Chapter 1

Exercise 1A

1 **a** $2\sqrt{2}$ is a surd
b 9
c 3
d $\sqrt{5}$ is a surd
e 1
f 30
g $\sqrt{2.5}$ is a surd
h 0.5
i $\sqrt[3]{52}$ is a surd
j 0.2
k $3\sqrt{7}$ is a surd
l $\sqrt{10}$ is a surd

2 **a** $10\sqrt{5}$
b $\sqrt{2}$
c $5\sqrt{7}$
d $9\sqrt{3}$
e $-2\sqrt{11}$
f $4\sqrt{3} - 4\sqrt{2}$
g $9\sqrt{5} - 3\sqrt{10}$
h $-\sqrt{3}$
i $2\sqrt{2} + 11\sqrt{3}$

3 **a** $2\sqrt{6}$
b $10\sqrt{5}$
c $4\sqrt{2}$
d $5\sqrt{3}$
e $10\sqrt{10}$
f $6\sqrt{2}$
g $12\sqrt{3}$
h $25\sqrt{2}$

4 **a** $5\sqrt{2} + 2\sqrt{3}$
b $-\sqrt{2}$
c $3\sqrt{7} + 7\sqrt{2}$
d $-\sqrt{3}$
e $8\sqrt{5}$
f $2\sqrt{7}$
g $-10\sqrt{2}$
h $22\sqrt{3}$
i 0

Exercise 1B

1 **a** $\sqrt{6}$
b 5
c 12
d $3\sqrt{2}$
e 20
f 72
g $30\sqrt{3}$
h 32
i 245

2 **a** $\sqrt{2}$
b $3\sqrt{2}$
c $\sqrt{3}$
d 1
e 4
f $5\sqrt{10}$
g 4
h $8\sqrt{10}$
i 3

3 **a** $4\sqrt{3}$
b $18\sqrt{14}$
c 18
d $12\sqrt{2}$
e $\frac{4}{3}$
f $\frac{7}{25}$

4 **a** $5\sqrt{5}$
b $3\sqrt{6}$
c $12\sqrt{2}$
d $9\sqrt{3}$
e $10\sqrt{7} - 7\sqrt{2}$
f $2\sqrt{14}$
g $10\sqrt{2}$
h $\sqrt{7}$
i $\sqrt{3}$
j 360
k 63

5 **a** $x = 5$

b $x = 10$

c $x = 5$

d $x = 2$

Exercise 1C

1 **a** **i** 333.33

ii 384.62

iii 377.36

b Greater accuracy achieved with more decimal places.

2 **a** **i** 9

ii 2

iii 5

b **i** 8.8

ii 1.7

iii 5.2

c 5.066

d Student's own answers

3 **a** $3\sqrt{5}$ cm^2

b 6 mm^2

c $6\sqrt{2}$ m^2

d $30\sqrt{10}$ cm^2

4 **a** 7 cm^2

b 20 m^2

c 176 m^2

5 $34\sqrt{5}$ cm^2

6 **a** $8\sqrt{3}$ – 2 m by 3 m

b $(24\sqrt{3} - 6)$ m^2

c $(16\sqrt{3} + 6)$ m^2

7 **a** $x = \sqrt{2}$ cm

b $x = \sqrt{34}$ cm

c $x = \sqrt{6}$ cm

d $x = 4$ cm

8 $PS = \sqrt{6}$ cm

9 **a** $2\sqrt{3}$ cm

b $5\sqrt{2}$ cm

c $3\sqrt{3}$ cm

10 **a** $x = \sqrt{13}$ cm

b $x = \sqrt{35}$ cm

11 **a** $4\sqrt{3}$ cm

b $\sqrt{41}$ cm

Exercise 1D

1 **a** $\frac{\sqrt{5}}{5}$

b $\frac{\sqrt{2}}{2}$

c $2\sqrt{3}$

d $4\sqrt{2}$

e $\frac{\sqrt{2}}{6}$

f $\frac{5\sqrt{7}}{14}$

g $\frac{2\sqrt{21}}{7}$

h $\frac{2\sqrt{3}}{5}$

2 **a** $\frac{\sqrt{15}}{3}$

b $\frac{\sqrt{2}}{8}$

c $\frac{4\sqrt{5}}{25}$

d $\frac{\sqrt{7}}{7}$

e $\frac{\sqrt{10}}{2}$

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

g $\frac{6\sqrt{5}}{5}$

h $\frac{2\sqrt{7}}{21}$

i $\frac{2\sqrt{2}}{5}$

j $\frac{\sqrt{10}}{2}$

k $\frac{3\sqrt{10}}{4}$

l $\frac{2\sqrt{2}}{3}$

Exercise 1E

1 **a** $3\sqrt{2} + 2$

b $5 - \sqrt{5}$

c $5\sqrt{7} - 7$

d $12\sqrt{3} - 6$

e $3\sqrt{2} - 3\sqrt{5}$

f $7\sqrt{3} - 56$

g $4 - 2\sqrt{6}$

h $3\sqrt{6} - 4\sqrt{3}$

2 **a** $-1-2\sqrt{2}$

b $2\sqrt{3}-5$

c -22

d -5

e $6+2\sqrt{5}$

f $5-2\sqrt{6}$

g $32-10\sqrt{7}$

h $27+15\sqrt{5}$

3 **a** 7 cm^2

b $\sqrt{22}\text{ cm}$

Activity

a 1.61803

b Student's own answers

c Student's own answers

Chapter 2

Exercise 2A

1, 2

a 16

b 729

c 64

d 1000000

e 23

f 0.027

g $\frac{1}{256}$

h 1

3, 4

a 7^2

b 30^3

c 0.3^4

d 10^4

e g^3

f a^3b^2

Activity p. 15

a 2^6; 4^3; 8^2

b 3^4; 9^2

c 2^8; 4^4; 16^2

d 3^6; 9^3; 27^2

Exercise 2B

1 **a** $\frac{1}{6^3}=\frac{1}{216}$

b $\frac{1}{2^5}=\frac{1}{32}$

c $\frac{1}{3^4}=\frac{1}{81}$

d $\frac{1}{(3a)^2}=\frac{1}{9a^2}$

2 **a** $\frac{1}{x^3}$

b $\frac{1}{y^8}$

c $\frac{3}{t^4}$

d $\frac{7}{y^6}$

e $\frac{2}{7t^5}$

f $\frac{1}{2y^3}$

3 **a** $6x^{-3}$

b $9t^{-5}$

c $3m^{-4}$

d $10a^{-8}$

4 **a** when $m=4$:

i 64

ii $\frac{1}{16}$

iii $\frac{5}{4}$

b when $a=2$:

i 32

ii $\frac{1}{8}$

iii $\frac{1}{2}$

5 **a** From smallest to largest if m is a positive whole number greater than 1: m^{-2}; m^0; m^3

b From smallest to largest if m is a negative whole number less than 1: m^3; m^{-2}; m^0

Activity p. 16

a

Factor	Name	Symbol
10^{24}	yotta	Y
10^{21}	zetta	Z
10^{18}	exa	E
10^{15}	peta	P
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hecto	h
10^{1}	deca	da

Factor	Name	Symbol
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a
10^{-21}	zepto	z
10^{-24}	yocto	y

b Y = 10^{24} while Z = 10^{21}, so yotta (Y) is bigger than zetta (Z).

Exercise 2C

1 **a** 4^8
b 7^5
c x^{12}
d t^9
e $\frac{1}{3^5}$
f $\frac{1}{c^6}$
g a^0
h $20y^9$
i $8c^6$
j $\frac{24}{c^5}$
k $\frac{30}{a^{13}}$
l $\frac{24}{t^3}$

2 **a** 3^5
b 6^{-2}
c x^3
d t^2
e p^5
f y^0
g $4y^7$
h $2y^{-5}$
i $5x^6$
j $2058p^8$
k $-2t^{12}$
l $10y^{-7}$

3 **a** $15x^5y^3$
b $21a^3b^7$
c $5xy^{-3}$

Exercise 2D

1 **a** 3^{20}
b 2^{12}
c 10^{15}
d t^{-12}
e a^{21}

2 **a** $9y^2$

b $x^{15}y^{20}$

c a^4b^{12}

d $27p^{12}q^6$

e $16t^{12}u^{-8} = \frac{16t^{12}}{u^8}$

f $1{,}000u^{-15}v^{-6} = \frac{1{,}000}{u^{15}v^6}$

3 **a** 6^{12}

b 2^{28}

c a^{30}

d $t^{-21} = \frac{1}{t^{21}}$

e x^{10}

f $36a^6b^8$

g $16x^{-12}y^{20} = \frac{16y^{20}}{x^{12}}$

h $243a^{30}b^{-15} = \frac{243a^{30}}{b^{15}}$

i $x^{12}y^{-6}z^9$

4 **a** False, because $3 + 4 \neq 12$

b False, because $2 \times 2 \times 2 \neq 3 \times 3$

c True, because $9 - 5 = 4$

d True, because $2 \times 3 = 3 \times 2$

e True, because $12 : 6 = 2$

f True, because $5 + 5 = 10$

g True, because $6 - 6 = 0$

h False, because $5 \times 3 \neq 8$

i False, because $6 + 2 - (-2) \neq 6$

Exercise 2E

1 **a** $\sqrt[3]{a}$

b $\sqrt[5]{a}$

c $\sqrt{t}$

d $\sqrt[3]{a^2}$

e $\sqrt[5]{a^3}$

f $\sqrt{t^5}$

g $\sqrt[3]{x^4}$

h $\sqrt[5]{y^2}$

i $\sqrt[4]{p}$

j $\sqrt[4]{m^3}$

2 **a** $t^{\frac{5}{2}}$

b $a^{\frac{3}{4}}$

c $x^{\frac{3}{5}}$

d $\mathrm{m}^{\frac{4}{7}}$

e $a^{\frac{12}{3}} = a^4$

3 **a** 3

b 2

c 4

d 343

e $\frac{1}{5}$

f $\frac{1}{27}$

g $\frac{1}{1{,}000}$

h $\frac{1}{9}$

i $\frac{7}{9}$

j $\frac{64}{125}$

4 **a** x^3

b y^2

c a^{-3}

d 1

e 18

f $15a$

g $2x^2$

h $15y^{\frac{9}{5}}$

i $2t^{-1}$

5 20^{-1}; 5^0; $4^{\frac{1}{2}}$; $8^{\frac{2}{3}}$

6 **a** **i** 9

ii 9

iii $\frac{1}{6}$

iv $\frac{1}{1000}$

v $\frac{5}{7}$

vi $\frac{3}{2}$

b **i** y

ii $x^{-\frac{5}{2}} = \frac{1}{x^{\frac{5}{2}}}$

iii $a^{\frac{7}{3}}$

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

v $12t^{-1} = \frac{12}{t}$

vi $3t$

Activity p. 21

a $x = 2$

b $x = 4$

c $x = 3$

d $x = 5$

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

f $x = 1$

g $x = 2$

h $x = 8$

i $x = 8$

j $x = 27$

Exercise 2F

1 a $a^5 + a^2$

b $x^{-2} + x^{-5}$

c $y + 1$

d $m^{-2} - 4m^3$

e $10 - 35a^5$

2 a $p^{\frac{3}{2}} + 3p^{\frac{1}{2}}$

b $t^{\frac{3}{2}} + 1$

c $3z^2 + 6z^{\frac{1}{3}}$

d $b^{\frac{1}{2}} - b^{-\frac{3}{4}}$

e $1 + 3y$

f $1 - c^{-\frac{1}{6}}$

3

1a $a^5 + a^2,\ a = 3 : 252$

1b $x^{-2} + x^{-5},\ x = 2 : 0.28125$

1c $y + 1,\ y = 10 : 11$

1d $m^{-2} - 4m^3,\ m = 5 : -499.96$

1e $10 - 35a^5,\ a = 3 : -8495$

2a $p^{\frac{3}{2}} + 3p^{\frac{1}{2}},\ p = 4 : 14$

2b $t^{\frac{3}{2}} + 1,\ t = 9 : 28$

2c $3z^2 + 6z^{\frac{1}{3}},\ z = 27 : 2205$

2d $b^{-\frac{1}{2}} - b^{-\frac{3}{4}},\ b = 16 : 0.125$

2e $1 + 3y,\ y = 10 : 31$

2f $1 - c^{-\frac{1}{6}},\ c = 64 : 0.5$

4 a $t^4 + 16 - 8t^2$

b $y^2 - y^5 + 2y^{-3} - 2$

c $x + 9 + 6x^{\frac{1}{2}}$

d $m^6 - 1$

e $c^{\frac{4}{3}} - 9$

f $5m^{\frac{1}{2}} + 10 - m^{\frac{3}{4}} - 2m^{\frac{1}{4}}$

Exercise 2G

1 a 2.34×10^6

b 1.07×10^3

c 3.5×10^7

d 2.7×10

e 3.5×10^6

f 7.12×10^{11}

g 5.6×10^{-4}

h 3.12×10^{-2}

i 4.08×10^{-1}

j 7.8×10^{-1}

k 6.04×10^{-3}

l 5.1×10^{-6}

2 a 5 000 000

b 63 200

c 701 000 000

d 0.000 047

e 0.000 000 804

f 0.000 000 0889

Exercise 2H

1 a 8.4×10^{12}

b 1.902×10^6

c 2.1×10^2

d 7×10^8

e 1.68×10^7

f 4.7×10^8

2 1.08×10^{12} m

3 1.35×10^8 g

4 4.1850×10^{10} miles

5 7.5×10^2 s

6 **a** 5.88×10^{15} miles

b 1.119×10^7 miles

7 2.75×10^{14} Earths

8 1.4×10^{-4} cm^2

9 2×10^3 g

Exercise 2I

1 **a** speed, $\frac{\text{m}}{\text{s}}$

b acceleration, $\frac{\text{m}}{\text{s}^2}$

c wave number, $\frac{1}{\text{m}}$

d frequency, $\frac{1}{\text{s}}$

e force, $\frac{\text{m.kg}}{\text{s}^2}$

f pressure, $\frac{\text{kg}}{\text{m.s}^2}$

g energy, $\frac{\text{m}^2\text{.kg}}{\text{s}^2}$

h power, $\frac{\text{m}^2\text{.kg}}{\text{s}^3}$

i electric potential difference, $\frac{\text{m}^2\text{.kg}}{\text{s}^3\text{.A}}$

j electric resistance, $\frac{\text{m}^2\text{.kg}}{\text{s}^3\text{.A}^2}$

k magnetic flux density, $\frac{\text{kg}}{\text{s}^2\text{.A}}$

i inductance, $\frac{\text{m}^2\text{.kg}}{\text{s}^2\text{.A}^2}$

2 **a** mass density kg m^{-3}

b m^3.kg^{-1}

c Am^{-1}

d m^2.s^{-2}

e mol.s^{-1}

f m^2.kg.s^{-2}A^{-1}

g s^{3}A^{2}m^{-2}kg^{-1}

h s^{4}A^{2}m^{-2}kg^{-1}

3 **d** gray

e katal

f weber

g siemens

h farad

Activity p. 26

Student's own answers

Chapter 3

Exercise 3A

1 **a** $7t$

b $-2y$

c $2x^2$

d $10ab$

e $5x + 16y$

f $6a + a^2$

2 **a** $5p$

b Cannot be simplified

c $13c - 8$

d $4\,pq$

e 0

f $-3a^2 - 6a$

g Cannot be simplified

h $7m - 5n$

i 5s − 4rs

Exercise 3B

1 **a** $2t + 8$

b $5m - 15$

c $-12a - 6$

d $90y - 110$

e $16t + 24y + 8$

f $20m - 10n + 35r$

g $4a + ac$

h $16a - 2ac$

i $15xy - 20x$

j $y^2 - 4y$

k $-b^2 + bc$

l $ab - ac + a^2$

2 **a** $6x + 9$
b $38y - 70$
c $12 + 3y$
d $8t$
e $13p - 20$
f $12y - 11$
g $4 - 2p$
h -9

3 **a** $10x^2 + 15x$
b $12y^2 - 15y$
c $-30t^2 + 6t$
d $-8c^2 + 28c$
e $45m^2 + 36m$
f $16mw - 24w^2$
g $-x^2 + 7xy$
h $36su - 27s^2$

4 **a** $8x^2 + 6x$
b $6y - 5y^2$
c $8 - 10x^2 - 15x$
d $10t^2 - 3t$
e $4x^2 + 34x - 3$
f $8w^2 + 2w$

5 **a** $4x - 5$
b $26x + 40y$
c $-25t + 21w + 11$
d 0
e $3x + 2xy + 4y$
f $7a + 5b - ab$
g $4mt + 15t + 21m$
h $24np - 6p + 10n$

6 **a** $10t^2 - 2t$
b $12y^2 + 8y$
c $21x^2 - 28x$

7 **a** $\frac{1}{2}y^2 + 3y$
b $6t^2 + 15t$
c $5w^2 - 3w$

8 $24x^2 + 42x + 15\ \text{m}^2$

9 **a** The triangle
b The rectangle

Exercise 3C

1 **a** $x^2 + 5x + 6$
b $y^2 + 11y + 28$
c $t^2 + 12t + 32$
d $a^2 - 10a + 21$
e $w^2 - 11w + 18$
f $z^2 - 18z + 80$
g $r^2 + 7r - 30$
h $t^2 + 7t - 44$
i $a^2 - 2a - 63$

2 **a** $2x^2 - 5x - 3$
b $15y^2 + y - 28$
c $8u^2 + 45u - 18$
d $7a^2 + 33a - 10$
e $18t^2 - 27t + 10$
f $8b^2 - 67b + 24$
g $6w^2 - w - 35$
h $24 - 10s - 21s^2$
i $10m + 3m^2 - 8$

3 **a** $x^2 + 10x + 25$
b $t^2 - 4t + 4$
c $16a^2 - 24a + 9$
d $9x^2 + 6x + 1$
e $2x^2 + 16x + 40$
f $22y + 55$
g $x^4 + 14x^2 + 49$
h $t^4 - 8t^2 + 16$
i $a^4 + 19a^2 - 14a + 130$

4 **a** $8y^2 + 18y + 7$
b $40a^2 + 87a + 27$
c $15t^2 + 2t - 8$

5 a $6y^2 + \frac{17}{2}y - \frac{7}{2}$

b $6t^2 - 6t + \frac{3}{2}$

c $\frac{15}{2}y^2 + \frac{19}{2}y + 3$

6 a Denise has thought that $(a+b)^2 = a^2 + b^2$, which is incorrect.

When Keith has multiplied the two terms in x together, he has forgotten to multiply the two accompanying factors of 5.

b $25x^2 + 10x + 1$

7 a $12y^2 - 8y - 15$ m^2

b $10y^2 - 8y - 15$ m^2

c £13.50

d £9x

Exercise 3D

1 a $3x^3 + 5x^2 + 9x + 7$

b $2y^3 + 3y^2 - 18y + 8$

c $5x^3 + 14x^2 - 4x - 3$

d $3t^3 - 13t + 2$

e $w^3 - 9w^2 + 18w + 10$

f $4a^3 + 18a^2 - 5a + 25$

2 a $12x^3 + x^2 - 3x - 2$

b $12y^3 - 16y^2 - 15y - 2$

c $14a^3 - 27a^2 + a + 12$

d $4w^3 - 17w^2 + 31w - 20$

e $16b^3 + 42b^2 + 23b - 63$

f $30x^3 + 4x^2 - 17x + 3$

3 a $2x^3 + 23x^2 + 68x + 35$

b $3a^3 - 13a^2 + 18a - 8$

c $-5a^3 + 24a^2 + 37a - 6$

d $27u^3 - 57u^2 + 23u + 35$

e $6b^3 + 28b^2 - 5b + 25$

f $32w^3 - 44w^2 + 29w - 3$

Activity

$2.5^2 = 6.25$

$3.5^2 = 12.25$

$4.5^2 = 20.25$

For any value of x, $(x + 0.5)^2 = x^2 + x + 0.25$

Chapter 4

Exercise 4A

1 a $3(b + c)$

b $2(a + 5b)$

c $2(2x + 7y)$

d $a(t + r)$

e $4(3x - 2y)$

f $b(a - c)$

g $cy(y - 1)$

h $12b(2a - c)$

i $7(2y - 5z)$

j $2t(2t - 3a)$

k $p(4 - 5r)$

l $20b(1 - b)$

2 a $q(p - r)$

b $5(xt - 2ay)$

c $2\pi r(r - 3h)$

d $4ab(2a - 5b)$

e no factorisation possible

f $6(2t^2 - u)$

g $t(3t - 5y + 4)$

h $8x(3y - 2z)$

i $b(a + c - d)$

j $m^2(m^2 + m + 1)$

k $(p + q)(r + s)$

l $2(3qp - 4rs)$

3 a $53(48 + 52) = 5300$

b $74(63 - 53) = 740$

c $2.7(8.6 + 1.4) = 27$

d $3.9(6.75 + 3.25) = 39$

e $63(24 + 39 + 37) = 6300$

f $0.17(7.9 + 2.8 - 0.7) = 1.7$

4 a $3(3t + 4r)$

b $y(a - b)$

c $6(4 - t)$

d $p(p - 1)$

e no factorisation possible

f $bc(a + d)$

g $7(5m - 2n)$

h $5t(5t - 3x + 4z)$

i no factorisation possible

j $3(5x - 3y + 2z)$

k $3t(2r + s - 4y)$

l $t^3(t^3 + t - 1)$

Exercise 4B

1 a $(x - 7)(x + 7)$

b $(a - b)(a + b)$

c $(6 - a)(6 + a)$

d $(1 - t)(1 + t)$

e $(5a - b)(5a + b)$

f $(3t - 5s)(3t + 5s)$

g $(8c - 7d)(8c + 7d)$

h $(6a - 1)(6a + 1)$

i $(c - 4d)(c + 4d)$

j $(10x - 7y)(10x + 7y)$

2 a $(t^2 + 1)(t + 1)(t - 1)$

b $(4 + a^2)(2 + a)(2 - a)$

c $(16 + p^2)(4 + p)(4 - p)$

d $(t^2 + 9)(t + 3)(t - 3)$

e $-4mn$

f $(x + y + z)(x - y - z)$

3 a $(t + 9)(t - 9)$

b $(s + t)(s - t)$

c $(9 + p)(9 - p)$

d (m + 1)(m − 1)

e $(a + 2b)(a - 2b)$

f $(5p + q)(5p - q)$

g $(5a + 6b)(5a - 6b)$

h $(10 + 49)(10 - 49)$

i $(3x + 5y)(3x - 5y)$

j $(a + 2bc)(a - 2bc)$

4 a Outer square area $= t^2$;
inner square area $= 1^2 = 1$.
Shaded area = outer square area – inner square area
Shaded area $= (t + 1)(t - 1)$ m^2

b Button area $= \pi R^2$;
small circles area $= 4(\pi r^2)$,
Shaded area $= \pi(R + 2r)(R - 2r)$mm^2

5 a $x = \sqrt{(10 + a)(10 - a)}$ cm

b $x = \sqrt{(t + 4)(t - 4)}$ cm

6 a $5\sqrt{5}$ cm

b $4\sqrt{7}$cm

Exercise 4C

1 a $8(p + q)(p - q)$

b $3(x + 3)(x - 3)$

c $4(y + 5)(y - 5)$

d $2(a + 3b)(a - 3b)$

e $9(x + 2y)(x - 2y)$

f $5(1 + t)(1 - t)$

g $5(3m + n)(3m - n)$

h $2(y + 2z)(y - 2z)$

i $3(y + 5z)(y - 5z)$

j $2a(a + 2b)(a - 2b)$

k $7(2t + 5r)(2t - 5r)$

l $2(2c + 5d)(2c - 5d)$

Exercise 4D

1 a $(a + 11)(a + 1)$

b $(x - 5)(x - 4)$

c $(w - 7)(w - 4)$

d $(b - 6)(b - 4)$

e $(p + 21)(p + 3)$

f $(x - 9)(x - 2)$

g $(t - 1)(t - 19)$

h $(y + 17)(y + 2)$

i $(t - 3)(t + 4)$

j $(y - 6)(y + 3)$

k $(x - 9)(x + 7)$

l $(y - 9)(y + 4)$

2 a $7(x - y)(x + y)$

b $2(t + 1)^2$

c $3(a - 2)(a - 4)$

d $4(x + 3)(x + 2)$
e $2(t + 3)(t + 8)$
f $2(y + 5)(y + 10)$
g $5(m - 4)(m + 2)$
h $6(t - 2)(t + 4)$

3 a $(t - 3)(t + 2)$
b $(m - 1)(m + 8)$
c $(x - 1)(x + 7)$
d $(y + 2)^2$
e $(u + 3)(u - 1)$
f $(c - 5)(c + 4)$
g $(y - 8)(y + 3)$
h $(m - 8)(m + 1)$
i $2(p - 3)(p + 5)$
j not factorable
k $2(x + 2)(x - 5)$
l $4(a - 3)(a - 5)$

Exercise 4E

1 a $(x + 1)(2x + 3)$
b $(t + 1)(3t - 2)$
c $(6m - 1)(2m - 1)$
d $(4y - 1)(y + 2)$
e $(2u + 3)(4u - 1)$
f $(4p + 7)(p - 1)$
g $(2t + 3)^2$
h $(m + 3)(6m - 1)$
i $-(4y + 3)(2y - 1)$

2 a $2(t + 3)(2t + 1)$
b $3(2m - 1)(m - 2)$
c $5(3x + 4)(x - 2)$
d $9(y + 1)(5y - 1)$
e $4(u + 1)(2u - 1)$
f $6(3c + 4)(c - 2)$
g $(x + 6y)(x + 2y)$
h $(4m + n)(m - 2n)$
i $(3x + 1)(x - 2)$
j $(2b + 3)(b - 7)$

3 a $8(y - 3)$
b $(m - 6)(m + 6)$
c $(x + 2)^2$
d $2y(3y + 2)$
e $(u - 1)(2u + 5)$
f $14(c - 2d)(c + 2d)$
g $(m - 5)(2m + 3)$
h $(4p - 1)^2$
i $(2y + 1)(5y - 3)$

Activity p. 41

Student's own answers

Chapter 5

Exercise 5A

1 a $(x - 3)^2 - 9$
b $(x + 7)^2 - 49$
c $(y - 10)^2 - 100$
d $(m - 1)^2 - 1$
e $(t - 4)^2 - 16$
f $(a - 6)^2 - 36$
g $(y - 3)^2 - 9$
h $h\left(w - \frac{1}{2}\right)^2 - \frac{1}{4}$
i $\left(x + \frac{5}{2}\right)^2 - \frac{25}{4}$
j $(y + 2)^2 - 4$
k $(t - 15)^2 - 225$
l $\left(x + \frac{7}{2}\right)^2 - \frac{49}{4}$

2 a $(x + 5)^2 - 22$; $a = 5$; $b = -22$
b $(y - 2)^2 + 2$; $a = -2$; $b = 2$
c $(t + 7)^2 - 58$; $a = 7$; $b = -58$
d $(m - 3)^2 - 5$; $a = -3$; $b = -5$
e $(w - 10)^2 - 90$; $a = -10$; $b = -90$
f $(x + 6)^2 - 39$; $a = 6$; $b = -39$
g $(x + 4)^2 - 15$; $a = 4$; $b = -15$
h $\left(m + \frac{7}{2}\right)^2 - \frac{37}{4}$; $a = \frac{7}{2}$; $b = -\frac{37}{4}$
i $\left(x + \frac{3}{2}\right)^2 - \frac{13}{4}$; $a = \frac{3}{2}$; $b = -\frac{13}{4}$

j $(a-2)^2-6;\ a=-2;\ b=-6$

k $(w-9)^2-76;\ a=-9;\ b=-76$

l $\left(t+\frac{9}{2}\right)^2-\frac{93}{4};\ a=\frac{9}{2};\ b=-\frac{93}{4}$

3 a $(m+1)^2-1$

b $(t-5)^2-25$

c $(x+6)^2-36$

d $(y-4)^2-12$

e $(a-2)^2-7$

f $(t+11)^2-136$

g $(p+8)^2-71$

h $(m+1)^2+6$

i $(y+5)^2-30$

j $\left(y-\frac{5}{2}\right)^2-\frac{13}{4}$

k $\left(a-\frac{1}{2}\right)^2+\frac{15}{4}$

l $\left(x+\frac{7}{2}\right)^2-\frac{57}{4}$

Exercise 5B

1 a $y=-1+2\sqrt{2};\ y=-1-2\sqrt{2}$

b $t=3+2\sqrt{5};\ t=3-2\sqrt{5}$

c $x=5+\sqrt{21};\ x=5-\sqrt{21}$

d $a=-2+\sqrt{3};\ a=-2-\sqrt{3}$

e $y=-4+\sqrt{3};\ y=-4-\sqrt{3}$

f $t=\frac{1}{2}\left(3+\sqrt{33}\right);\ t=\frac{1}{2}\left(3-\sqrt{33}\right)$

g $x=-7+3\sqrt{6};\ x=-7-3\sqrt{6}$

h $x=3+\sqrt{6};\ x=3-\sqrt{6}$

i $x=-3+\sqrt{6};\ x=-3-\sqrt{6}$

2 a $m=-0.4;\ m=-7.6$

b $x=11.7;\ x=0.3$

c $w=6.5;\ w=-1.5$

d $a=3.7;\ a=0.3$

e $-1;-13$

f $x=1.5;\ x=-4.5$

3 a $x=-1+\sqrt{6};\ x=-1-\sqrt{6}$

b $x=2+\sqrt{11};\ x=2-\sqrt{11}$

c $x=-1+\sqrt{10};\ x=-1-\sqrt{10}$

Exercise 5C

1 a $4(x+2)^2-13$

b $2(y+3)^2-21$

c $5(t-3)^2-53$

d $11-(m-3)^2$

e $6(w+1)^2-10$

f $3(t+2)^2-15$

Activity pp. 45–46

Part 1

Student's own research into different curves.

Part 2

a i $(-3,-7)$

ii $(2,-2)$

iii $\left(-4\frac{1}{2},-25\frac{1}{4}\right)$

b i $x^2+6x+13$

ii $x^2-10x+27$

iii $x^2-12x+35$

Chapter 6

Exercise 6A

1 a $5a$

b $\frac{1}{3}$

c 4

d $\frac{x}{2y}$

e 2

f $\frac{x}{2}$

g $\frac{3b}{4}$

h $\frac{y}{3x}$

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

j $\frac{7+3y}{3}$

k $\frac{4a+1}{a}$

l $\frac{2+3x}{3}$

m $\frac{5}{7-m}$

n $\frac{y}{3+2x}$

o $\frac{2x+1}{y}$

p $\frac{p+2q}{3pq}$

q $\frac{3-y}{2x}$

r $\frac{4}{5}$

s $r - 3$

t $\frac{1}{a+b}$

2 a $\frac{a+2}{3}$

b $\frac{3}{b-3}$

c $\frac{c+1}{5}$

d $\frac{d}{d+1}$

e $\frac{1}{2}$

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

g $\frac{x-4}{x-10}$

h $\frac{x+5}{x-2}$

i $\frac{x+5}{x-2}$

j $\frac{2x-1}{x+3}$

k $\frac{2x+3}{3x+2}$

l $\frac{2x-3}{2x-1}$

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

b $\frac{x}{x-2}$

c $\frac{x-2}{2(x-1)}$

d $\frac{x(x+2)}{x-3}$

e $\frac{x+2}{x-2}$

f $\frac{2x-3}{2(x-1)}$

Activity p. 49

Student's own answers

Exercise 6B

1 a $\frac{x^2+1}{x^2}$

b $12x + 1$

c $\frac{3x^2-1}{2x}$

d $\frac{2(3x+1)}{3(4x-1)}$

e $\frac{3x^2+1}{x^2+2}$

f $\frac{2x-1}{4}$

2 a $\frac{2+x}{2-x}$

b $\frac{c+b}{c-b}$

Activity p. 50

Student's own answers

Exercise 6C

1 a -1

b $-\frac{3}{2}$

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

d $-\frac{(x+3)}{2}$

e $-\frac{1}{x}$

f $-(x + a)$

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

h $\frac{y-x}{y+x}$

Activity p. 51

Student's own answers

Chapter 7

Exercise 7A

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

b $\frac{9x}{8}$

c $\frac{11x}{20}$

d $\frac{8x}{9}$

e x

f $\frac{11x}{12}$

g $\frac{5x}{12}$

h $\frac{73x}{60}$

2 a $\frac{5y-2x}{xy}$

b $\frac{ad+bc}{cd}$

c $\frac{17}{12x}$

d $\frac{35x-12}{20x^2}$

e $\frac{zy+2xz+3xy}{xyz}$

f $\frac{q-3p}{pqr}$

g $\frac{2t-3s}{s^2t^2}$

h $\frac{afe-bdf+cde}{def}$

3 a $\frac{7x+3}{x}$

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

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

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

e $\frac{x^2+5}{x}$

f $\frac{8x-y}{x}$

g $\frac{2x+y}{x}$

h $\frac{x^3-5}{x}$

4 $\frac{1}{R} = \frac{R_1+R_2}{R_1R_2}$ giving $R = \frac{R_1R_2}{R_1+R_2}$

Exercise 7B

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

b $\frac{3x-1}{8}$

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

d $\frac{8x-21}{15}$

e $\frac{x-7}{6}$

f $\frac{5(x+1)}{12}$

g $\frac{7x-7}{12}$

2 a $\frac{x-2}{x(x+1)}$

b $\frac{7x-6}{x(x-2)}$

c $\frac{8x+9}{(x-2)(x+3)}$

d $\frac{1-5x}{1-x^2}$

e $\frac{8x+1}{(2x+1)(x-1)}$

f $\frac{x+9}{(3x-1)(x+1)}$

g $\frac{x^2+3x-7}{(x-2)(x-1)}$

h $\frac{x^3-x+4}{(x+3)(x+1)}$

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

3 a $\frac{5-x}{x^2-16}$

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

c $\frac{2x-11}{(x-3)(x+2)}$

d $\frac{x^2+5x-5}{(x^2-4)(x+1)}$

e $\frac{x+21}{x^2-9}$

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

4 a Time upstream = $\frac{500}{x}$

b Time downstream = $\frac{500}{x+3}$

c Total time = $\frac{500}{x} + \frac{500}{x+3} = 100\left(\frac{10x+15}{x^2+3x}\right)$

Exercise 7C

1 a $\frac{14}{x^2}$

b $\frac{2}{y}$

c $\frac{y}{2}$

d $\frac{5y}{2xz}$

e $\frac{1}{6x}$

f $2x + 10$

2 a $\frac{10y}{x}$

b $\frac{5x^2}{3}$

c $\frac{12x^4}{5}$

d $\frac{x^2-25}{3}$

e $\frac{5}{4(x-4)}$

f $\frac{x^2+9}{x-3}$

g $\frac{3x-21}{x^2-4x}$

h $\frac{x-2}{x^2+2x+1}$

i 1

Exercise 7D

1 a $15x^2$

b $\frac{xy^2}{3}$

c $\frac{2x}{7}$

d $\frac{y}{9x}$

e $\frac{4}{5x}$

f $-\frac{y}{2x}$

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

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

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

d $\frac{x+3}{y+3}$

e $-\frac{1}{x}$

f $\frac{x-2}{(x+1)(x+2)}$

3 **a** $\frac{y}{x}$

b $\frac{x+1}{x}$

c $x - 2$

d $\frac{ad}{bc}$

Activity p. 58

$\frac{x+3}{2}$	$\frac{2(x-1)}{3}$	$\frac{x+2}{3}$
$\frac{x-1}{3}$	$\frac{x+1}{2}$	$\frac{2(x+2)}{3}$
$\frac{2x+1}{3}$	$\frac{x+5}{3}$	$\frac{x-1}{2}$

Chapter 8

Exercise 8A

1 **a** $m_{AB} = 3$

b $m_{CD} = -2$

c $m_{EF} = 4$

d $m_{GH} = -1$

e $m_{JK} = \frac{2}{3}$

f $m_{MN} = -\frac{5}{4}$

g $m_{PQ} = \frac{3}{2}$

h $m_{RS} = -\frac{4}{3}$

i $m_{TU} = \frac{5}{2}$

2 **a** $m_{AB} = 0$

b The line is parallel to the x-axis.

c The line is horizontal, because the vertical change is zero.

3 **a** The gradient is undefined.

b The line is parallel to the y-axis.

c The line is vertical because the horizontal change is zero.

4 **a** $m_{TU} = -3$

b $m_{VW} = -\frac{6}{5}$

5 $y = 7$

6 $x = -6$

7 $y = -\frac{4}{3}$

8 $m_{GH} = a - 2$

9 **a** The race finishes at $t = 7$min.

b The greatest rate of change is in AB and EF.

c The maximum acceleration of the bike is $a = 0.14\text{ms}^{-2}$.

d True, because the absolute value of the gradient is the same.

e A gradient of zero represents a constant velocity.

10 **a** $1° \frac{C}{h}$

b $4.5° \frac{C}{h}$ between 7:00 and 8:00.

c Between 22:00 and 00:00

Exercise 8B

1 **a** $m_{PQ} = \frac{2}{5}$

b $m_{RS} = \frac{2}{5}$

c PQ and RS are parallel because they have equal gradients.

2 $m_{TU} = 2$ and $m_{VW} = 2$

3 $m_{PQ} = \frac{4}{3}$ and $m_{RS} = \frac{4}{3}$, so $PQ \parallel RS$;
$m_{PS} = -\frac{3}{4}$ and $m_{QR} = -\frac{3}{4}$, so $PS \parallel QR$.

Exercise 8C

1 **a** $m = 0.58$

b $m = 1.00$

c $m = -1.73$

d $m = -1.00$

e $m = -0.58$

f $m = 0.00$

2 **a** $\theta = 63.4°$

b $\theta = 26.6°$

c $\theta = 108°$

d $\theta = 149°$

e $\theta = 74.1°$

f $\theta = 107°$

3 $\theta = 18.4$

4 $\theta = 153.435°$

5 **a** $\theta = 45.0°$

b $m = -\frac{5}{2}$

6 $\theta = 45.0°$

Activity p. 65

Student's own answers

Exercise 8D

1 **a** $m_{\perp} = -\frac{4}{3}$

b $m_{\perp} = \frac{2}{5}$

c $m_{\perp} = -3$

d $m_{\perp} = -\frac{1}{5}$

e $m_{\perp} = \frac{5}{4}$

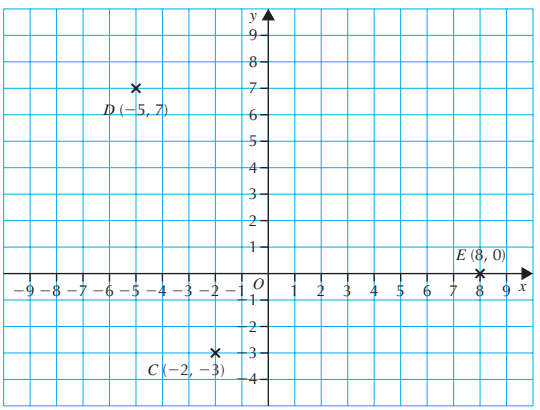
f $m_{\perp} = 1$

g $m_{\perp} = 2$

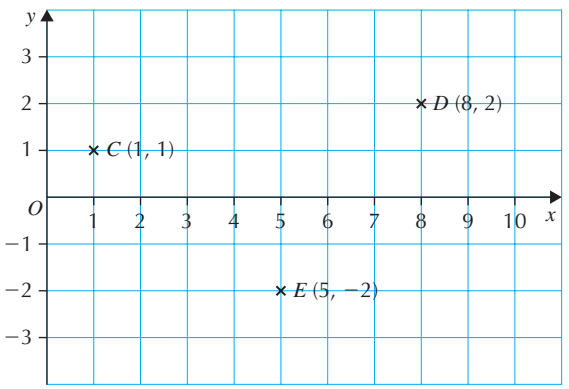
h $m_{\perp} = -1$

2 $m_{\perp} = -\frac{2}{15}$

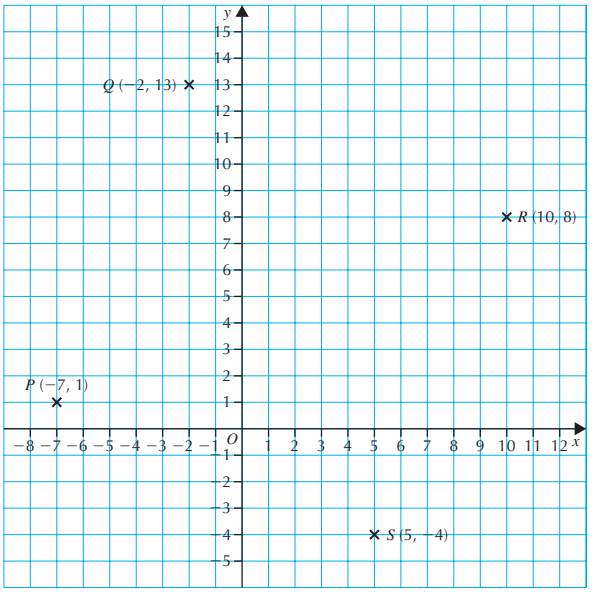
3 $m_{CD} = -\frac{10}{3}$, $m_{CE} = \frac{3}{10}$



4 $m_{CE} = -\frac{3}{4}$, $m_{DE} = \frac{4}{3}$



5 $m_{PQ} = \frac{12}{5}$, $m_{RS} = \frac{12}{5}$ so $PQ \parallel RS$;
$m_{PS} = -\frac{5}{12}$, $m_{RQ} = -\frac{5}{12}$ so $PS \parallel RQ$.
$m_{PQ} \times m_{PS} = -1$ and $m_{RQ} \times m_{RS} = -1$ so $PQ \perp PS$ and $RQ \perp RS$. $PQ = 13$, $RS = 13$, $RQ = 13$ and $PS = 13$ so all sides are equal in length.



Chapter 9

Exercise 9A

1 **a** **i** 14.7 cm

ii 88.0 cm^2

b **i** 3.7 cm

ii 11.0 cm^2

c **i** 3.7 cm

ii 25.7 cm^2

d **i** 4.1 m

ii 3.7 m^2

e **i** 25.7 m

ii 107.8 m^2

f **i** 30.1 cm

ii 225.8 cm^2

2 **a** 52.3 cm

b 169.6 cm^2

3 **a** 185.3 mm

b 1690.8 mm^2

4 **a** **i** 29.6 cm

ii 35.3 cm^2

b **i** 35.6 cm

ii 75.7 cm^2

5 64.2 cm^2

6 **a** 6.3 cm

b 1052 cm

7 294.5 cm^2

Exercise 9B

1 **a** **i** 4π cm

ii 24π cm^2

b **i** 3π cm

ii 27π cm^2

c **i** 10π cm

ii 75π cm^2

2 **a** **i** $1\frac{1}{5}\pi$ cm

ii $10\frac{4}{5}\pi$ cm^2

b **i** 20π cm

ii 240π cm^2

c **i** 9π cm

ii 54π cm^2

3 **a** 6 cm

b 10 cm

c 0.5 cm

4 20π cm^2

Exercise 9C

1 **a** 48°

b 115°

c 179°

d 172°

e 64°

f 25°

2 **a** 72°

b 20π cm^2

3 **a** 30°

b 12 cm

4 40°

Activity p. 75

Student's own research and poster.

Chapter 10

Exercise 10A

1 **a** $V = 1436.8\,cm^3$

b $V = 7238.2\,cm^3$

c $V = 381.7\,cm^3$

d $V = 4.189 \times 10^{-3}\,cm^3$

e $V = 8.18 \times 10^{-3}\,cm^3$

f $V = 8.2\,m^3$

2 $V = 3619\,cm^3$

3 $r = 2.7$ cm

4 **a** The original ball has volume $V_{big} = 33510.3\,cm^3$, each small ball has volume $V_{small} = 268.1\,cm^2$. The number of smaller spheres that can be made is $\frac{V_{big}}{V_{small}} = 124.99$; 124 spheres

b 1048 smaller spheres.

c 125 000 000 smaller spheres.

5 **a** Six spheres can fit in the box

b $V_{water} = 617.4\,cm^3$

6 **a** The volume of risen water equals the volume of the sphere, so $h = 1.7$ cm.

b $h = 2.3$ cm

7 **a** $r = 4.6$ cm

b $r = 11.4$ cm

8 $V = 587.7\,cm^3$

Activity p. 79

Student's own answers

Exercise 10B

1 **a** $V = 84\,cm^3$

b $V = 35\,cm^3$

c 39.7 cm^3

2 $h = 11.3\,\text{cm}$

3 $h = 6.0\,\text{cm}$

4 **a** $V = 432.0\,\text{cm}^3$

b $V = 2.0\,\text{m}^3$

Exercise 10C

1 **a** $V = 66.0\,\text{cm}^3$

b $V = 20.9\,\text{cm}^3$

c $V = 8.3\,\text{cm}^3$

d $V = 0.1\,\text{m}^3$

2 $h = 6.79\,\text{cm}$

3 $d = 4.7\,\text{cm}$

4 $V = 194.0\,\text{cm}^3$

5 $V = 84.8\,\text{cm}^3$

Exercise 10D

1 $V = 335\,\text{cm}^3$

2 $V = 942.5\,\text{mm}^3$

3 $V = 149.9\,\text{cm}^3$

4 $V = 197.9\,\text{cm}^3$

5 $V = 678.6\,\text{mm}^3$

$l_{\text{tot}} = 24 + 6 = 30\,\text{mm}$

6 **a** $V = 672\,\text{cm}^3$

b $V = 5376\,\text{cm}^3$

Activity p. 83

Student's own answers

Chapter 11

Exercise 11A

1 **a** 5

b 4

c 2

d 5

e 2

f 3

g 2

h 1

2 **a** 2

b 1

c 3

d 4

e 4

f 6

g 6

h 5

3 **a** 2

b 4

c 4

d 2

e 3

f 5

g 7

h 8

4 **a** 3

b 4

c 1

d 2

5 **a** 2

b 1

c 2

d 1

e 2

f 3

Exercise 11B

1 **a** 3000

b 90

c 10 000

d 10 000

e 0.04

f 0.005

g 0.3
h 1
i 200
j 8
k 200
l 10
m 6×10^{8}
n 3×10^{5}
o 8×10^{-5}
p 4×10^{-7}

2 **a** 7000
b 30060
c 400
d 35200
e 0.85
f 0.038
g 0.305
h 0.003006
i 24.5
j 700
k 840.1
l 450.00

3 **a** **i** 6.4
ii 21
iii 2.9
b **i** 6.3
ii 20
iii 2.9
c **i** i and ii

Exercise 11C

1 **c** **ai** 6.4 **bi** 6.3
aii 21 **bii** 20
aiii 2.9 **biii** 2.9

Activity p. 88

For addition and subtraction, answers should be rounded to the least number of decimal places of any number in the question. For multiplication and division, the number of significant figures in the answer should equal the least number of significant figures of any number in the question.

1 9068
2 3.29
3 1.5×10^{8}
4 420 000