 6π d $\frac{23\pi}{4}$ e $\frac{3\pi}{4}$
 f $\frac{9\pi}{4}$ g $\frac{13\pi}{6}$ h $\frac{7\pi}{3}$ i $\frac{4\pi}{9}$
- 2 a 150° b 315° c 495° d 45° e 1350°
 f -135° g -45° h -495° i -1035°
- 3 a $\frac{1}{\sqrt{2}}$ b $\frac{1}{\sqrt{2}}$ c $-\frac{1}{2}$ d $-\frac{\sqrt{3}}{2}$
 e $\frac{\sqrt{3}}{2}$ f $-\frac{1}{2}$ g $\frac{1}{2}$ h $-\frac{1}{\sqrt{2}}$

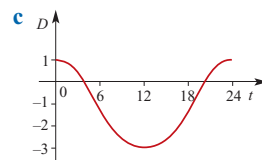
	Amplitude	Period
a	2	4π
b	3	$\frac{\pi}{2}$
c	$\frac{1}{2}$	$\frac{2\pi}{3}$
d	3	π
e	4	6π
f	$\frac{2}{3}$	3π



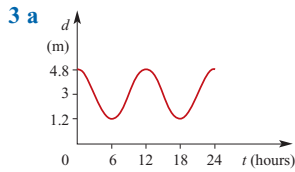
- 6 a $-\frac{2\pi}{3}, -\frac{\pi}{3}$
 b $-\frac{\pi}{3}, -\frac{\pi}{6}, \frac{2\pi}{3}, \frac{5\pi}{6}$
 c $\frac{\pi}{6}, \frac{3\pi}{2}$ d $\frac{7\pi}{6}$ e $\frac{\pi}{2}, \frac{7\pi}{6}$

Extended-response questions

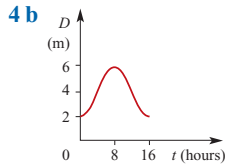
- 1 a i 1.83×10^{-3} hours
 ii 11.79 hours
 b 26 April ($t = 3.86$) 14 August ($t = 7.48$)
- 2 a 19.5°C b $D = -1 + 2 \cos\left(\frac{\pi t}{12}\right)$



- d $\{t: 4 < t < 20\}$



- b** 3.00 am 3.00 pm 3.00 am
c 9.00 am 9.00 pm **d** 10.03 am
e i 6.12 pm ii 5 trips



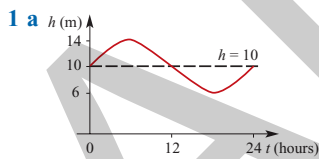
- c** $t = 16$ (8.00 pm)
d $t = 4$ and $t = 12$ (8.00 am and 4.00 pm) depth is 4 m
e i 1.5 m ii 2.086 m
f 9 hours 17 minutes

Chapter 17

17.1 Multiple-choice questions

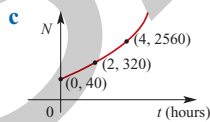
- 1** B **2** B **3** B **4** E **5** D **6** A
7 D **8** C **9** B **10** A **11** A **12** D
13 A **14** D **15** D **16** D **17** A **18** E
19 D **20** D **21** E **22** A **23** E **24** B
25 D **26** B

17.2 Extended-response questions



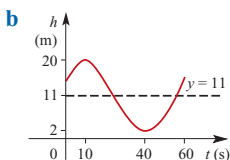
- b** $t = 3.2393$ and $t = 8.7606$
c The boat can leave the harbour for $t \in [0.9652, 11.0348]$

- 2 a** 40 bacteria
b i 320 bacteria ii 2560 bacteria
 iii 10 485 760 bacteria



- d** 40 minutes, ($= \frac{2}{3}$ hours)

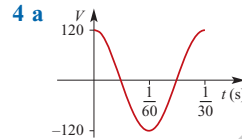
- 3 a** 60 seconds



- c** $[2, 20]$

- d** After 40 seconds and they are at this height every 60 seconds after they first attain this height.

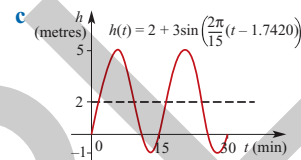
- e** At $t = 0, t = 20$ and $t = 60$ for $t \in [0, 60]$



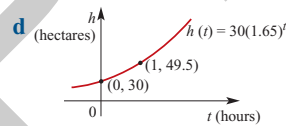
- b** $t = \frac{1}{180}$ s **c** $t = \frac{k}{30}$ s, $k = 0, 1, 2$

- 5 a** i Period = 15 seconds
 ii amplitude = 3 **iii** $c = \frac{2\pi}{15}$

- b** $h = 1.74202$

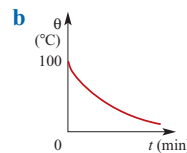


- 6 a** i 30 **ii** 49.5 **iii** 81.675
b 1.65 **c** 6.792



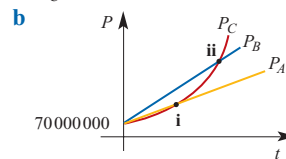
7 a

t	0	1	2	3	4	5
θ	100	60	40	30	25	22.5



- c** 1 minute **d** 27.071

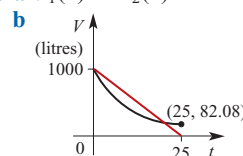
- 8 a** $P_A = 70\,000\,000 + 3\,000\,000t$
 $P_B = 70\,000\,000 + 5\,000\,000t$
 $P_C = 70\,000\,000 \times 1.3^{\frac{t}{10}}$



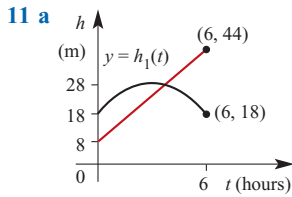
- c** i 35 years **ii** 67 years

- 9 a** i 4 billion **ii** 5.944 billion **iii** 7.25 billion
b 2032

- 10 a** $V_1(0) = V_2(0) = 1000$



- c** 82.08 litres **d** $t = 0$ and $t = 22.32$



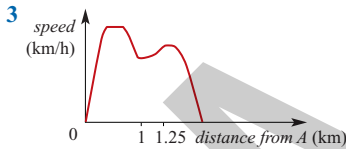
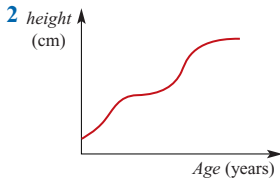
- b** $t = 3.31$ Approximately 3.19 am (correct to nearest minute)
c **i** 9.00 am
d $8 + 6t$ metres

Chapter 18

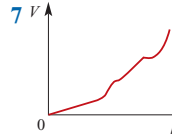
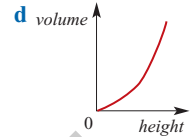
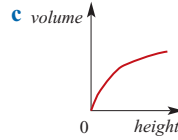
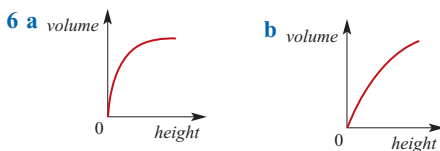
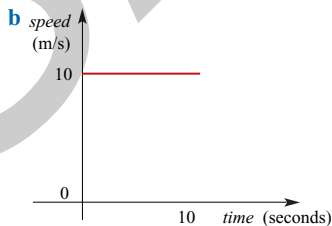
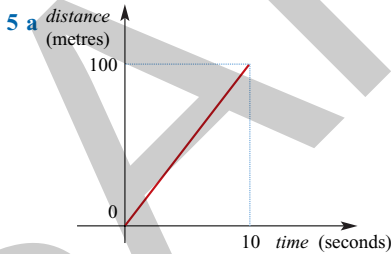
Exercise 18A

Note: For questions 1–4 there may not be a single correct answer.

- 1** *C* and *D* are the most likely. Scales should come into your discussion.



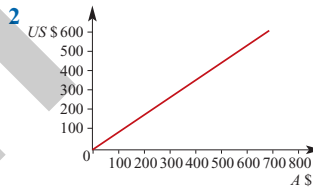
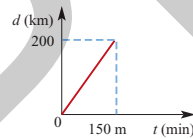
- 4** *C* or *B* are the most likely.



- 8** **D** **9** **C**
10 a $[-7, -4] \cup (0, 3]$ **b** $[-7, -4] \cup (0, 3]$
11 a $[-5, -3] \cup (0, 2]$ **c** $[-5, -3] \cup (0, 2]$

Exercise 18B

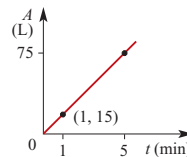
1 $\frac{4}{3}$ km/min = 80 km/h



- 3 a** 60 km/h **b** 3 m/s
c 400 m/min = 24 km/h = $6\frac{2}{3}$ m/s
d 35.29 km/h **e** 20.44 m/s
4 a 8 litres/minute **b** 50 litres/minute
c $\frac{200}{17}$ litres/min **d** $\frac{135}{13}$ litres/min

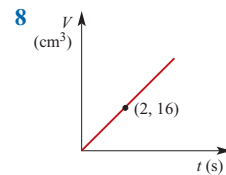
5

<i>t</i>	0	0.5	1	1.5	2	3	4	5
<i>A</i>	0	7.5	15	22.5	30	45	60	75



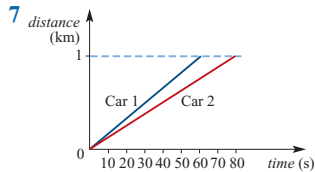
6 $\frac{\$200}{13}$ per hour = \$15.38 per hour

7 $208\frac{1}{3}$ m/s



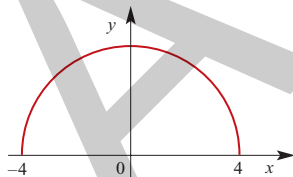
Exercise 18C

- 1 a 2 b 7 c $\frac{-1}{2}$ d $\frac{1-\sqrt{5}}{4}$
 2 a $\frac{-25}{7}$ b $\frac{-18}{7}$ c 4 d $\frac{4b}{3a}$
 3 a 4 m/s b 32 m/s
 4 a \$2450.09 b \$150.03 per year
 5 3.125 cm/min 6 C



Exercise 18D

- 1 a $\frac{1}{3}$ kg/month (answers will vary)
 b $\frac{1}{2}$ kg/month (answers will vary)
 c $\frac{1}{5}$ kg/month (answers will vary)
 2 a ≈ 0.004 m³/s (answers will vary)
 b ≈ 0.01 m³/s (answers will vary)
 c ≈ 0.003 m³/s (answers will vary)
 3 a $\frac{1}{80} = 0.0125$ litres/kg m
 b $\frac{1}{60} \approx 0.0167$ litres/kg m
 4 a ≈ 8 years b ≈ 7 cm/year
 5 a 25°C at 1600 hours b $\approx 3^\circ\text{C/h}$ c -2.5°C/h
 6 -0.5952
 7 a

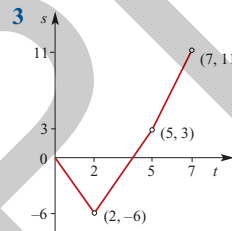
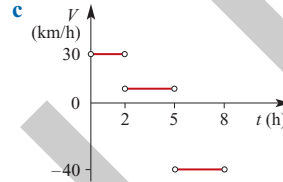


- b 0 c -0.6 d -1.1
 8 a 4
 9 a 16 m³/min b 10 m³/min
 10 a 18 million/min b 8.3 million/min
 11 a 620 m³/min flowing out
 b 4440 m³/min flowing out
 c 284 000 m³/min flowing out
 12 7.19
 13 a 7 b 9 c 2 d 35
 14 28 b 12
 15 a 10 b 4
 16 a i $\frac{2}{\pi} \approx 0.637$ ii $\frac{2\sqrt{2}}{\pi} \approx 0.9003$
 iii 0.959 iv 0.998
 b 1

- 17 a i 9 ii 4.3246 iii 2.5893 iv 2.3293
 b 2.30

Exercise 18E

- 1 a 4 m/s b 1.12 m/s c 0 m/s
 d $(-\infty, -\sqrt{3})$ and $(0, \sqrt{3})$ e $(-1, 1)$
 2 a i 30 km/h ii $\frac{20}{3}$ km/h iii -40 km/h

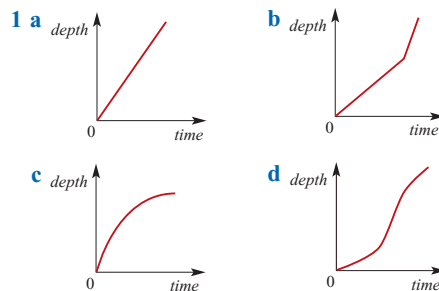


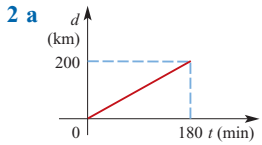
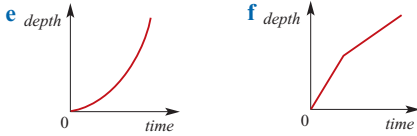
- 4 a C b A c B
 5 a +ve slowing down b +ve speeding up
 c -ve slowing down d -ve speeding up
 6 a gradually increasing speed
 b constant speed (holds speed attained at a)
 c final speeding up to finishing line
 7 a $t = 6$ b 15 m/s c 17.5 m/s
 d 20 m/s e -10 m/s f -20 m/s
 8 a $t = 2.5$ b $0 \leq t < 2.5$
 c 6 m d 5 seconds e 3 m/s
 9 a 11 m/s b 15 m c 1 s d 2.8 s e 15 m/s
 10 a $t = 2, t = 3, t = 8$ b $0 < t < 2.5$ and $t > 6$
 c $t = 2.5$ and $t = 6$

Multiple-choice questions

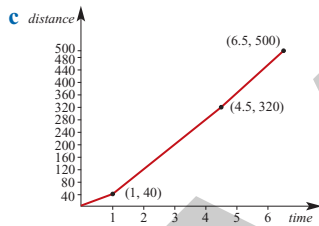
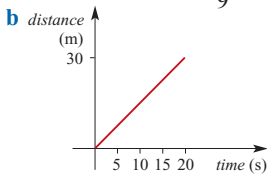
- 1 C 2 B 3 D 4 E 5 D
 6 B 7 C 8 E 9 A 10 A

Short-answer questions (technology-free)





$$\begin{aligned} \text{constant speed} &= \frac{200}{3} \text{ km/h} \\ &= \frac{200}{180} \text{ km/min} \\ &= \frac{10}{9} \text{ km/min} \end{aligned}$$



3 $36 \text{ cm}^2/\text{cm}$

4 a **i** 1 **b** 13

5 a -2 m/s **b** -12.26 m/s **c** -14 m/s

Extended-response questions

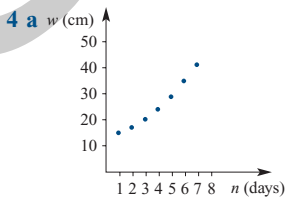
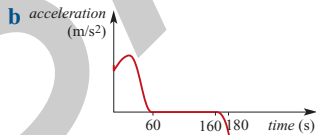
1 a Yes, the relation is linear.

b $0.05 \text{ ohm}/^\circ\text{C}$

2 a **i** 9.8 m/s **ii** 29.4 m/s

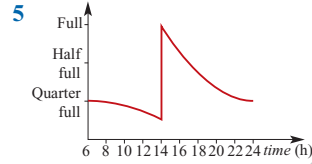
b **i** $4.9(8h - h^2)$ **ii** $4.9(8 - h)$ **iii** 39.2 m/s

3 a **i** $\frac{1}{4} \text{ m/s}^2$ **ii** 0.35 m/s^2



b gradient $= 5\frac{1}{4}$; Average rate of growth of the watermelon is $5\frac{1}{4} \text{ cm/day}$

c $\approx 4.5 \text{ cm/day}$



6 a $b + a$ ($a \neq b$) **b** 3 **c** 4.01

7 a $2\frac{2}{3}, 1\frac{3}{5}$; gradient $= -1\frac{1}{15}$

b $2.1053, 1.9048$; gradient $= -1.003$

c -1.000025 **d** -1.0000003 **e** gradient is -1

8 6

9 a $\approx 3\frac{1}{3} \text{ kg/year}$ **b** $\approx 4.4 \text{ kg/year}$

c $\{t: 0 < t < 5\} \cup \{t: 10 < t < 12\}$

d $\{t: 5 < t < 7\} \cup \{t: 11 < t < 17\frac{1}{2}\}$

10 a **i** 2.5×10^8 **ii** 5×10^8

b $0.007 \text{ billion/year}$

c **i** $0.004 \text{ billion/year}$ **ii** $0.015 \text{ billion/year}$

d $25 \text{ years after 2020}$

11 a **i** 1049.1 **ii** 1164.3 **iii** 1297.7 **iv** 1372.4

b 1452.8

12 a $a^2 + ab + b^2$ **b** 7 **c** 12.06 **d** $3b^2$

13 a B **b** A **c** 25 m **d** 45 s

e $0.98 \text{ m/s}, 1.724 \text{ m/s}, 1.136 \text{ m/s}$

14 a **i** m **ii** cm **iii** $-m$

b results are the same

Chapter 19

Exercise 19A

1 2000 m/s **2** 7 per day

3 a 1 **b** $3x^2 + 1$ **c** 20 **d** $30x^2 + 1$ **e** 5

4 a $2x + 2$ **b** 13 **c** $3x^2 + 4x$

5 a $5 + 3h$ **b** 5.3 **c** 5

6 a $\frac{-1}{2+h}$ **b** -0.48 **c** $\frac{-1}{2}$

7 a $6 + h$ **b** 6.1 **c** 6

Exercise 19B

1 a $6x$ **b** 4 **c** 0 **d** $6x + 4$

e $6x^2$ **f** $8x - 5$ **g** $-2 + 2x$

2 a $2x + 4$ **b** 2 **c** $3x^2 - 1$

d $x - 3$ **e** $15x^2 + 6x$ **f** $-3x^2 + 4x$

3 a $12x^{11}$ **b** $21x^6$ **c** 5

d 5 **e** 0 **f** $10x - 3$

g $50x^4 + 12x^3$ **h** $8x^3 + x^2 - \frac{1}{2}x$

4 a -1 **b** 0 **c** $12x^2 - 3$ **d** $x^2 - 1$

e $2x + 3$ **f** $18x^2 - 8$ **g** $15x^2 + 3x$

5 a **i** 3 **ii** $3a^2$ **b** $3x^2$

6 a $\frac{dy}{dx} = 3(x - 1)^2 \geq 0$ for all $x \in R$ and gradient of graph ≥ 0 for all x

b $\frac{dy}{dx} = 1$ for all $x \neq 0$ **c** $18x + 6$

- 7 a 1, gradient = 2 b 1, gradient = 1
 c 3, gradient = -4 d -5, gradient = 4
 e 28, gradient = -36 f 9, gradient = -24

8 a i $4x - 1, 3, \left(\frac{1}{2}, 0\right)$

ii $\frac{1}{2} + \frac{2}{3}x, \frac{7}{6}, \left(\frac{3}{4}, \frac{25}{16}\right)$

iii $3x^2 + 1, 4, (0, 0)$

iv $4x^3 - 31, -27, (2, -46)$

b coordinates of the point where gradient = 1

- 9 a $6t - 4$ b $-2x + 3x^2$ c $-4z - 4z^3$
 d $6y - 3y^2$ e $6x^2 - 8x$ f $19.6t - 2$

- 10 a (4, 16) b (2, 8) and (-2, -8)

c (0, 0) d $\left(\frac{3}{2}, -\frac{5}{4}\right)$

e (2, -12) f $\left(-\frac{1}{3}, \frac{4}{27}\right), (1, 0)$

Exercise 19C

- 1 b and d 2 a, b and e

- 3 a $x = 1$ b $x = \frac{1}{2}$ c $x > 1$

d $x < 1$ e $x = \frac{1}{2}$

4 a $(-\infty, -3) \cup \left(\frac{1}{2}, 4\right)$

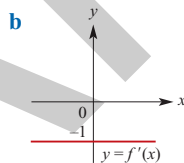
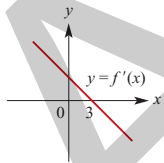
b $\left(-3, \frac{1}{2}\right) \cup (4, \infty)$ c $\left\{-3, \frac{1}{2}, 4\right\}$

- 5 a B b C c D d A e F f E

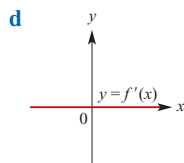
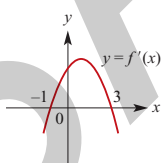
- 6 a (-1, 1.5) b $(-\infty, -1) \cup (1.5, \infty)$

c $\{-1, 1.5\}$

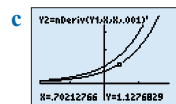
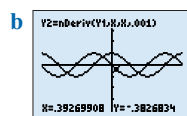
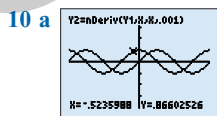
- 7 a



- c



- 8 a (3, 0) b (4, 2) 9 a $\left(\frac{1}{2}, -6\frac{1}{4}\right)$ b (0, -6)



- 11 a $(0.6)t^2$ b 0.6 m/s, 5.4 m/s, 15 m/s

- 12 a height = 450 000 m; speed = 6000 m/s

b $t = 25$ s

- 13 a $a = 2, b = -5$ b $\left(\frac{5}{4}, -\frac{25}{8}\right)$

Exercise 19D

- 1 a 15 b 1 c $-3\frac{1}{2}$ d $-2\frac{1}{2}$

- e 0 f 4 g 2 h $2\sqrt{3}$

- i -2 j 12 k $\frac{11}{9}$ l $\frac{1}{4}$

- 2 a 3, 4 b 7

- 3 a 0 as $f(0) = 0, \lim_{x \rightarrow 0^+} f(x) = 0$ but

$\lim_{x \rightarrow 0^-} f(x) = 2$

- b 1 as $f(1) = 3, \lim_{x \rightarrow 1^+} f(x) = 3$ but

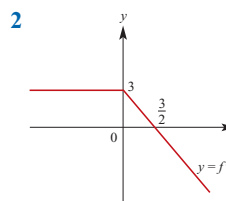
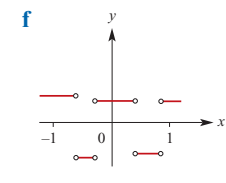
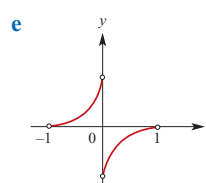
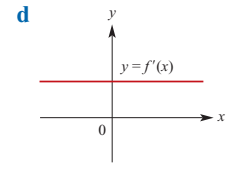
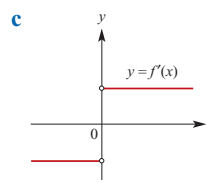
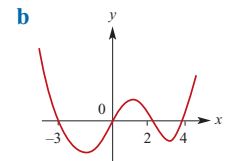
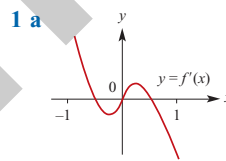
$\lim_{x \rightarrow 1^-} f(x) = -1$

- c 0 as $f(0) = 1, \lim_{x \rightarrow 0^+} f(x) = 1$ but

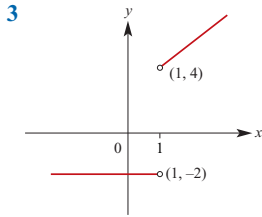
$\lim_{x \rightarrow 0^-} f(x) = 0$

4 $x = 1$

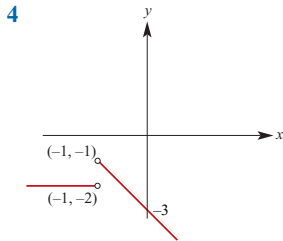
Exercise 19E



$$f'(x) = \begin{cases} -2x + 3 & \text{if } x \geq 0 \\ 3 & \text{if } x < 0 \end{cases}$$



$$f'(x) = \begin{cases} 2x + 2 & \text{if } x \geq 1 \\ -2 & \text{if } x < 1 \end{cases}$$



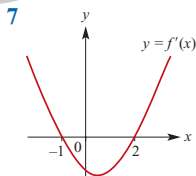
$$f'(x) = \begin{cases} -2x - 3 & \text{if } x \geq -1 \\ -2 & \text{if } x < -1 \end{cases}$$

Multiple-choice questions

- 1 D 2 B 3 E 4 B 5 C
6 C 7 A 8 E 9 A 10 D

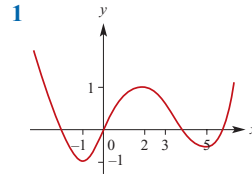
Short-answer questions (technology-free)

- 1 a $6x - 2$ b 0 c $4 - 4x$
d $4(20x - 1)$ e $6x + 1$ f $-6x - 1$
- 2 a -1 b 0 c $\frac{4x + 7}{4}$ d $\frac{4x - 1}{3}$ e x
- 3 a 1; 2 b 3; -4 c -5; 4 d 28; -36
- 4 a $\left(\frac{3}{2}, -\frac{5}{4}\right)$ b (2, -12)
c $\left(-\frac{1}{3}, \frac{4}{27}\right), (1, 0)$ d (-1, 8)(1, 6)
e (0, 1) $\left(\frac{3}{2}, -\frac{11}{16}\right)$ f (3, 0)(1, 4)
- 5 a $x = \frac{1}{2}$ b $x = \frac{1}{2}$ c $x > \frac{1}{2}$
d $x < \frac{1}{2}$ e $R \setminus \left\{\frac{1}{2}\right\}$ f $x = \frac{5}{8}$
- 6 a $a = 2, b = -1$ b $\left(\frac{1}{4}, -\frac{1}{8}\right)$



- 8 a (-1, 4) b $(-\infty, -1) \cup (4, \infty)$ c $\{-1, 4\}$

Extended-response questions



2 $y = \frac{7}{36}x^3 + \frac{1}{36}x^2 - \frac{20}{9}x$

- 3 a i $71^\circ 34'$ ii $89^\circ 35'$ b 2 km
4 a 0.12, -0.15
b $x = 2, y = 2.16$. The height of the pass is 2.16 km.
5 a $t = \sqrt[3]{250}, 11.9$ cm/s b 3.97 cm/s
6 a At $x = 0$, gradient = -2; at $x = 2$, gradient = 2
Angles of inclination to positive directions of x -axis are supplementary.

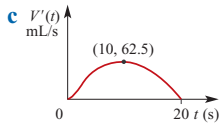
Chapter 20

Exercise 20A

- 1 a $y = 4x - 4; 4y + x = 18$
b $y = 12x - 15; 12y + x = 110$
c $y = -x + 4; y = x$
d $y = 6x + 2; 6y + x = 49$
- 2 $y = 2x - 10$
- 3 $y = 2x - 1; y = 2x - \frac{8}{3}$;
both have gradient = 2;
distance apart = $\frac{\sqrt{5}}{3}$
- 4 $y = 3x + 2; y = 3x + 6$
- 5 a Tangents both have gradient 2; b (0, -3)
- 6 (3, 12) (1, 4)
- 7 a $y = 10x - 16$ b (-4, -56)
8 a $y = 5x - 1$ b (2, 4) (4, -8)

Exercise 20B

- 1 a 36; $\frac{36}{1} = 36$ b $48 - 12h$ c 48
- 2 a $1200t - 200t^2$ b 1800 dollars/month
c At $t = 0$ and $t = 6$
- 3 a -3 cm/s b $2\sqrt{3}$ s
- 4 a $15 - 9.8t$ m/s b -9.8 m/s²
- 5 a $30 - 4p$ b 10; -10
c For $P < 7.5$ revenue is increasing as P increases.
- 6 a i 50 people/year ii 0 people/year
iii decreasing by 50 people/year
- 7 a i 0 mL ii $833\frac{1}{3}$ mL
- b $V'(t) = \frac{5}{8}(20t - t^2)$



- 8 a i 64 m/s ii 32 m/s iii 0 m/s
 9 a 0 s, 1 s, 2 s
 b 2 m/s, -1 m/s, 2 m/s; -6 m/s², 0 m/s², 6 m/s²
 c 0 m/s²
 10 a $\frac{1}{2}$ m/s² b $2\frac{1}{2}$ m/s²
 11 a 12 cm to the right of O
 b 2 cm to the right of O
 c moving to the left at 7 cm/s
 d when $t = 3.5$ s and the particle is 0.25 cm to the left of O
 e -2 cm/s f 2.9 cm/s
 12 a after 3.5 s b 2 m/s² c 14.5 m
 d when $t = 2.5$ s and the particle is 1.25 m to the left of O
 13 a 3 cm to the left of O moving to the right at 24 cm/s
 b $v = 3t^2 - 22t + 24$
 c after $\frac{4}{3}$ s and 6 s
 d $11\frac{22}{27}$ cm to the right of O and 39 cm to the left of O
 e $4\frac{2}{3}$ s
 f $a = 6t - 22$
 g when $t = \frac{11}{3}$ s and the particle is $13\frac{16}{27}$ cm left of O moving to the left at $16\frac{1}{3}$ cm/s
 14 a when $t = \frac{2}{3}$ s and $a = -2$ cm/s², and when $t = 1$ and $a = 2$ cm/s²
 b when $t = \frac{5}{6}$ s and the particle is moving to the left at $\frac{1}{6}$ cm/s
 15 when $t = 2$ s, $v = 6$ cm/s, $a = -14$ cm/s², when $t = 3$, $v = -5$ cm/s, $a = -8$ cm/s², when $t = 8$ s, $v = 30$ cm/s, $a = 22$ cm/s²
 16 a $t = 4$ s and $t = -1$ b $t = \frac{3}{2}$ s

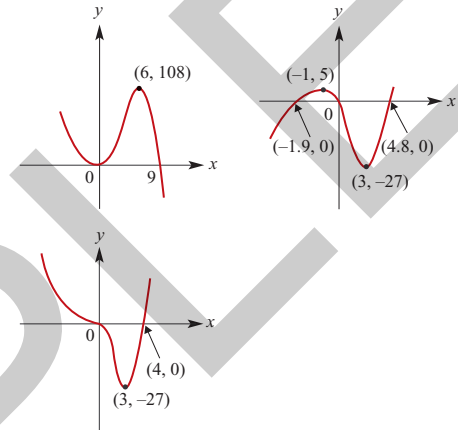
Exercise 20C

- 1 a (3, -6) b (3, 2) c (2, 2) d (4, 48)
 e (0, 0); (2, -8) f (0, -10); (2, 6)
 2 $a = 2, b = -8, c = -1$
 3 $a = -\frac{1}{2}, b = 1, c = 1\frac{1}{2}$
 4 a $a = 2, b = -5$ b $(\frac{5}{4}, -\frac{25}{8})$
 5 $a = -8$ 6 $a = 6$
 7 a (2.5, -12.25) b $(\frac{7}{48}, -\frac{625}{96})$
 c (0, 27) (3, 0) d (-2, 48) (4, -60)
 e (-3, 4) (-1, 0) f (-1.5, 0.5)

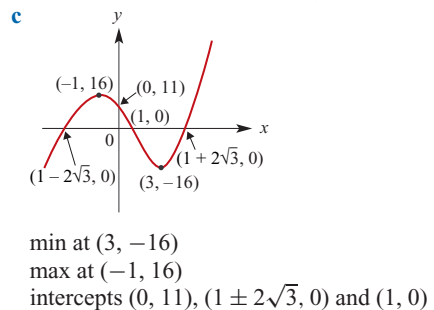
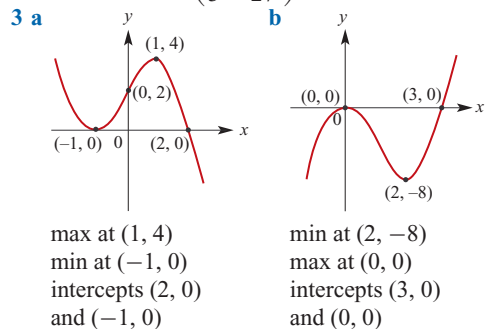
- 8 a $a = -1, b = 2$
 9 $a = -\frac{2}{9}, b = \frac{3}{2}, c = -3, d = 7\frac{1}{2}$

Exercise 20D

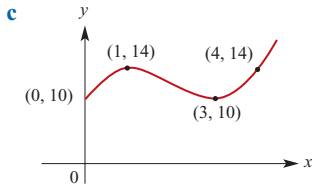
- 1 a min (0, 0); max (6, 108)
 b min (3, -27); max (-1, 5)
 c Stationary point of inflexion (0, 0); min (3, -27)



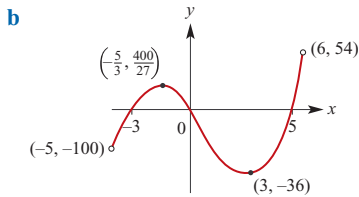
- 2 a (0, 0) max; $(\frac{8}{3}, -\frac{256}{27})$ min
 b (0, 0) min; (2, 4) max c (0, 0) min
 d $(\frac{10}{3}, -\frac{200\,000}{729})$ min; (0, 0) inflexion
 e (3, -7) min; $(\frac{1}{3}, 2\frac{13}{27})$ max
 f (6, -36) min; $(\frac{4}{3}, \frac{400}{27})$ max



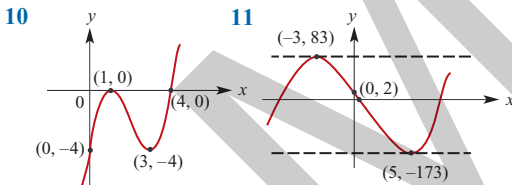
- 4 a $(-2, 10)$ max
 b $(-2, 10)$ stationary point of inflexion
 5 a $(-\infty, 1) \cup (3, \infty)$
 b $(1, 14)$ max; $(3, 10)$ min



- 6 25 7 $\{x : -2 < x < 2\}$
 8 a $\{x : -1 < x < 1\}$ b $\{x : x < 0\}$
 9 a $x = -\frac{5}{3}; x = 3$

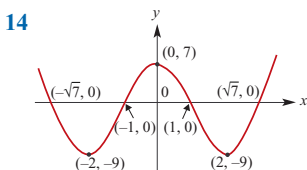
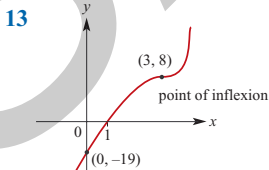
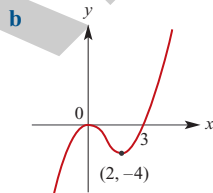


max at $(-\frac{5}{3}, \frac{400}{27})$
 min at $(3, -36)$
 intercepts $(5, 0)$ $(0, 0)$ $(-3, 0)$



Tangents are parallel to x -axis at $(-3, 83)$ and $(5, -173)$.

- 12 a i $(0, 2)$
 ii $(-\infty, 0) \cup (2, \infty)$
 iii $\{0, 2\}$



- min at $(-2, -9)$; $(2, -9)$
 max at $(0, 7)$
 intercepts $(\pm\sqrt{7}, 0)$ $(\pm 1, 0)$ $(0, 7)$

Exercise 20E

- 1 a $(x-2)(3x-2(b+1))$
 b $(2, 0)$ $(\frac{2(b+1)}{3}, \frac{-4(b-2)^3}{27})$
 d $b = 5$
 2 a i $(\frac{1}{2a}, \infty)$ ii $(-\infty, \frac{1}{2a})$
 b $y = -x + \frac{1}{a}$ c $y = x - \frac{1}{a}$
 d $(-\infty, \frac{1}{4a}]$
 3 a i $2(a-2)$ ii $m = 2(a-2)$
 b $(a, (a-2)^2)$ c $y = 2(a-2)x - a^2 + 4$
 d $\frac{a+2}{2}$
 4 a $h = 2$ b $a = 3$ c $a = -16, b = -24$
 5 a $(0, 0)$ b (a, b)
 6 a $(a, 0)$ b $(\frac{a+2}{3}, \frac{4(a-1)^3}{27})$
 b local minimum at $(a, 0)$
 local maximum at $(\frac{a+2}{3}, \frac{4(a-1)^3}{27})$
 c i $y = (a-1)^2(x-1)$
 ii $y = 0$
 iii $y = \frac{-(a-1)^2}{4}(x-a)$
 7 a $2(x-1)(x-b)(2x-b-1)$
 b $(1, 0)$ $(b, 0)$ $(\frac{b+1}{2}, \frac{(b-1)^4}{16})$
 c $b = 3$
 8 a $a = \frac{1}{486}, b = 0, c = \frac{-1}{162}$ and $d = \frac{1459}{243}$
 b $\frac{-x}{2} - 3 = a(y-1)^3 + c(y-1) + d$
 where $a, b,$ and c take the values of a .

Exercise 20F

- 1 a 0.6 km^2 b $0.7 \text{ km}^2/\text{h}$
 2 a $t = 1, a = 18 \text{ m/s}^2; t = 2, a = 54 \text{ m/s}^2; t = 3, a = 114 \text{ m/s}^2$
 b 58 m/s^2
 3 a i 0.9375 m ii 2.5 m iii 2.8125 m
 b $x = \frac{40}{3}, y = \frac{80}{27}$
 c i $x = 11.937, x = 1.396$ ii $x = 14.484$
 4 b $V = \frac{75x - x^3}{2}$ c 125 cm^3 d 118 cm^3
 5 absolute minimum = -9
 absolute maximum = 6
 6 absolute minimum = -8
 absolute maximum = 32
 7 absolute maximum = 1050
 absolute minimum = -8

8 absolute maximum = 2
absolute minimum = -30

9 b $\frac{dV}{dx} = 30x - 36x^2$

c $\frac{125}{36}$ d $\frac{432}{125}$

e $\frac{125}{36}$ when $x = \frac{5}{6}$

10 a $15 \leq y \leq 18$ b minimum = 36
maximum = 75

11 a $\frac{125\,000}{27}$ b 3000 c $\frac{125\,000}{27}$

12 b $\frac{dA}{dx} = \frac{1}{8}(2x - 10)$ c $x = 5$ d 3.625 m^2

Multiple-choice questions

1 D 2 E 3 E 4 A 5 C
6 D 7 D 8 A 9 A 10 C

Short-answer questions
(technology-free)

1 a $\frac{dy}{dx} = 4 - 2x$ b 2 c $y = 2x + 1$

2 a $3x^2 - 8x$ b -4 c $y = -4x$ d (0, 0)

3 a $3x^2 - 12$; $x = \pm 2$

b & c minimum when $x = 2$, $y = -14$
maximum when $x = -2$, $y = 18$

4 a $x = 0$ stationary point of inflexion

b $x = 0$ maximum

c minimum when $x = 3$, maximum
when $x = 2$

d minimum when $x = 2$, maximum
when $x = -2$

e maximum when $x = 2$, minimum
when $x = -2$

f maximum when $x = 3$, minimum
when $x = 1$

g maximum when $x = 4$, minimum
when $x = -3$

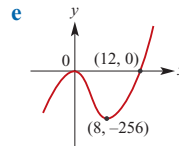
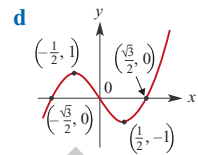
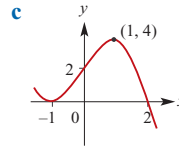
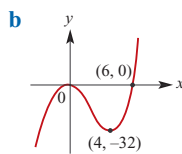
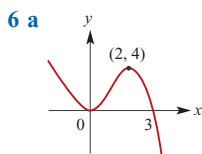
h maximum when $x = 3$, minimum
when $x = -5$

5 a $(-\frac{2}{3}, \frac{16}{9})$ minimum,

$(\frac{2}{3}, \frac{16}{9})$ maximum

b (-1, 0) maximum, (2, -27) minimum

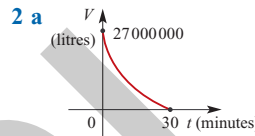
c $(\frac{2}{3}, \frac{100}{27})$ maximum, (3, -9) minimum



Extended-response questions

1 a -14 m/s

b -8 m/s²



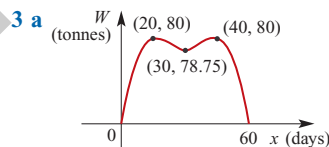
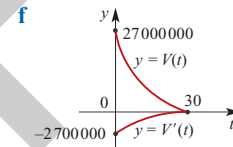
b i 17.4 minutes

ii 2.9 minutes

c $\frac{dV}{dt} = -3000(30 - t)^2$

d 30 minutes

e 28.36 minutes



b after 5.71 days until 54.29 days

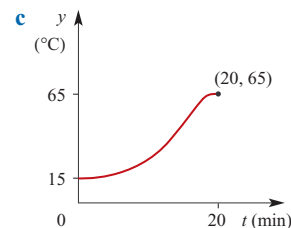
c $x = 20$, $\frac{dW}{dx} = 0$; $x = 40$, $\frac{dW}{dx} = 0$;

$x = 60$, $\frac{dW}{dx} = -12 \text{ t/day}$

d $x = 30$, $W = 78.75$

4 a 15°C

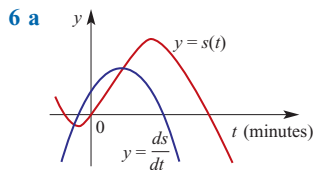
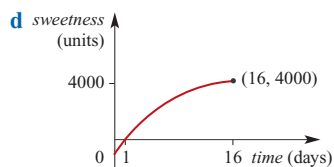
b 0°C/min, $\frac{45}{16}$ °C/min, $\frac{15}{4}$ °C/min,
 $\frac{45}{16}$ °C/min, 0°C/min



5 a 768 units/day

b 432, 192, 48, 0

c $t = 16$



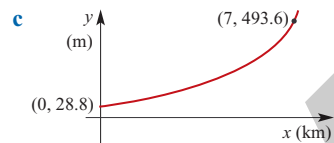
b 11.59 am; 12.03 pm **c** $\frac{5}{27}$ km, 1 km

d $\frac{8}{27}$ km/min = $17\frac{7}{9}$ km/h

e $\frac{1}{3}$ km/min = 20 km/h

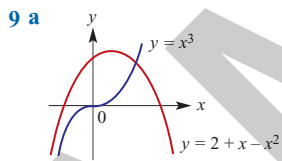
7 a $0 \leq t \leq 12$ **b i** 27 L/h **ii** 192 L/h

8 a 28.8 m **b** 374.4



d Path gets too steep after 7 km.

e i 0.0384 **ii** 0.0504 **iii** 0.1336



b For $x < 0$, minimum vertical distance occurs when $x = -1$.
Min distance = 1 unit

10 8 mm for maximum and $\frac{4}{3}$ mm for minimum

11 a $y = 5 - x$ **b** $P = x(5 - x)$

c maximum value = 6.25, when $x = 2.5$ and $y = 2.5$

12 a $y = 10 - 2x$ **b** $A = x^2(10 - 2x)$

c $\frac{1000}{27}$; $x = \frac{10}{3}$, $y = \frac{10}{3}$

13 $20\sqrt{10}$

14 a $y = 8 - x$ **b** $s = x^2 + (8 - x)^2$ **c** 32

15 $\frac{4}{3}$; $\frac{8}{3}$ **16** 25 m \times 25 m = 625 m²

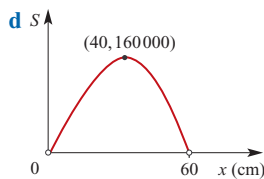
17 $x = 12$ **18** 32 **19** maximum $P = 2500$

20 2 km \times 1 km = maximum of 2 km²

21 $p = \frac{3}{2}$, $q = \frac{8}{3}$

22 a $y = 60 - x$ **b** $S = 5x^2(60 - x)$

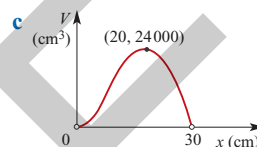
c $0 < x < 60$



e $x = 40$, $y = 20$ **f** 74 005

23 12°C

24 b $0 < x < 30$



d 20 cm, 40 cm, 30 cm

e $x = 14.82$ or $x = 24.4$

25 b Maximum when $x = 3$, $y = 18$

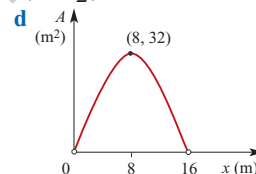
26 a 44 cm should be used to form circle, 56 cm to form square

b All the wire should be used to form the circle.

27 Width 4.5 metres, length 7.2 metres

28 a $A = xy$ **b** $A = \left(8 - \frac{x}{2}\right)x$

c $0 < x < 16$

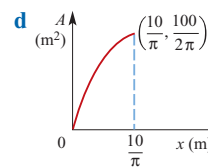


e 32 m²

29 a 937, $h = 1188$

30 a $y = 10 - \pi x$ **b** $0 \leq x \leq \frac{10}{\pi}$

c $A = \frac{x}{2}(20 - \pi x)$



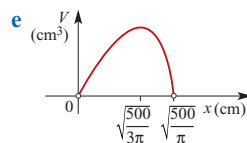
e maximum at $x = \frac{10}{\pi}$

f a semicircle

31 a $h = \frac{500}{\pi x} - x$ **b** $V = 500x - \pi x^3$

c $\frac{dV}{dx} = 500 - 3\pi x^2$

d $x = 10\sqrt{\frac{5}{3\pi}} \approx 7.28$



f 2427.89 cm³

g $x = 2.05$ and $h = 75.41$ or $x = 11.46$ and $h = 2.42$

32 a $r = 4.3$ cm, $h = 8.6$ cm

b $r = 4.3$ cm, $h = 8.6$ cm

Chapter 21

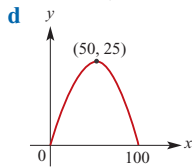
21.1 Multiple-choice questions

- 1 B 2 A 3 B 4 A 5 B 6 A
 7 D 8 B 9 C 10 A 11 C 12 B
 13 A 14 C 15 C 16 A 17 D 18 E
 19 C 20 B 21 E 22 D 23 A 24 A
 25 C 26 D 27 B 28 B 29 B 30 C
 31 D 32 E 33 A 34 A 35 C 36 C

21.2 Extended-response questions

1 a 100 b $\frac{dy}{dx} = 1 - 0.02x$

c $x = 50, y = 25$



d i (25, 18.75) ii (75, 18.75)

2 a $(66\frac{2}{3}, 14\frac{22}{27})$

b i 0.28 ii -0.32 iii -1

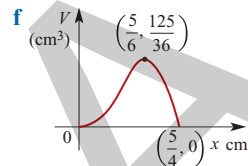
c A gradual rise to the turning point and a descent which becomes increasingly steep (in fact alarmingly steep).

d Smooth out the end of the trip

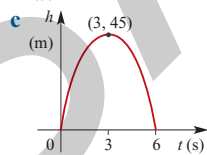
3 a $h = 5 - 4x$ c $0 < x < \frac{5}{4}$

d $\frac{dV}{dx} = 30x - 36x^2$

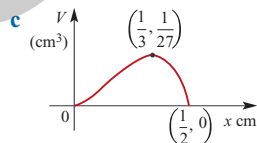
e $\{0, \frac{5}{6}\}$; maximum volume = $3\frac{17}{36}$ cm³



4 a $\frac{dh}{dt} = 30 - 10t$ b 45 m



5 a $A = 4x - 6x^2$ b $V = x^2 - 2x^3$

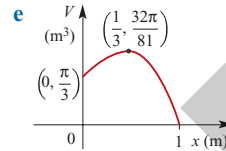


d $\frac{1}{3} \times \frac{1}{3} \times \frac{1}{3}, \frac{1}{27}$ cm³

6 a i $r = \sqrt{1 - x^2}$ ii $h = 1 + x$
 c $0 < x < 1$

d i $\frac{dV}{dx} = \frac{\pi}{3}(1 - 2x - 3x^2)$

ii $\{\frac{1}{3}\}$ iii $\frac{32\pi}{81}$ m³



7 a 1000 insects b 1366 insects

c i $t = 40$ ii $t = 51.70$

d 63.64

e i $\frac{1000 \times 2^{\frac{3}{4}}(2^{\frac{h}{20}} - 1)}{h}$

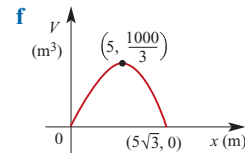
ii Consider h decreasing and approaching zero; instantaneous rate of change = 58.286 insects/day

8 a $h = \frac{150 - 2x^2}{3x}$

b $V = \frac{2}{3}(150x - 2x^3)$

c $\frac{dV}{dx} = 2(50 - 2x^2)$ d $0 < x < 5\sqrt{3}$

e $\frac{1000}{3}$ m³ when $x = 5$



9 a 10

c i $h = 2.5x$

d $V = 40(420x - 135x^2)$

e i $x = \frac{14}{9}, y = \frac{140}{9}$

ii $13\,066\frac{2}{3}$ m³

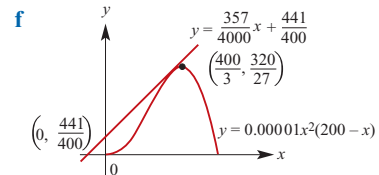
10 a $a = 200, k = 0.000\,01$

b i $x = \frac{400}{3}$ ii $y = \frac{320}{27}$

c i $\frac{8379}{800}$ ii $\frac{357}{4000}$

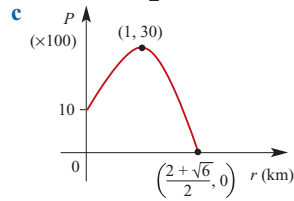
d i $y = \frac{357}{4000}x + \frac{441}{400}$ ii $\frac{441}{400}$

e 0.099 75

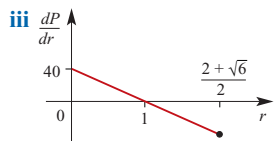


11 a 10 000 people/km²

b $0 < r \leq \frac{2 + \sqrt{6}}{2}$



d i $\frac{dP}{dr} = 40 - 40r$ ii 20; 0; -40

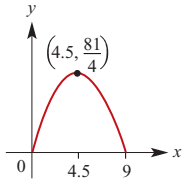


e when $r = 1$

12 a $y = ax - x^2$ b $0 < x < a$ c $\frac{a^2}{4}, \frac{a}{2}$

d negative coefficient of x^2 for quadratic function

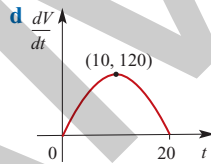
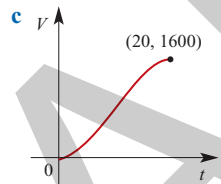
e i



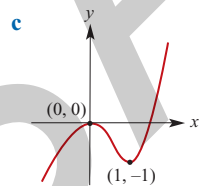
ii $(0, \frac{81}{4}]$

13 a i 0 ii 1600

b $\frac{dV}{dt} = 0.6(40t - 2t^2)$



14 a $-1 = a + b$ b $0 = 3a + 2b, a = 2, b = -3$



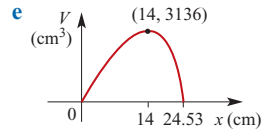
15 a i $80 - 2x$ ii $h = \frac{\sqrt{3}}{2}x$

b $A = \frac{\sqrt{3}}{4}x(160 - 3x)$ c $x = \frac{80}{3}$

16 a $y = \frac{1400 - 2x^2 - 8x}{4x}$

b $V = -\frac{x^3}{2} - 2x^2 + 350x$

c $\frac{dV}{dx} = -\frac{3}{2}x^2 - 4x + 350$ d $x = 14$



f maximum volume is 3136 cm³

g $x = 22.83$ and $y = 1.92$ or $x = 2.94$ and $y = 115.45$

Chapter 22

Exercise 22A

1 a $-6x^{-3} - 5x^{-2}$ b $-6x^{-3} + 10x$

c $-15x^{-4} - 8x^{-3}$ d $6x - \frac{20}{3}x^{-5}$

e $-12x^{-3} + 3$ f $3 - 2x^{-2}$

2 a $-2z^{-2} - 8z^{-3}, z \neq 0$

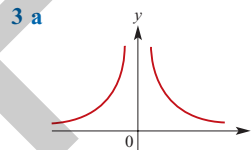
b $-9z^{-4} - 2z^{-3}, z \neq 0$

c $\frac{1}{2}, z \neq 0$

d $18z + 4 - 18z^{-4}, z \neq 0$

e $2z^{-3}, z \neq 0$

f $-\frac{3}{5}, z \neq 0$



b Gradient of chord $PQ = \frac{-2-h}{(1+h)^2}$

c -2 d $y = \frac{1}{2}x + \frac{1}{2}$

4 a $11\frac{3}{4}$ b $\frac{1}{8}$ c -1 d 5

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

Exercise 22B

1 a $30(x-1)^{29}$

b $100(x^4 - 2x^9)(x^5 - x^{10})^{19}$

c $4(1 - 3x^2 - 5x^4)(x - x^3 - x^5)^3$

d $8(x+1)^7$

e $-4(x+1)(x^2 + 2x)^{-3}$

f $-6(x+x^{-2})(x^2 - 2x^{-1})^{-4}$

2 a $24x^2(2x^3 + 1)^3$ b 648

3 a $-\frac{1}{16}$

b $-\frac{3}{256}$

4 a $-\frac{2}{9}$

b $(-3, -\frac{1}{3}) (0, \frac{1}{3})$

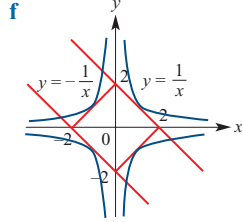
5 a $-\frac{1}{4}$

b $\frac{1}{4}$

c $y = -x + 2$

d $y = x - 2$

e at P , $y = x + 2$; at Q , $y = -x - 2$; $(-2, 0)$



Exercise 220

- 1 a $\frac{1}{3}x^{-\frac{2}{3}}$ b $\frac{3}{2}x^{\frac{1}{2}}; x > 0$
 c $\frac{5}{2}x^{\frac{3}{2}} - \frac{3}{2}x^{\frac{1}{2}}; x > 0$ d $x^{-\frac{1}{2}} - 5x^{\frac{2}{3}}$
 e $-\frac{5}{6}x^{-\frac{11}{6}}$ f $-\frac{1}{2}x^{-\frac{3}{2}}; x > 0$
 2 a $x(1+x^2)^{-\frac{1}{2}}$ b $\frac{1}{3}(1+2x)(x+x^2)^{-\frac{2}{3}}$
 c $-x(1+x^2)^{-\frac{3}{2}}$ d $\frac{1}{3}(1+x)^{-\frac{2}{3}}$
 3 a i $\frac{4}{3}$ ii $\frac{4}{3}$ iii $\frac{1}{3}$ iv $\frac{1}{3}$
 4 a $\{x : 0 < x < 1\}$ b $\left\{x : x > \left(\frac{2}{3}\right)^6\right\}$
 5 a $-5x^{-\frac{1}{2}}(2-5\sqrt{x})$ b $3x^{-\frac{1}{2}}(3\sqrt{x}+2)$
 c $-4x^{-3} - \frac{3}{2}x^{-\frac{5}{2}}$ d $\frac{3}{2}x^{\frac{1}{2}} - x^{-\frac{3}{2}}$
 e $\frac{15}{2}x^{\frac{3}{2}} + 3x^{-\frac{1}{2}}$

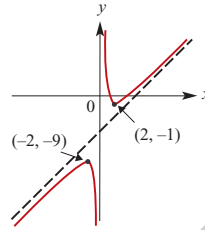
Exercise 22D

- 1 a $6x$ b 0 c $108(3x+1)^2$
 d $-\frac{1}{4}x^{-\frac{3}{2}} + 18x$ e $306x^{16} + 396x^{10} + 90x^4$
 f $10 + 12x^{-3} + \frac{9}{4}x^{-\frac{1}{2}}$
 2 a $18x$ b 0 c 12 d $432(6x+1)^2$
 e $300(5x+2)^2$ f $6x+4+6x^{-3}$
 3 -9.8 m/s^2
 4 a i -16 ii 4 m/s iii $\frac{7}{4} \text{ m/s}$ iv -32 m/s
 b $t = 0$ c -8 m/s

Exercise 22E

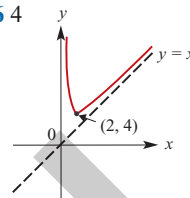
- 1 a $\left(\frac{1}{2}, 4\right) \left(-\frac{1}{2}, -4\right)$ b $y = \frac{15}{4}x + 1$
 2 $\pm \frac{1}{2}$ 3 $\frac{1}{2}$
 4 a $(4, 0) (1, 0)$ b $y = x - 5; x = 0$

c $(2, -1)$ min; $(-2, -9)$ max

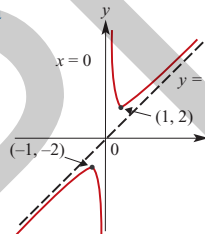


5 3

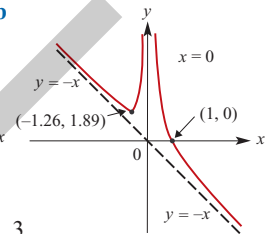
6 4



7 a

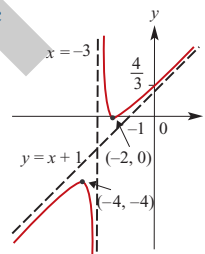


b

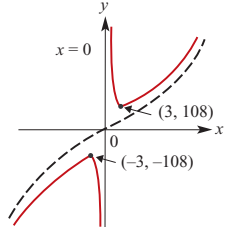


3

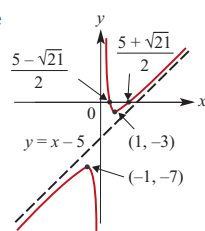
c



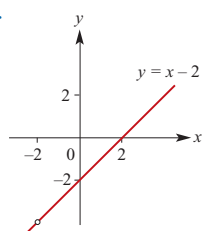
d



e



f



Multiple-choice questions

- 1 B 2 D 3 A 4 A 5 A
 6 E 7 A 8 B 9 A 10 D

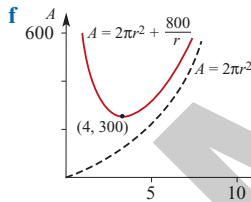
Short-answer questions (technology-free)

- 1 a $-4x^{-5}$ b $-6x^{-4}$ c $\frac{2}{3x^3}$ d $\frac{4}{x^5}$
 e $\frac{-15}{x^6}$ f $\frac{-2}{x^3} - \frac{1}{x^2}$ g $\frac{-2}{x^2}$ h $10x + \frac{2}{x^2}$

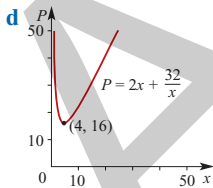
2 a $\frac{1}{2x^{\frac{1}{2}}}$ b $\frac{1}{3x^{\frac{2}{3}}}$ c $\frac{2}{3x^{\frac{4}{3}}}$
 d $\frac{4}{3}x^{\frac{1}{3}}$ e $-\frac{1}{3x^{\frac{4}{3}}}$ f $-\frac{1}{3x^{\frac{4}{3}}} + \frac{6}{5x^{\frac{2}{5}}}$
 3 a $8x + 12$ b $24(3x + 4)^3$ c $\frac{1}{(3 - 2x)^{\frac{3}{2}}}$
 d $\frac{-2}{(3 + 2x)^2}$ e $\frac{-4}{3(2x - 1)^{\frac{5}{3}}}$ f $\frac{-3x}{(2 + x^2)^{\frac{3}{2}}}$
 g $\frac{1}{3} \left(4x + \frac{6}{x^3}\right) \left(2x^2 - \frac{3}{x^2}\right)^{-\frac{2}{3}}$
 4 a $\frac{1}{6}$ b -2 c $-\frac{1}{16}$ d -2 e $\frac{1}{6}$ f 0
 5 $\left(\frac{1}{2}, 2\right)$ and $\left(-\frac{1}{2}, -2\right)$ 6 $\left(\frac{1}{16}, \frac{1}{4}\right)$

Extended-response questions

1 a $h = \frac{400}{\pi r^2}$ c $\frac{dA}{dr} = 4\pi r - \frac{800}{r^2}$
 d $r = \left(\frac{200}{\pi}\right)^{\frac{1}{3}} \approx 3.99$ e $A = 301$



2 a $y = \frac{16}{x}$ c $x = 4, P = 16$



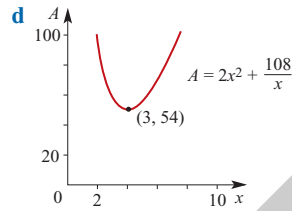
3 a $OA = \frac{120}{x}$ b $OX = \frac{120}{x} + 7$
 c $OZ = x + 5$ d $A = 7x + \frac{600}{x} + 155$

e $x = \frac{10\sqrt{42}}{7} \approx 9.26$ cm

4 a A(-2, 0), B(0, $\sqrt{2}$) b $\frac{1}{2\sqrt{x+2}}$
 c i $\frac{1}{2}$ ii $2y - x = 3$ iii $\frac{3\sqrt{5}}{2}$

d $x > -\frac{7}{4}$

5 a $h = \frac{18}{x^2}$ c $x = 3, h = 2$



6 a $y = \frac{250}{x^2}$
 c $\frac{dS}{dx} = 24x - \frac{3000}{x^2}$ d $S \text{ min} = 900 \text{ cm}^2$

Chapter 23

Exercise 23A

1 a $\frac{x^4}{8} + c$ b $x^3 - 2x + c$
 c $\frac{5x^4}{4} - x^2 + c$ d $\frac{x^4}{5} - \frac{2x^3}{3} + c$
 e $\frac{x^3}{3} - x^2 + x + c$ f $\frac{x^3}{3} + x + c$
 g $\frac{z^4}{2} - \frac{2z^3}{3} + c$ h $\frac{4t^3}{3} - 6t^2 + 9t + c$
 i $\frac{t^4}{4} - t^3 + 3\frac{t^2}{2} - t + c$

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

c $y = \frac{x^3}{3} + x^2 + 2$ d $y = 3x - \frac{x^3}{3} + 2$

e $y = \frac{2x^5}{5} + \frac{x^2}{2}$

3 a $V = \frac{t^3}{3} - \frac{t^2}{2} + \frac{9}{2}$ b $\frac{1727}{6} \approx 287.83$

4 $f(x) = x^3 - x + 2$

5 a B b $w = 2000t - 10t^2 + 100000$

6 $f(x) = 5x - \frac{x^2}{2} + 4$ 7 $f(x) = \frac{x^4}{4} - x^3 - 2$

8 a $k = 8$ b (0, 7) 9 $8\frac{2}{3}$

10 a $k = -4$ b $y = x^2 - 4x + 9$

11 a $k = -32$ b $f(x) = 201$

12 $y = \frac{1}{3}(x^3 - 5)$

Exercise 23B

1 a $-\frac{3}{x} + c$ b $3x^2 - \frac{2}{3x^3} + c$

c $\frac{4}{3}x^{\frac{3}{2}} + \frac{2}{5}x^{\frac{5}{2}} + c$ d $\frac{9}{4}x^{\frac{4}{3}} - \frac{20}{9}x^{\frac{9}{4}} + c$

e $\frac{3}{2}z^2 - \frac{2}{z} + c$ f $\frac{12}{7}x^{\frac{7}{4}} - \frac{14}{3}x^{\frac{3}{2}} + c$

2 a $y = \frac{2}{3}x^{\frac{3}{2}} + \frac{1}{2}x^2 - \frac{22}{3}$

b $y = 2 - \frac{1}{x}$ c $y = \frac{3}{2}x^2 - \frac{1}{x} + \frac{9}{2}$

3 $f(x) = x^3 + \frac{1}{x} - \frac{17}{2}$

4 $s = \frac{3t^2}{2} + \frac{8}{t} - 8$ 5 $y = 5$

6 a 2 b $y = x^2 + 1$

7 $y = \frac{x^3}{3} + \frac{7}{3}$

Exercise 23C

1 a $x = 2t^2 - 6t$ b at the origin O c 9 cm
d 0 cm/s e 3 cm/s

2 a $x = t^3 - 4t^2 + 5t + 4, a = 6t - 8$

b when $t = 1, x = 6$, when

$t = \frac{5}{3}, x = 5\frac{23}{27}$

c when $t = 1, a = -2 \text{ cm/s}^2$,

when $t = \frac{5}{3}, a = 2 \text{ cm/s}^2$

3 20 m to the left of O

4 $x = 215\frac{1}{3}, v = 73$

5 a $v = -10t + 25$ b $x = -5t^2 + 25t$ c 2.5 s

d $31\frac{1}{4} \text{ m}$ e 5 s

6 the 29th floor

Exercise 23D

1 a $\frac{7}{3}$ b 20 c $-\frac{1}{4}$ d 9 e $\frac{15}{4}$

f $\frac{297}{6} = 49.5$ g $15\frac{1}{3}$ h 30

2 a 1 b 1 c 14 d 31 e $2\frac{1}{4}$ f 0

3 a 8 b 16 c -4

4 a -12 b 36 c 20

5 $\frac{26}{3}$ 6 36 square units

7 3.08 square units

8 a 24, 21, 45 b 4, -1, 3

9 4.5 square units

10 $166\frac{2}{3}$ square units

11 $\frac{37}{12}$ square units

12 a $\frac{4}{3}$ square units b $\frac{1}{6}$ square units

c $121\frac{1}{2}$ square units d $\frac{1}{6}$ square units

e $4\sqrt{3} \approx 6.93$ square units

f 108 square units

Exercise 23E

1 a 13.2 b 10.2 c 11.7

2 Area ≈ 6 square units 3 $\pi \approx 3.13$

4 a 36.8 b 36.75

5 a 4.371 b 1.128

6 109.5 m²

Multiple-choice questions

1 C 2 D 3 A 4 D 5 B

6 B 7 D 8 B 9 C 10 A

Short-answer questions

(technology-free)

1 a $\frac{x}{2} + c$ b $\frac{x^3}{6} + c$ c $\frac{x^3}{3} + \frac{3x^2}{2} + c$

d $\frac{4x^3}{3} + 6x^2 + 9x + c$ e $\frac{at^2}{2} + c$

f $\frac{t^4}{12} + c$ g $\frac{t^3}{3} - \frac{t^2}{2} - 2t + c$

h $-\frac{t^3}{3} + \frac{t^2}{2} + 2t + c$

2 $f(x) = x^2 + 5x - 25$

3 a $f(x) = x^3 - 4x^2 + 3x$ b 0, 1, 3

4 a $-\frac{1}{x^2} + c$ b $\frac{2x^{\frac{5}{2}}}{5} - \frac{4x^{\frac{3}{2}}}{3} + c$

c $\frac{3x^2}{2} + 2x + c$ d $\frac{-6x - 1}{2x^2} + c$

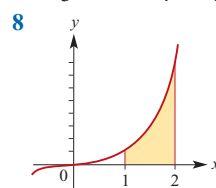
e $\frac{5x^2}{2} - \frac{4x^{\frac{3}{2}}}{3} + c$ f $\frac{20x^{\frac{7}{4}}}{7} - \frac{3x^{\frac{4}{3}}}{2} + c$

g $2x - \frac{2x^{\frac{3}{2}}}{3} + c$ h $-\frac{3x + 1}{x^2} + c$

5 $s = \frac{1}{2}t^2 + 3t + \frac{1}{t} + \frac{3}{2}$

6 a 3 b 6 c 114 d $\frac{196}{3}$ e 5

7 a $\frac{14}{3}$ b $48\frac{3}{4}$ c $\frac{1}{2}$ d $\frac{15}{16}$ e $\frac{16}{15}$



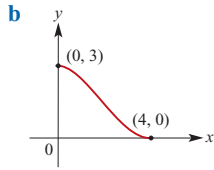
Area = $\frac{15}{4}$ square units

9 $4\frac{1}{2}$ square units 10 $21\frac{1}{12}$ square units

11 a (1, 3) (3, 3) b 6 c $\frac{4}{3}$

Extended-response questions

1 a $y = \frac{9}{32} \left(\frac{x^3}{3} - 2x^2 \right) + 3$

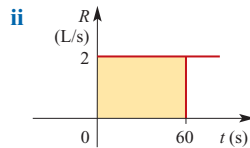


c Yes, for the interval $\left[\frac{4}{3}, \frac{8}{3}\right]$

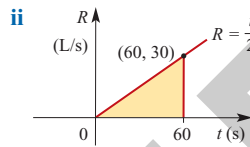
2 a 27 square units **b** $y = \frac{3}{25}(x - 4)^2$

c $\frac{189}{25}$ square units **d** $\frac{486}{25}$ square units

3 a i 120 L



b i 900 L



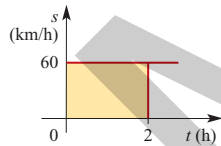
iii $900a^2$ L

c i 7200 square units

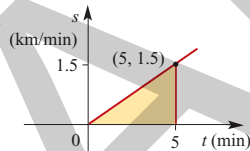
ii volume of water which has flowed in

iii 66.94 s

4 a i & ii

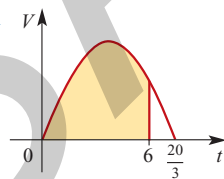


b i



c i $20 - 6t$ m/s²

ii



ii 3.75 km

iii 144 metres

5 a i 4 m **ii** 16 m **b i** 0.7 **ii** -0.8

c i $\frac{100}{3}$ **ii** $\frac{500}{27}$

d $\frac{3125}{6}$ m²

e i $(15 + 5\sqrt{33}, 12)$

ii $R = 60\sqrt{33} - 60, q = 20,$
 $p = 15 + 5\sqrt{33}$

6 a i 9 **ii** $y = 9x - 3$

iii $y = 3x^2 + 3x$

b i $12 + k$ **ii** $k = -7$

iii $f(x) = 3x^2 - 7x + 12$

7 a 6 m²

b i $y = x - \frac{1}{2}$ **ii** $\left(x^2 - \frac{1}{4}\right)$ m²

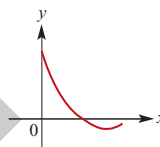
c i $P = (-2, 2); S = (2, 2),$
equation $y = \frac{1}{2}x^2$

ii $\frac{16}{3}$ m²

8 a $y = 7 \times 10^{-7}x^3 - 0.00116x^2 + 0.405x + 60$

b 100 m

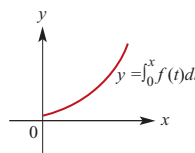
c i



ii (0, 60)

d 51 307 m²

9 a



b $x = 2.988$

Chapter 24

Multiple-choice questions

- | | | | | |
|------|------|------|------|------|
| 1 D | 2 E | 3 C | 4 D | 5 E |
| 6 D | 7 A | 8 A | 9 C | 10 D |
| 11 E | 12 C | 13 B | 14 C | 15 C |
| 16 E | | | | |