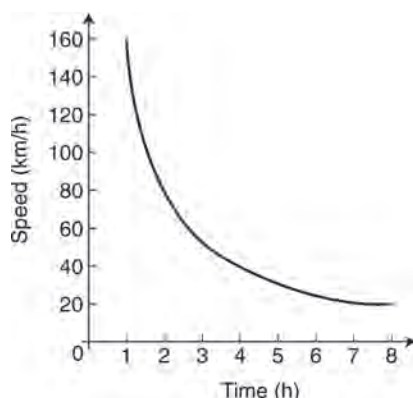


Unit 1

NUMBER 1

ACTIVITY 1

Time (h)	1	2	4	6	7	8
Speed (km/h)	160	80	40	26.7	22.9	20



Speed and time are inversely related.

EXERCISE 1

- 1 a 4 days b 2 days c $2\frac{2}{3}$ days
 2 a 24 days b 6 days c 4.8 days
 3 a 8 people b 16 people c 32 people
 4 a 12 people b 8 people c 6 people
 5 a 60 years b 15 years c 1200 years
 6 a 40 000 men b 20 000 men c 400 men
 7 a 12 hours b 72 km/h c 400 men
 8 a 32 km/litre b 20 litres

EXERCISE 1*

1 a

Number of light bulbs (N)	Power of each bulb (P)
6	500
5	600
2	1500
30	100

b $3000 = NP$

2 a

Number of years (N)	Number of men (M)
1	100 000
2	50 000
4	25 000
10	10 000

b $100\,000 = NM$

- 3 a 12 g/cm^3 b 1.5 cm^3
 4 a 10 minutes b 12.8 litres/minute

5

Number of men	Number of tunnels	Time in years
100 000	4	4
100 000	2	2
20 000	8	40
400 000	2	0.5

6

Number of mosquitoes	Number of young	Time
1	18 000	1 hour
1	5	1 second
500	9 million	1 hour
500	4.5 billion	500 hours

- 7 a 5 b 1000 c 2.26×10^8 tonnes
 8 a 910 kg (2 s.f.) b 4600 tonnes (2 s.f.) c 180 000 tonnes (2 s.f.)
 9 a 16 tonnes (2 s.f.)
 b (i) 4 minutes (ii) 30 seconds
 (iii) 70 seconds (iv) 8 seconds

EXERCISE 2

- 1 0.375 2 0.05 3 0.08 4 0.1875
 5 0.28125 6 0.1375 7 0.2 8 0.5
 9 0.18 10 $0.\dot{3}\dot{6}$ 11 $0.2\dot{6}$ 12 $0.5\dot{3}$
 13 $0.3\dot{8}$ 14 $0.9\dot{4}$ 15 $\frac{9}{16}$ 16 $\frac{5}{32}, \frac{3}{8}$
 17 $\frac{3}{20}, \frac{5}{64}$ 18 $\frac{3}{40}, \frac{7}{80}, \frac{9}{25}, \frac{9}{24}$ 19 $\frac{1}{3}$
 20 $\frac{4}{9}$ 21 $\frac{5}{9}$ 22 $\frac{2}{3}$ 23 $\frac{7}{9}$
 24 1 25 $\frac{7}{90}$ 26 $\frac{1}{90}$ 27 $\frac{1}{30}$
 28 $\frac{1}{45}$ 29 $\frac{1}{18}$ 30 $\frac{1}{15}$

EXERCISE 2*

- 1 $0.4\dot{6}$ 2 $0.6\dot{1}$ 3 $0.4\dot{6}$ 4 $0.06\dot{1}$
 5 $2.\dot{3}\dot{0}$ 6 $4.\dot{1}\dot{2}$ 7 $0.3\dot{0}\dot{1}$ 8 $0.2\dot{8}\dot{0}$
 9 $\frac{11}{16}, \frac{7}{40}, \frac{3}{15}$ 10 $\frac{7}{40}, \frac{5}{32}, \frac{7}{8}$ 11 $\frac{19}{20}, \frac{3}{25}, \frac{5}{64}$ 12 $\frac{11}{125}, \frac{55}{128}, \frac{9}{512}, \frac{9}{48}$
 13 $\frac{8}{33}$ 14 $\frac{38}{99}$ 15 $\frac{10}{33}$ 16 $\frac{31}{33}$
 17 $9\frac{19}{990}$ 18 $8\frac{29}{990}$ 19 $\frac{3}{110}$ 20 $\frac{2}{55}$
 21 $\frac{412}{999}$ 22 $\frac{101}{999}$ 23 $\frac{128}{333}$ 24 $\frac{158}{333}$
 25 $\frac{11}{90}$ 26 $\frac{13}{15}$ 27 $\frac{28}{495}$ 28 $\frac{31}{198}$
 29 $0.\dot{0}3\dot{7}$ 30 $0.01\dot{6}$

REVISION EXERCISE 3

- 1 a 2 hours b 6 mowers
 2 a 7.5 km/litre b 6 litres
 3 a 0.2 b 0.125 c 0.05
 4 a $0.1\dot{6}$ b 0.4 c $0.42857\dot{1}$
 5 a $\frac{2}{9}$ b $\frac{7}{90}$ c $\frac{23}{99}$

REVISION EXERCISE 3*

- 1 a 16 km/litre b 40 litres
 2 a 25 b 10 g c 6 million km
 3 0.153 846
 4 $\frac{11}{25}, \frac{7}{256}, \frac{9}{500}, \frac{9}{15}$
 5 a $\frac{7}{9}$ b $\frac{1}{90}$ c $\frac{67}{99}$ d $3\frac{1}{22}$
 6 0.12

ALGEBRA 1

ACTIVITY 2

Variables	Related? Y/N
Area of a circle (A) and its radius (r)	Y
Circumference of a circle (C) and its diameter (d)	Y
Volume of water in a tank (V) and its weight (w)	Y
Distance travelled (D) at constant speed and time taken (t)	Y
Number of pages in a book (N) and its thickness (t)	Y
Mathematical ability (M) and a person's height (h)	N
Wave height in the sea (W) and wind speed (s)	Y
Grill temperature (T) and time to toast bread (t)	Y

EXERCISE 4

- 1 a $y = 5x$ b 30 c 5
 2 a $d = 4t$ b 60 c 45
 3 a $y = 2x$ b 10 cm c 7.5 kg
 4 a $e = \frac{M}{20}$ b 5 m c 120 kg
 5 1950 sales
 6 Yes, as 210 people would turn up to swim

EXERCISE 4*

- 1 a $v = 9.8t$ b 49 m/s c 2.5 s
 2 a $c = \frac{m}{3}$ b \$2.50 c 600 g
 3 a $d = 150m$ b 1500 km c 266.7 g
 4 a $m = 6.5n$ b 975 g c 1540 approx.
 5 a $h = \frac{3y}{2}$ b 0.75 m c 4 months

6 a

Advertising medium	£x million	£P million
TV	1.5	6
Radio	0.5	2
Newspapers	1.25	5
Internet	0.1	0.4

- b £13.4 million c £3.35 million d 25%

EXERCISE 5

- 1 a $y = 4x^2$ b 144 c 4
 2 a $p = 2q^2$ b 18 c 7
 3 a $v = 2w^3$ b 54 c 4
 4 a $m = 10\sqrt{n}$ b 20 c 25
 5 a $y = 5t^2$ b 45 m c $\sqrt{20} \text{ s} \approx 4.47 \text{ s}$
 6 a $P = \frac{h^3}{20}$ b \$86.40 c 8 cm

EXERCISE 5*

1

g	2	4	6
f	12	48	108

2

n	1	2	5
m	4	32	500

- 3 a $R = \left(\frac{5}{256}\right)s^2$ b 113 km/h
 4 a $H = 1.5\sqrt[3]{y}$ b 512 years old
 5 $x = 10\sqrt{2}$
 6 $y = \frac{100}{\sqrt[3]{2}}$

ACTIVITY 3

$$t^2 \approx 3.95 \times 10^{-20} d^3$$

Planet	d (million km)	t (Earth days) (2 s.f.)
Mercury	57.9	88
Jupiter	778	4300
Venus	108	220
Mars	228	680
Saturn	1430	11 000
Uranus	2870	31 000
Neptune	4500	60 000

EXERCISE 6

- 1 a $y = \frac{12}{x}$ b $y = 6$ c $x = 4$
 2 a $d = \frac{250}{t}$ b $d = 125$ c $t = 5$
 3 a $m = \frac{36}{n^2}$ b $m = 9$ c $n = 6$
 4 a $V = \frac{100}{w^3}$ b $V = 100$ c $w = 5$
 5 a $I = 4 \times \frac{10^5}{d^2}$ b 0.1 candle power
 6 a $L = \frac{1}{4d^2}$ b 25 days

EXERCISE 6*

1

b	2	5	10
a	50	8	2

2 a $r \propto \frac{1}{t}$, in fact $r = \frac{20}{t}$

b

t	1	4	5	10
r	20	5	4	2

- 3 a $R = \frac{2}{r^2}$ b $\frac{2}{9} \text{ ohm}$
 4 a $C = \frac{5000}{t}$ b \$277.78 c 12.5 °C
 5 a
- | Day | N | t |
|------|-----|----|
| Mon | 400 | 25 |
| Tues | 447 | 20 |
| Wed | 500 | 16 |
- b 365 approx.
 6 4.5 s

ACTIVITY 4

	Hare	Dog	Man	Horse
Pulse (beats/min)	200	135	83	65
Mass (kg)	5	12	70	200

Total heartbeats for a human life span of 75 years $\approx 3.27 \times 10^9$

According to theory:

	Hare	Dog	Man	Horse
Life span (years)	31.1	46.1	75	95.8

Theory clearly not correct.

REVISION EXERCISE 7

- 1 a $y = 6x$ b $y = 42$ c $x = 11$
 2 a $p = 5q^2$ b $p = 500$ c $q = 11$
 3 a $c = \frac{3}{4}a^2$ b \$675 c 28.3 m^2

4

n	1	2	4	8
t	80	40	20	10

REVISION EXERCISE 7*

- 1 a $y^2 = 50z^3$ b 56.6 c 5.85
 2 a $m = \frac{8839}{\sqrt{n}}$ b 3.23×10^5 c 7.81×10^{-5}

3 1500 m

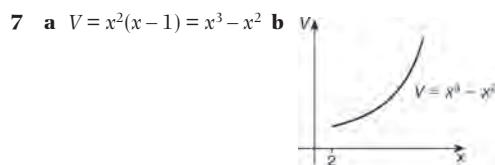
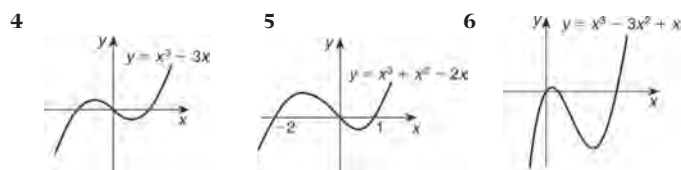
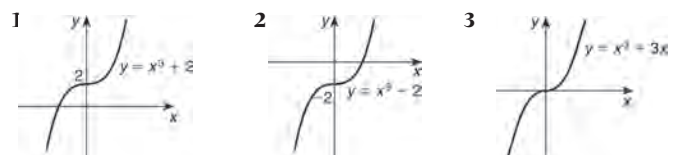
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x	0.25	1	4	25
y	20	10	5	2

$$y = \frac{10}{\sqrt{x}}$$

GRAPHS 1

EXERCISE 8



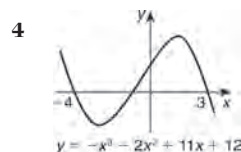
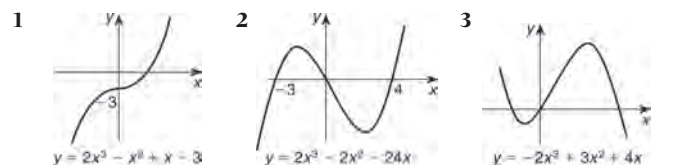
c 48 m^2 d $4.5 \text{ m} \times 4.6 \text{ m} \times 3.6 \text{ m}$

8

x	0	1	2	3	4	5
y	8	17	16	11	8	13

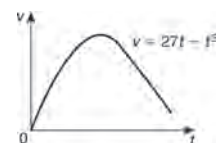
b 9.5 m

EXERCISE 8*



5 a

t	0	1	2	3	4	5
v	0	26	46	54	44	10

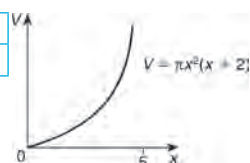


- b $v_{\max} = 54 \text{ m/s}$ and occurs at $t = 3 \text{ s}$
 c $v \geq 30 \text{ m/s}$ when $1.2 \geq t \geq 4.5$ so for about 3.3 s

- 6 a $V = \pi x^3 + \frac{1}{3}\pi x^2 \cdot 6 = \pi x^3 + 2\pi x = \pi x^2(x+2)$

b

x	0	1	2	3	4	5
V	0	3π	16π	45π	96π	175π

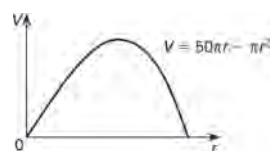


- c When $x = 3.5 \text{ cm}$, $V \approx 212 \text{ cm}^3$
 d When $V = 300 \text{ cm}^3$, $x \approx 4 \text{ cm} \rightarrow A \approx 100.5 \text{ cm}^2$

- 7 a $A = 100\pi = 2\pi r^2 + 2\pi rh$
 $\rightarrow 100\pi - 2\pi r^2 = 2\pi rh$
 $\rightarrow \frac{50}{r} - r = h$
 $\rightarrow V = \pi r^2 h = \pi r^2 \left(\frac{50}{r} - r \right) = 50\pi r - \pi r^3$

b

r	0	1	2	3	4	5	6	7
V	0	153.9	289.0	386.4	427.3	392.7	263.9	22.0

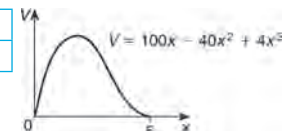


- c $V_{\max} = 427.3 \text{ cm}^3$
 d $d = 8.16 \text{ cm}$, $h = 8.2 \text{ cm}$

- 8 b $V = (10-2x)(10-2x)x = 100x - 40x^2 + 4x^3$

c

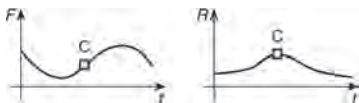
x	0	1	2	3	4	5
V	0	64	72	48	16	0



- d $V_{\max} = 74 \text{ cm}^3$, $1.67 \text{ cm} \times 6.66 \text{ cm} \times 6.66 \text{ cm}$

ACTIVITY 5

Year interval	Fox numbers	Rabbit numbers	Reason
A-B	Decreasing	Increasing	Fewer foxes to eat rabbits
B-C	Increasing	Increasing	More rabbits attract more foxes into the forest
C-D	Increasing	Decreasing	More foxes to eat rabbits so rabbit numbers decrease
D-A	Decreasing	Decreasing	Fewer rabbits to be eaten by foxes so fox numbers decrease



ACTIVITY 6

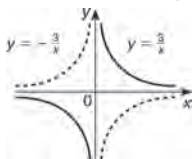
$$y = \frac{3}{x}$$

x	-3	-2	-1	0	1	2	3
y	-1	-1.5	-3	∅	3	1.5	1

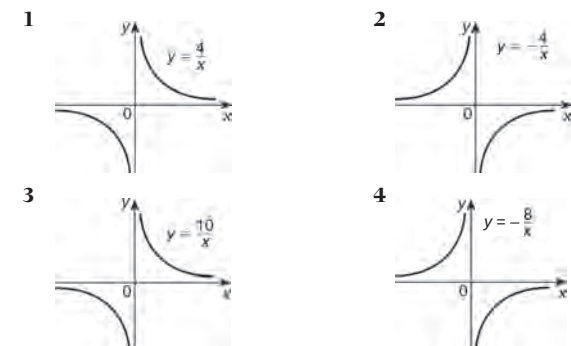
$$y = -\frac{3}{x}$$

x	-3	-2	-1	0	1	2	3
y	1	1.5	3	∅	-3	-1.5	-1

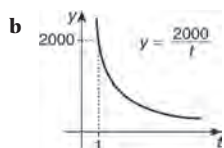
As x approaches 0, y approaches ∞ so at $x = 0$, y is not defined as denoted by $\emptyset$.



EXERCISE 9



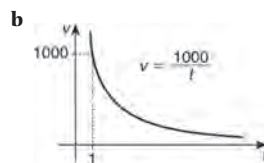
t (months)	1	2	3	4	5	6
y	2000	1000	667	500	400	333



c 3.3 months

d 2.7 months approx.

t (hours)	1	5	10	15	20
v (m³)	1000	200	100	67	50

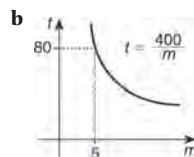


c 4 hours

d 62.5 m³

7 a $k = 400$

m (min)	5	6	7	8	9	10
t (°C)	80	67	57	50	44	40

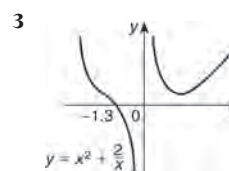
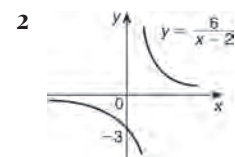
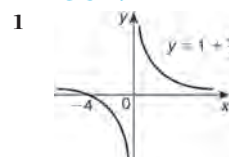


c 53 (°C)

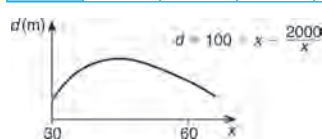
d 6 min 40 s

e $5.3 \leq m \leq 8$

EXERCISE 9*



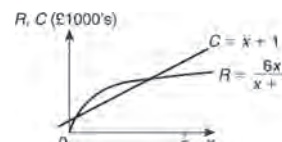
x (°)	30	35	40	45	50	55	60
d (m)	3.3	7.9	10	10.6	10	8.6	6.7



b 10.6 m at $x = 45^\circ$

c $37^\circ < x < 54^\circ$

x	0	1	2	3	4	5
R	0	3	4	4.5	4.8	5
C	2	4	6			



b $P > 0$ when $0.27 < x < 3.7$ so between 27 and 370 boards per week

c £1100 when $x = 1.45$ so 145 boards hired out

7 a Volume = $\pi r^2 h$

$$50 = \pi r^2 h$$

$$\frac{50}{\pi r^2} = h$$

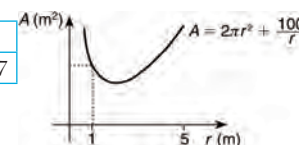
$$\text{Area} = 2\pi r^2 + 2\pi r h$$

$$A = 2\pi r^2 + \frac{2r\pi \times 50}{\pi r^2}$$

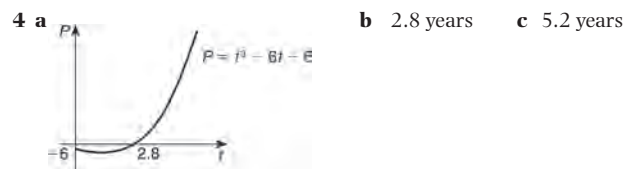
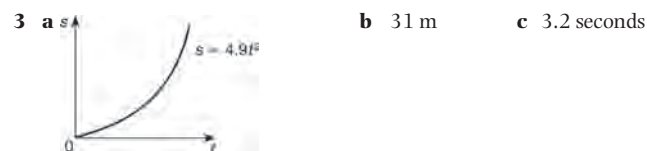
$$A = 2\pi r^2 + \frac{100}{r}$$

r (m)	1	2	3	4	5
A (m²)	106	75	90	126	177

c $A = 75 \text{ m}^2$ at $r = 2.0 \text{ m}$

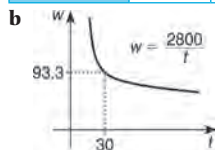


REVISION EXERCISE 10



5 a $k = 2800$

t (weeks)	30	32	34	36	38	40
x (kg)	93	88	82	78	74	70



c 35 weeks
d Clearly after 500 weeks, Nick cannot weigh 5.6 kg. So there is a domain over which the equation fits the situation being modelled.

6 a

m	5	6	7	8	9	10
t	85	70.8	60.7	53.1	47.2	42.5

b $6 < m < 8.4$

x	5	10	15	20	25	30	35	40
L	130	80	70	70	74	80	87	95

d 69.3 m at $x = 17.3$ m

e $11.6 < x < 25.9$

6 a When $x = 0, y = 5$

$$0 - 0 + 0 + b = 5$$

$$b = 5$$

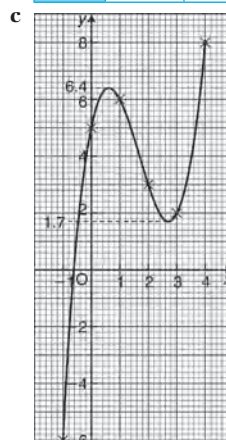
$$\text{When } x = 1, y = 6$$

$$1 + a = 6$$

$$a = 5$$

b

x	-1	0	1	2	3	4
y	-6	5	6	3	2	9



d R(0.6, 6.4) S(2.7, 1.7)

SHAPE AND SPACE 1

ACTIVITY 7

$\angle PQO = y$ and $\angle PRO = x$ (isosceles triangles)

$\therefore \angle QOT = 2y$ and $\angle ROT = 2x$

$\therefore \angle QOR = 2y + 2x = 2(x + y)$

$$= 2 \times \angle QPR$$

EXERCISE 11

- 1 100° 2 30° 3 45° 4 10° 5 280°
6 140° 7 60° 8 110° 9 60° 10 112°

11 $\angle ADB$ and $\angle BCA$ are angles in the same segment

12 $\angle ADC + \angle ABC$ sum to 180°

13 LKMN is an isosceles trapezium

14 PXQY is a kite and PQ is the line of symmetry. This could also be proved using congruent triangles.

EXERCISE 11*

- 1 140° 2 60° 3 115° 4 110° 5 54°
6 76° 7 119° 8 22° 9 $3x$

10 $(90^\circ - x)$

11 $\angle ADB = x^\circ$ ($\triangle ABD$ is isosceles)

$\angle BDC = (180 - 4x)^\circ$ ($\triangle BCD$ is isosceles)

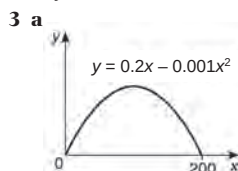
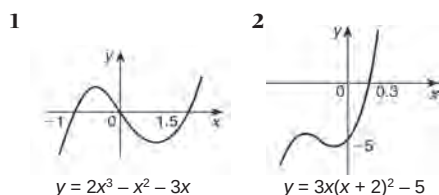
$$\therefore \angle ADC = (180 - 3x)^\circ$$

$\therefore \angle ADC + \angle ABC = 180^\circ$ so quadrilateral is concyclic

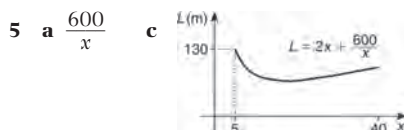
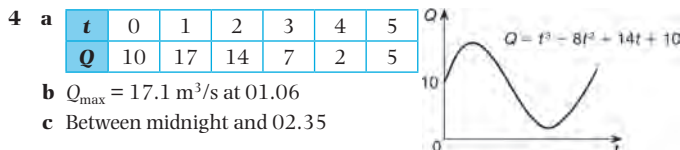
12 $\angle AFE + \angle EDA = 180^\circ$ (opposite angles of a concyclic quadrilateral)

$$\therefore \angle ABC + \angle CDA + \angle EFA = 360^\circ$$

REVISION EXERCISE 10*



b 10 m c $29 \leq x \leq 170$



- 13 $\angle BEC = \angle CDB$ (angles in the same segment)
 $\therefore \angle CEA = \angle BDA$
- 14 Join AO. $\angle OAX = 90^\circ$ (OX is diameter)
 $\triangle XOY$ is isosceles $\therefore \triangle OAX \equiv \triangle OAY$ and $AX = AY$
- 15 Let $\angle QYZ = y^\circ$ and $\angle YZQ = x^\circ$. So $\angle ZWX = y^\circ$ and $\angle PWZ = 180 - y^\circ$
 In $\triangle YQZ$: $x + y + 20 = 180$
 $\therefore x + y = 160$ (i)
 In $\triangle PWZ$: $180 - y + x + 30 = 180$
 $\therefore y - x = 30$ (ii)
 From (i) and (ii) $x = 65$ and $y = 95$
 $\therefore$ angles of the quadrilateral are $65^\circ, 85^\circ, 95^\circ, 115^\circ$
- 16 Draw OP and OQ. Let $\angle POQ = 2x^\circ$.
 $\therefore \angle PRQ = x^\circ$ and $\angle XOQ = (180 - x)^\circ$
 $\therefore \angle XRQ + \angle XOQ = 180^\circ$ and RXOQ is concyclic

ACTIVITY 8

	$\widehat{QPB}$	$\widehat{OPB}$	$\widehat{OBP}$	$\widehat{BOP}$	$\widehat{BAP}$
C_1	50°	40°	40°	100°	50°
C_2	62°	28°	28°	124°	62°
C_3	x°	$(90 - x)^\circ$	$(90 - x)^\circ$	$2x^\circ$	x°

EXERCISE 12

- 1 70° 2 30° 3 80° 4 50°
 5 30° 6 30° 7 100° 8 110°
 9 a 90° b 60° c 60° d 60°
 10 a 90° b 20° c 20° d 20°
- 11 $\angle NTM = \angle NPT$ (Alternate segment)
 $\angle PLT = \angle NTM$ (Corresponding angles)
- 12 $\angle ATF = \angle FDT$ (Alternate segment)
 $\angle FDT = \angle BAF$ (AC parallel to DT)
- 13 $\angle ATC = \angle ABT$ (Alternate segment)
 $\angle ABT = \angle BTD$ (AB parallel to CD)
- 14 $\angle CTB = \angle CDT$ (Alternate segment)
 $\angle CBT$ is common

EXERCISE 12*

- 1 65° 2 35° 3 140° 4 10°
 5 $\angle ATE = 55^\circ$ (alternate segment)
 $\angle TBC = 125^\circ$ (angles on straight line)
 $\angle BTC = 35^\circ$ (angle sum of triangle)
 $\angle ATB = 90^\circ$ (angles on straight line)
 $\therefore$ AB is a diameter
- 6 $\angle ATD = x^\circ$ (alternate segment), $\angle DTC = 90^\circ$ (CD is a diameter),
 $\therefore \angle BTC = (90 - x)^\circ$ (angles on straight line) $\therefore \angle TBC$ is a right angle
 (angle sum of triangle)
- 7 a 56° b 68°
 8 a 110° b 40°
 9 a 55° b 35°
 c $\angle ACD = 35^\circ$ (angle sum of triangle)
 $\therefore \triangle ACD$ is isosceles
- 10 a 70° b 110°
 c $\angle CTB = 40^\circ$ (alternate segment)
 $\therefore \triangle s$ BCT and BTD are similar
- 11 20°
 12 130°
 13 a Triangles ACG and ABF are right-angled
 b Angles ACG and ABF are equal and in the same segment of the chord FG

- 14 a (i) $\angle T_2CT_1, \angle T_2T_1B$
 (ii) $\angle AT_1C, \angle BT_1D, \angle T_1DB, \angle CT_2T_1$
 b Triangles BT_1T_2 and T_1BD are isosceles, $\therefore BT_2 = BD$
- 15 a $\angle EOC = 2x^\circ$ (angle at centre twice angle at circumference)
 $\angle CAE = (180 - 2x)^\circ$ (opposite angles of a cyclic quadrilateral)
 $\angle AEB = x^\circ$ (angle sum of triangle AEB)
 $\therefore$ triangle ABE is isosceles
 b $\angle ECB = x^\circ$ (base angles of isosceles triangle)
 $\therefore \angle BEC = (180 - 2x)^\circ = \angle CAE$
 Since $\angle BAE$ and $\angle BEC$ are equal and angles in the alternate segment,
 BE must be the tangent to the larger circle at E

EXERCISE 13

- 1 22.5 cm 2 5.25 cm 3 10.5 cm 4 13.5 cm
 5 18 cm 6 14 cm 7 4 cm 8 11 cm
 9 12 cm 10 9 cm

EXERCISE 13*

- 1 3 cm 2 10.5 cm
 3 $x^2 - 22x + 120 = 0$, $x = 10$ or 12 cm 4 $4x^2 = 100$, $x = 5$ cm
 5 8 cm 6 15 cm
 7 24 cm 8 4.5 cm
 9 a Pythagoras: $(y + r)^2 = r^2 + x^2$ b 12 cm
 $y^2 + 2ry = x^2$
 Intersecting chords: $x^2 = y(y + 2r)$
 $x^2 = y^2 + 2ry$
- 10 a 60 mm b 40 mm

REVISION EXERCISE 14

- 1 20° 2 120° 3 65°
 4 45° 5 13.5 cm 6 7.75 cm
 7 a 80° b 100° c 50° d 50°

REVISION EXERCISE 14*

- 1 a 55°
 b 35°
 c $\angle TDC = 35^\circ$ (Angles in the same segment)
 $\therefore \angle EDC = 90^\circ$ and EC is the diameter
- 2 a $x(x + 25) = 900$
 b 20 cm
 3 $x = 3$ cm, $y = 12$ cm
 4 $x = 4$ cm, $y = 6$ cm
 5 a 40°
 b 50°
 c $\angle ZXT = \angle WVT$ (Angle in alternate segment)
 $\therefore XZ$ is parallel to WV (Alternate angles)
- 6 a $\angle BAY = \angle BCY$ (Angles in the same segment)
 b Triangles ABY and BXY are similar
 $\therefore \angle ABY = \angle BXY$

SETS 1

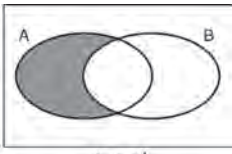
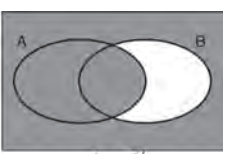
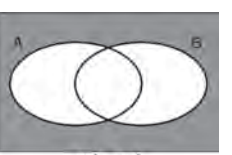
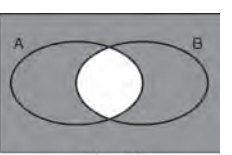
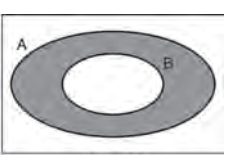
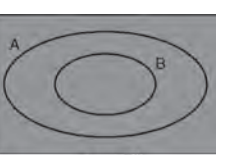
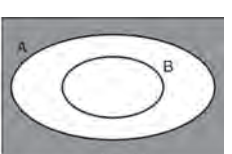
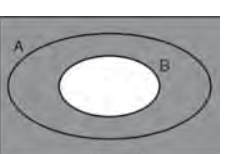
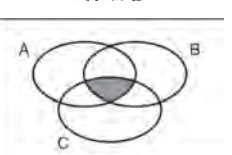
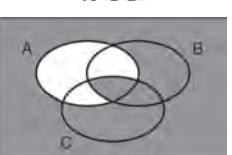
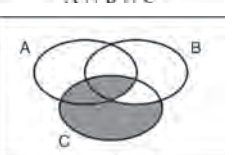
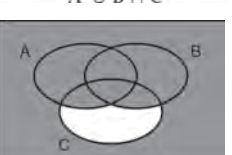
EXERCISE 15

- 1 6 2 93 3 22 4 41
 5 a 10 b 8 c 5
 6 18

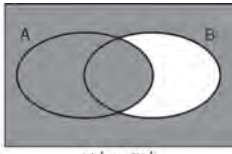
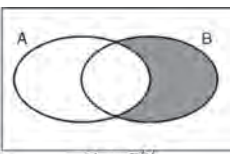
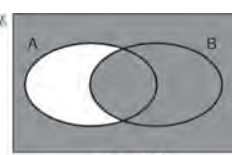
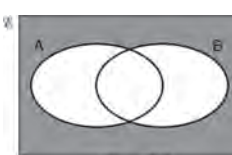
EXERCISE 15*

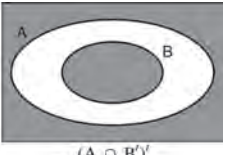
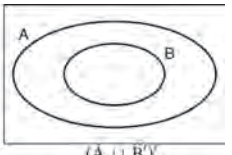
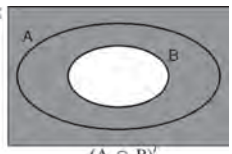
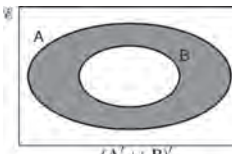
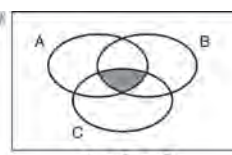
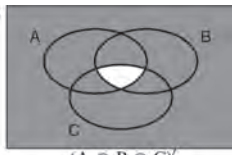
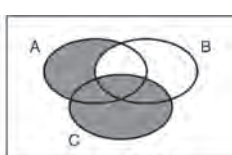
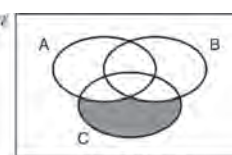
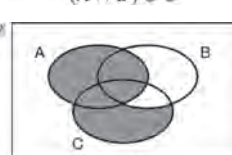
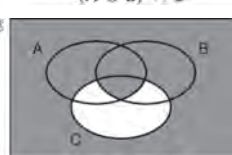
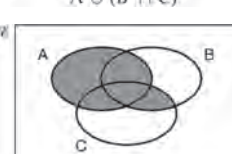
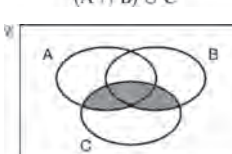
- 1 23 2 10 3 100 4 3
5 $8 \leq x \leq 14, 0 \leq y \leq 6$ 6 40% can do both

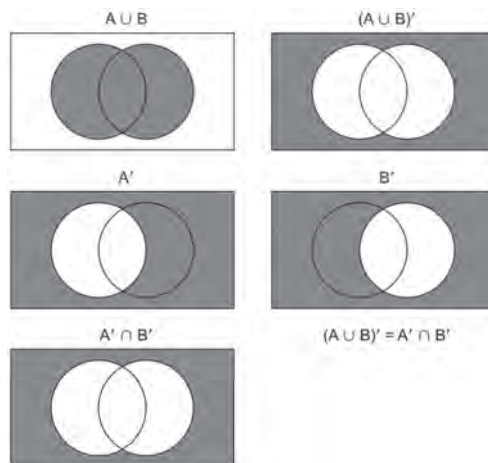
REVISION EXERCISE 16

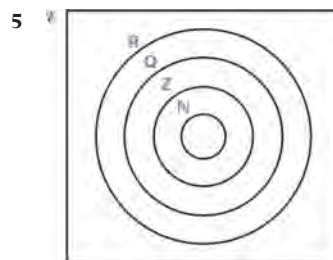
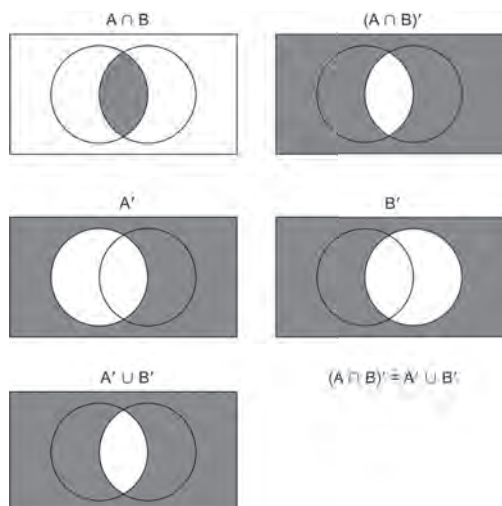
- 1 a  $A \cap B'$ b  $A \cup B'$
c  $A' \cap B'$ d  $A' \cup B'$
2 a  $A \cap B'$ b  $A \cup B'$
c  $A' \cap B'$ d  $A' \cup B'$
3 a  $A \cap B \cap C'$ b  $A' \cup B \cap C$
4 a  $(A \cup B') \cap C$ b  $A \cup B \cup C'$
5 a $A \cap B'$ b $A' \cap B'$ c $A' \cup B'$
6 a $A' \cup B$ b $(A' \cap B') \cup (A \cap B)$ c $A \cap B'$

EXERCISE 16*

- 1 a  $(A' \cap B)'$ b  $(A \cup B')'$
c  $(A \cap B')'$ d  $(A \cup B)'$

- 2 a  $(A \cap B)'$ b  $(A \cup B)'$
c  $(A \cap B)'$ d  $(A' \cup B)'$
3 a  $A \cap B \cap C$ b  $(A \cap B \cap C)'$
c  $(A \cap B') \cup C'$ d  $(A \cup B)' \cap C$
4 a  $A \cup (B' \cap C)$ b  $(A \cap B) \cup C'$
c  $A \cup (B \cap C)$ d  $(A \cup B) \cap C$
5 a $B \cap (A \cup C)'$ b $(B' \cap C)$
c $(B' \cap C) \cup (A \cap B \cap C')$
6 a $A \cap C \cap B'$ b $A' \cap (B \cup C)$
c $[A' \cap (B \cup C)] \cup [A \cap (B \cup C)']$
7





REVISION EXERCISE 18

- 1 a b 17 c 30
 2 a 6 b 2
 3 a 17% b 52%
 4 a b c 10
 c 31%

- 5 $A' \cup B'$
 6 a $\{-2, -1, 0, 1, 2, 3\}$ b $\{1, 2, 3, 4\}$
 c $\emptyset$
 7 a $\{x: x \text{ is even, } x \in \mathbb{N}\}$
 b $\{x: x \text{ is a factor of } 24, x \in \mathbb{N}\}$
 c $\{x: -1 \leq x \leq 4, x \in \mathbb{N}\}$

REVISION EXERCISE 18*

- 1 28 2 10
 4 a b c $\emptyset$
 5 a $(A \cup B') \cap C$ b $A \cup B \cup C'$
 6 a $\{-1, 1\}$ b $\{0, -4\}$ c $\emptyset$
 7 a $\{x: x > -5, x \in \mathbb{N}\}$
 b $\{x: 4 < x < 12, x \in \mathbb{N}\}$
 c $\{x: x \text{ is a multiple of } 3, x \in \mathbb{N}\} \text{ or } \{x: x = 3y, y \in \mathbb{N}\}$

EXAMINATION PRACTICE 1

- 1 a 1.2 mpg b 1920 gallons
 2 a $\frac{58}{99}$ b $\frac{63}{111}$
 3 $\frac{9}{40}, \frac{7}{8}, \frac{7}{128}$
 4 a $y = \frac{x}{2}$ b 2.5 c 1
 5 a $p = \frac{1}{5}q^2$ b 80 c ± 10
 6 a 9000 b $N = \frac{9000}{d^2}$ c 2250 d 3 cm
 7 a $x = 4\sqrt[3]{y}$ b $y = 512$

EXERCISE 17

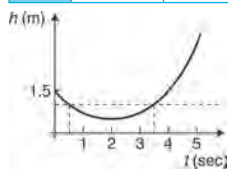
- 1 a {Tuesday, Thursday}
 b {Red, Amber, Green}
 c $\{1, 2, 3, 4, 5, 6\}$
 d $\{-1, 0, 1, 2, 3, 4, 5, 6\}$
 2 a {Africa, Antarctica, Asia, Australia, Europe, North America, South America}
 b {All Mathematics teachers in the school}
 c $\{1, 2, 3, 4, 5\}$
 d $\{-3, -2, -1, 0, 1, 2\}$
 3 a $\{x: x < 7, x \in \mathbb{N}\}$
 b $\{x: x > 4, x \in \mathbb{N}\}$
 c $\{x: 2 \leq x \leq 11, x \in \mathbb{N}\}$
 d $\{x: -3 < x < 3, x \in \mathbb{N}\}$
 e $\{x: x \text{ is odd, } x \in \mathbb{N}\}$
 f $\{x: x \text{ is prime}\}$
 4 a $\{x: x > -3, x \in \mathbb{N}\}$
 b $\{x: x \geq 9, x \in \mathbb{N}\}$
 c $\{x: 5 < x < 19, x \in \mathbb{N}\}$
 d $\{x: -4 \leq x \leq 31, x \in \mathbb{N}\}$
 e $\{x: x \text{ is a multiple of } 5, x \in \mathbb{N}\} \text{ or } \{x: x = 5y, y \in \mathbb{N}\}$
 f $\{x: x \text{ is a factor of } 48, x \in \mathbb{N}\}$

EXERCISE 17*

- 1 a $\{2, 4, 6, 8, 10, 12\}$ b $\{3, 7, 11, 15, 19, 23\}$
 c $\{2, 4, 6\}$ d {Integers between 1 and 12 inclusive}
 2 a $\{0, 1, 4\}$ b $\{\frac{1}{4}, \frac{1}{2}, 1, 2, 4\}$
 c $\{1\}$ d $\{(1, 1), (2, 2)\}$
 3 a $\emptyset$ b $(1, \frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16})$
 c $\{2\}$ d $\{-3, 2\}$
 4 a $\emptyset$ b $\{1, 2, 4, 8, 16, 32\}$
 c $\emptyset$ d $\{-1 + \sqrt{7}, -1 - \sqrt{7}\}$

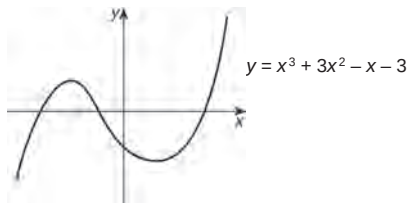
8 a

t	0	1	2	3	4	5
h	1.5	0.75	0.5	0.75	1.5	2.75



- b 1.5 m c 0.5 m at 2 s d 0.6 s to 3.4 s

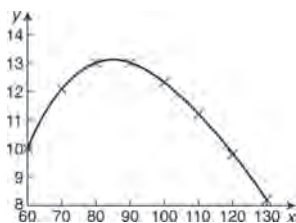
- 9 a b $x = -3, -1, 1$



10 a

x	60	70	80	90	100	110	120	130
$\frac{x}{3}$	20	23.3	26.7	30	33.3	36.7	40	43.3
$\frac{2400}{x}$	40	34.3	30	26.7	24	21.8	20	18.5
y	10	12.4	13.3	13.3	12.7	11.5	10	8.2

b $y = 70 - \frac{x}{3} - \frac{2400}{x}$



- c 10.75 km/litre d ≈ 85 km/h

- 11 a 80° b 74°

- 12 a $m = 35^\circ, n = 126^\circ$

- b (i) $(90 - x)^\circ$ (ii) x° (iii) $(90 - 2x)^\circ$

- c $\angle ABE = 90^\circ$ ($\angle DBE = x^\circ$)

$\therefore$ triangles ABE and ACD are similar

$\therefore \frac{BE}{CD} = \frac{AE}{AC}$

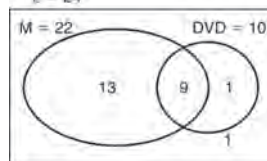
- 13 a $BP = 1.6$ cm b $CQ = 4$ cm

- 14 a (i) 4, 6 (ii) 2, 3, 4, 5, 6, 8

- b (i) 4 is a member (or element) of set B

- (ii) There are four members in set B

- 15 a $\overline{B} = 24$



- b (i) 13 (ii) 1 (iii) 9

Unit 2

NUMBER 2

EXERCISE 19

	km	m	cm	mm
1	5	5000	5×10^5	5×10^6
2	8	8000	8×10^5	8×10^6
3	3	3000	3×10^5	3×10^6
4	4	4000	4×10^5	4×10^6
5	2	2000	2×10^5	2×10^6
6	7	7000	7×10^5	7×10^6
7	0.05	50	5000	5×10^4
8	0.06	60	6000	6×10^4
9	1	10^3	10^5	10^6
10	10	10^4	10^6	10^7
11	15	1.5×10^4	1.5×10^6	1.5×10^7
12	3.3	3.3×10^3	3.3×10^5	3.3×10^6

EXERCISE 19*

	km	m	cm	mm
1	500	5×10^5	5×10^7	5×10^8
2	700	7×10^5	7×10^7	7×10^8
3	2.5×10^4	2.5×10^7	2.5×10^9	2.5×10^{10}
4	4.3×10^3	4.3×10^6	4.3×10^8	4.3×10^9
5	5×10^3	5×10^6	5×10^8	5×10^9
6	700	7×10^5	7×10^7	7×10^8
7	5×10^{-4}	0.5	50	500
8	6×10^{-4}	0.6	60	600
9	9×10^3	9×10^6	9×10^8	9×10^9
10	8×10^5	8×10^8	8×10^{10}	8×10^{11}
11	4×10^{-6}	4×10^{-3}	0.4	4
12	7×10^{-6}	7×10^{-3}	0.7	7

13 a 2×10^{14}

b 1×10^6

14 a 5×10^{12}

b 1×10^6

EXERCISE 20

	km ²	m ²	cm ²	mm ²
1	2	2×10^6	2×10^{10}	2×10^{12}
2	4	4×10^6	4×10^{10}	4×10^{12}
3	1	10^6	10^{10}	10^{12}
4	3	3×10^6	3×10^{10}	3×10^{12}
5	5×10^{-5}	50	5×10^5	5×10^7
6	8×10^{-5}	80	8×10^5	8×10^7
7	6×10^{-4}	6×10^2	6×10^6	6×10^8
8	3×10^{-3}	3×10^3	3×10^7	3×10^9
9	10	10^7	10^{11}	10^{13}
10	10^2	10^8	10^{12}	10^{14}
11	4×10^{-2}	4×10^4	4×10^8	4×10^{10}
12	5×10^{-1}	5×10^5	5×10^9	5×10^{11}

EXERCISE 20*

	km ²	m ²	cm ²	mm ²
1	80	8×10^7	8×10^{11}	8×10^{13}
2	90	9×10^7	9×10^{11}	9×10^{13}
3	6×10^{-3}	6000	6×10^7	6×10^9
4	4×10^{-3}	4000	4×10^7	4×10^9
5	6	6×10^6	6×10^{10}	6×10^{12}
6	300	3×10^8	3×10^{12}	3×10^{14}
7	2×10^9	2×10^{15}	2×10^{19}	2×10^{21}
8	5×10^7	5×10^{13}	5×10^{17}	5×10^{19}
9	7×10^{-2}	7×10^4	7×10^8	7×10^{10}
10	9×10^{-4}	900	9×10^6	9×10^8
11	4×10^{-10}	4×10^{-4}	4	4×10^2
12	5×10^{-12}	5×10^{-6}	5×10^{-2}	5

EXERCISE 21

	km ³	m ³	cm ³	mm ³
1	1	10^9	10^{15}	10^{18}
2	2	2×10^9	2×10^{15}	2×10^{18}
3	4	4×10^9	4×10^{15}	4×10^{18}
4	3	3×10^9	3×10^{15}	3×10^{18}
5	8×10^{-9}	8	8×10^6	8×10^9
6	6×10^{-9}	6	6×10^6	6×10^9
7	4×10^{-12}	4×10^{-3}	4×10^3	4×10^6
8	5×10^{-10}	0.5	5×10^5	5×10^8
9	10^{-3}	10^6	10^{12}	10^{15}
10	10^{-4}	10^5	10^{11}	10^{14}
11	7×10^{-7}	7×10^2	7×10^8	7×10^{11}
12	3×10^{-6}	3×10^3	3×10^9	3×10^{12}

13 1000

14 1×10^{12}

15 10

16 1×10^7

EXERCISE 21*

	km ³	m ³	cm ³	mm ³
1	70	7×10^{10}	7×10^{16}	7×10^{19}
2	80	8×10^{10}	8×10^{16}	8×10^{19}
3	6×10^{-7}	600	6×10^8	6×10^{11}
4	5×10^{-7}	500	5×10^8	5×10^{11}
5	3×10^{-7}	3×10^2	3×10^8	3×10^{11}
6	6×10^{-5}	6×10^4	6×10^{10}	6×10^{13}
7	5×10^7	5×10^{16}	5×10^{22}	5×10^{25}
8	2×10^5	2×10^{14}	2×10^{20}	2×10^{23}
9	4×10^{-6}	4×10^3	4×10^9	4×10^{12}
10	8×10^{-8}	80	8×10^7	8×10^{10}
11	3×10^{-18}	3×10^{-9}	3×10^{-3}	3
12	8×10^{-18}	8×10^{-9}	8×10^{-3}	8

13 5.12×10^5

14 1.2×10^{13}

15 10^3

16 10^8

17 10^{45}

18 8.47×10^{56}

EXERCISE 22

1 $\frac{1}{9}$

2 $\frac{1}{16}$

3 $\frac{1}{10}$

4 $\frac{1}{100}$

5 $\frac{1}{8}$	6 $\frac{1}{25}$	7 $\frac{1}{8}$	8 $\frac{1}{144}$
9 9	10 8	11 $\frac{1}{64}$	12 $\frac{1}{27}$
13 3	14 2	15 2	16 4
17 $\frac{1}{16}$	18 $\frac{1}{32}$	19 $\frac{1}{9}$	20 $\frac{1}{16}$
21 $\frac{1}{16}$	22 $\frac{1}{27}$	23 $\frac{1}{2}$	24 $\frac{1}{3}$
25 16	26 729	27 625	28 64
29 2.84	30 4.90	31 0.167	32 0.0204
33 0.0123	34 0.0156	35 46 700	36 3130
37 0.0370	38 0.0313	39 0.111	40 0.0156
41 64	42 6560	43 a	44 b^2
45 c^{-3}	46 d^5	47 e	48 f
49 a^{-2}	50 g^{-2}		

EXERCISE 22*

1 $\frac{1}{64}$	2 $\frac{1}{81}$	3 5	4 3
5 1	6 1	7 512	8 $\frac{1}{3}$
9 12.5	10 100	11 4	12 36
13 10	14 25	15 8	16 $2\frac{1}{4}$
17 $\frac{1}{2}$	18 $1\frac{1}{2}$	19 $\frac{1}{36}$	20 -27
21 0.364	22 0.888	23 1.92	24 1.95
25 0.001 37	26 0.003 91	27 a^2	28 b^3
29 $2c^{-4}$	30 $4c^{-2}$	31 $3a^{-2}$	32 $2b^{-3}$
33 $12a^{-1}$	34 $8b^{-1}$	35 a	36 1
37 c^{-1}	38 d^{-1}	39 2	40 3
41 2	42 1	43 -3	44 -2
45 $k = 2\frac{1}{3}$	46 $k = -6$	47 a^{-3}	48 a^2
49 b	50 c^{-2}	51 $2a^{-2}$	52 0
53 $5a^{-2}$	54 $\frac{1}{2}$	55 $\frac{1}{3}$	56 $4b^3$
57 $-9a^6$	58 $4d^{-2}$	59 $\frac{b}{a}$	60 $a = 3, b = -3$

EXERCISE 23

1 $\frac{1}{3}$	2 $\frac{1}{4}$	3 $\frac{1}{10}$	4 0.2
5 $\frac{1}{9}$	6 0.2	7 $\frac{1}{4}$	8 8
9 27	10 0.125	11 $\frac{1}{27}$	12 0.408
13 0.224	14 0.316	15 0.376	16 11.2
17 36.5	18 0.192	19 0.0540	20 a^2
21 b^{-1}	22 c^3	23 d	24 e^2
25 f^{-1}			

EXERCISE 23*

1 $\frac{1}{6}$	2 $\frac{1}{12}$	3 6	4 10
5 16	6 1	7 $\frac{1}{16}$	8 1
9 1.29	10 1.83	11 0.894	12 0.647
13 2.85	14 0.867	15 0.351	16 1.15
17 a^{-2}	18 b^{-3}	19 c^{-2}	20 d^2
21 e	22 f^2	23 9	24 8
25 $\frac{1}{36}$	26 $\frac{1}{100}$	27 0.952	28 1.13
29 $x = 3, y = -2$	30 $x = \frac{4}{5}, y = -\frac{3}{5}$		

REVISION EXERCISE 24

1 3×10^6 mm	2 4 m ²	3 10^6 cm ³	4 $\frac{1}{16}$
5 10	6 4	7 8	8 5
9 5	10 $\frac{1}{64}$	11 $\frac{1}{4}$	12 $\frac{1}{11}$
13 9	14 $\frac{1}{81}$	15 27	
16 $36^{-\frac{1}{2}} = \frac{1}{36^{\frac{1}{2}}} = \frac{1}{\sqrt{36}} = \frac{1}{6}$		17 $9^{\frac{3}{2}} = (9^{\frac{1}{2}})^3 = (\sqrt{9})^3 = 3^3 = 27$	
18 a^2	19 a^4	20 d^{-2}	21 $b^{-\frac{3}{2}}$
22 $b^{\frac{5}{2}}$	23 c		

REVISION EXERCISE 24*

1 4 km	2 5×10^6 mm ²	3 8×10^3 m ³	4 $\frac{1}{32}$
5 6	6 1	7 3	8 4
9 $\frac{1}{7}$	10 64	11 8	12 $\frac{1}{9}$
13 $\frac{1}{625}$	14 $(0.125)^{-\frac{2}{3}} = \left(\frac{1}{8}\right)^{-\frac{2}{3}} = \left(\frac{8}{1}\right)^{\frac{2}{3}} = (8^{\frac{1}{3}})^2 = (\sqrt[3]{8})^2 = 2^2 = 4$		
15 $(4^{\frac{1}{3}})^{-1\frac{1}{2}} = (4^{\frac{1}{3}})^{-\frac{3}{2}} = 4^{-\frac{1}{2}} = \frac{1}{4^{\frac{1}{2}}} = \frac{1}{\sqrt{4}} = \frac{1}{2}$		16 $3c$	
17 $5b^{-2}$	18 a^2	19 $3c^{-2}$	20 $2a^{-1}$
21 $d^{\frac{7}{6}}$	22 $-a^6$	23 $\frac{1}{2}$	

ALGEBRA 2

EXERCISE 25

1 $x = -2$ or $x = -1$	2 $x = -2$ or $x = -3$	3 $x = -3$ or $x = 2$
4 $x = 1$ or $x = -2$	5 $x = -5$ or $x = -2$	6 $x = -4$ or $x = -3$
7 $x = -3$ or $x = 5$	8 $x = -2$ or $x = 4$	9 $x = 3$
10 $x = 2$	11 $x = -6$ or $x = 2$	12 $x = -8$ or $x = 3$
13 $x = -1$ or $x = 0$	14 $x = 0$ or $x = -2$	15 $x = 0$ or $x = 4$
16 $x = 0$ or $x = 3$	17 $x = \pm 2$	18 $x = -3$ or $x = 3$
19 $x = -6$ or $x = 6$	20 $x = -7$ or $x = 7$	

EXERCISE 25*

1 $x = -5$ or $x = -1$	2 $x = -2$ or $x = -4$	3 $x = -1$ or $x = 4$
4 $x = -6$ or $x = 3$	5 $x = -8$ or $x = -7$	6 $x = -9$ or $x = -6$
7 $x = -5$ or $x = 9$	8 $x = -9$ or $x = 7$	9 $x = 7$
10 $x = 5$	11 $x = -5$ or $x = 8$	12 $x = -15$ or $x = 12$
13 $x = 0$ or $x = 13$	14 $x = 0$ or $x = 11$	15 $x = 0$ or $x = -17$
16 $x = 0$ or $x = -19$	17 $x = \pm 9$	18 $x = -12$ or $x = 12$
19 $x = -11$ or $x = 11$	20 $x = -13$ or $x = 13$	

EXERCISE 26

1 $x = \pm \frac{7}{2}$	2 $x = \pm \frac{3}{5}$	3 $x = \pm \frac{9}{4}$
4 $x = \pm \frac{4}{3}$	5 $x = -2$ or $x = 0$	6 $x = 0$ or $x = 5$
7 $x = 0$ or $x = 1$	8 $x = 0$ or $x = -3$	9 $x = 2$ or $x = 3$
10 $x = -5$ or $x = -2$	11 $x = 0.5$ or $x = 2$	12 $x = 1.5$ or $x = 2$
13 $x = -1.5$ or $x = -1$	14 $x = -3$ or $x = -0.5$	15 $x = -2$ or $x = -1$
16 $x = -5$ or $x = 1$	17 $x = \pm 3$	18 $x = -5$ or $x = 5$
19 $x = 0$ or $x = 2$	20 $x = -3$ or $x = 0$	21 $x = -2$ or $x = -\frac{1}{3}$
22 $x = -4$ or $x = -\frac{2}{3}$	23 $x = -\frac{1}{3}$ or $x = 2$	24 $x = \frac{2}{3}$ or $x = 3$
25 $x = -2$ or $x = 3$	26 $x = -5$ or $x = 1$	27 $x = -2$ or $x = -\frac{2}{3}$
28 $x = -3$ or $x = -\frac{1}{4}$	29 $x = -4$ or $x = \frac{2}{3}$	30 $x = -1\frac{1}{4}$ or $x = 2$

EXERCISE 26*

- 1 $x = \pm \frac{5}{7}$
- 2 $x = \pm \frac{8}{3}$
- 3 $x = \pm \frac{8}{3}$
- 4 $x = \pm \frac{5}{2}$
- 5 $x = -2$ or $x = 0$
- 6 $x = 0$ or $x = 4$
- 7 $x = 0$ or $x = \frac{3}{2}$
- 8 $x = -\frac{2}{7}$ or $x = 0$
- 9 $x = 1$ or $x = 2$
- 10 $x = -5$ or $x = -3$
- 11 $x = 1.5$ or $x = 2$
- 12 $x = -5$ or $x = 1.5$
- 13 $x = -9$ or $x = -\frac{4}{3}$
- 14 $x = -7$ or $x = -3$
- 15 $x = -\frac{1}{3}$ or $x = 1.5$
- 16 $x = \frac{1}{3}$ or $x = 0.5$
- 17 $x = -\frac{1}{2}$ or $x = -\frac{1}{4}$
- 18 $x = -1$ or $x = \frac{1}{4}$
- 19 $x = \frac{2}{5}$ or $x = 5$
- 20 $x = -3.5$ or $x = 1.5$
- 21 $x = 0.8$ or $x = 1.5$
- 22 $x = -2.5$ or $x = 1.4$
- 23 $x = -\frac{4}{3}$ or $x = 7$
- 24 $x = -2.5$ or $x = 3$
- 25 $x = -4$ or $x = 4$
- 26 $x = -3$ or $x = 3$
- 27 $x = 0$ or $x = 3$
- 28 $x = 0$ or $x = 3$
- 29 $x = -5$ (repeated root)
- 30 $x = 2$ or $x = 4$
- 31 $x = 0.25$ or $x = 7$
- 32 $x = 0.75$ or $x = 5$
- 33 $x = \frac{2}{3}$ or $x = 1.5$
- 34 $x = 2$ or $x = 2.5$
- 35 $x = \frac{5}{3}$ (repeated root)
- 36 $x = 0.5$ or $x = \frac{2}{3}$

EXERCISE 27

- 1 $x = -3.45$ or $x = 1.45$
- 2 $x = -7.12$ or $x = 1.12$
- 3 $x = -1.65$ or $x = 3.65$
- 4 $x = -1.9$ or $x = 7.90$
- 5 $x = -5.46$ or $x = 1.46$
- 6 $x = -3.83$ or $x = 1.83$
- 7 $x = 1.84$ or $x = 8.16$
- 8 $x = -7.41$ or $x = -4.59$
- 9 $x = -14.2$ or $x = 0.211$
- 10 $x = -16.4$ or $x = 0.426$
- 11 $x = -1.53$ or $x = 21.5$
- 12 $x = 5.59$ or $x = 8.41$
- 13 $x = -2.90$ or $x = 6.90$
- 14 $x = -1.10$ or $x = 9.10$
- 15 $x = -7.04$ or $x = 17.0$
- 16 $x = -2.49$ or $x = 16.5$
- 17 $x = -3.56$ or $x = 0.562$
- 18 $x = 3.37$ or $x = -2.37$
- 19 $x = -0.541$ or $x = 5.54$
- 20 $x = 1.70$ or $x = 5.30$
- 21 $x = -3.37$ or $x = 2.37$
- 22 $x = -3.24$ or $x = 1.24$
- 23 $x = -1.83$ or $x = 3.83$
- 24 $x = -1.30$ or $x = 2.30$
- 25 $x = -1.58$ or $x = -0.423$
- 26 $x = -1.77$ or $x = -0.566$
- 27 $x = -1.13$ or $x = 0.883$
- 28 $x = -1.43$ or $x = -0.232$
- 29 $x = -2.79$ or $x = 1.79$
- 30 $x = -3.65$ or $x = 1.65$
- 31 $x = 0.172$ or $x = 5.83$
- 32 $x = 0.190$ or $x = 15.8$
- 33 $x = 1.30$ or $x = -0.876$
- 34 $x = 1.85$ or $x = -0.180$
- 35 $x = 0.310$ or $x = 1.29$
- 36 $x = -0.527$ or $x = 0.813$

EXERCISE 27*

- 1 $x = 0.172$ or $x = 5.83$
- 2 $x = 0.586$ or $x = 3.41$
- 3 $x = 0.190$ or $x = 15.8$
- 4 $x = -1.81$ or $x = 13.8$
- 5 $x = -7.58$ or $x = 1.58$
- 6 $x = -0.586$ or $x = -3.41$
- 7 $x = -12.7$ or $x = -0.315$
- 8 $x = -11.5$ or $x = -0.523$
- 9 $x = 1.59$ or $x = 4.41$
- 10 $x = 0.807$ or $x = 6.19$
- 11 $x = -\frac{1}{3}$ or $x = 2$
- 12 $x = -\frac{1}{3}$ or $x = 1$
- 13 $x = -1.69$ or $x = 7.69$
- 14 $x = 2.59$ or $x = 5.41$
- 15 $x = -0.414$ or $x = 2.41$
- 16 $x = -0.317$ or $x = 6.32$
- 17 $x = 0.258$ or $x = 7.74$
- 18 $x = -4.65$ or $x = 0.646$
- 19 $x = -1$ or $x = 3.5$
- 20 $x = -3.89$ or $x = 0.386$
- 21 $x = -1.86$ or $x = -0.537$
- 22 $x = -2.39$ or $x = -0.279$
- 23 $x = -2.77$ or $x = 0.271$
- 24 $x = -1.12$ or $x = 0.448$
- 25 $x = -0.522$ or $x = 1.09$
- 26 $x = -0.396$ or $x = 1.90$
- 27 $x = 0.137$ or $x = 1.46$
- 28 $x = -0.690$ or $x = 0.290$
- 29 $x = -0.257$ or $x = 2.59$
- 30 $x = -0.323$ or $x = 2.32$
- 31 $x = 3.11$ or $x = -1.61$
- 32 $x = 0.896$ or $x = -1.40$

33 $x = 0.105$ or $x = 5.37$

35 $x = -2.16$ or $x = 1.16$

34 $x = 0.345$ or $x = 2.20$

36 $x = -2.62$ or $x = -0.382$

ACTIVITY 9

$y = x^2 + 8x + 15$ cuts the x axis at two points, when $x = -5$ and $x = -3$, so two solutions:

$b^2 - 4ac = 4$, two solutions are $x = -5$ and $x = -3$

$y = x^2 + 8x + 16$ cuts the x axis at one point, when $x = -4$, so one solution:

$b^2 - 4ac = 0$, one solution is $x = -4$

$y = x^2 + 8x + 17$ does not cut the x axis, so no solution:

$b^2 - 4ac = -4$, no solutions

$b^2 - 4ac > 0$ means two solutions

$b^2 - 4ac = 0$ means one solution

$b^2 - 4ac < 0$ means no solutions

INVESTIGATE

$k \leq 16$

EXERCISE 28

- 1 1
- 2 2
- 3 0
- 4 1
- 5 0
- 6 1
- 7 2
- 8 2
- 9 0
- 10 2

EXERCISE 28*

- 1 2
- 2 0
- 3 2
- 4 0
- 5 1
- 6 0
- 7 2
- 8 0
- 9 2
- 10 1

EXERCISE 29

- 1 2 or 5
- 2 6 seconds
- 3 12, 8 or -8, -12
- 4 7, 9 or -7, -9
- 5 2.61
- 6 4.18 cm
- 7 3.22
- 8 4.42 cm
- 9 2.32
- 10 3.32

EXERCISE 29*

- 1 4 cm
- 2 6 m $\times$ 8 m
- 3 3.21
- 4 3.71
- 5 8, 9 or -9, -8
- 6 7 and 9 or -9 and -7
- 7 2.32 by 4.43
- 8 4.40 m by 11.6 m
- 9 a 1414
- b 446 terms too small, 447 terms too big
- 10 a 38 sides
- b 30 sides too few, 31 sides too many
- 11 6 days
- 12 10

EXERCISE 30

- 1 $-4 < x < 4$
- 2 $-3 < x < 3$
- 3 $x \leq -5$ or $x \geq 5$
- 4 $x \leq -6$ or $x \geq 6$
- 5 $-9 \leq x \leq 9$
- 6 $-6 \leq x \leq 6$
- 7 $-5 < x < 5$
- 8 $-6 < x < 6$
- 9 $x < -4$ or $x > 4$
- 10 $x < -2$ or $x > 2$
- 11 $-3 \leq x \leq 1$
- 12 $-1 \leq x \leq 3$
- 13 $x < -4$ or $x > -3$
- 14 $x < -7$ or $x > -2$
- 15 $-1 < x < \frac{1}{2}$
- 16 $-\frac{1}{3} < x < 1$
- 17 $x \leq -5$ or $x \geq -2$
- 18 $x \leq -6$ or $x \geq -2$
- 19 $-5 \leq x \leq 3$
- 20 $-3 \leq x \leq 2$

EXERCISE 30*

- 1 $-5 \leq x \leq 5$
- 2 $-4 \leq x \leq 4$
- 3 $x \leq -4$ or $x \geq 4$
- 4 $x \leq -2$ or $x \geq 2$
- 5 $-5 < x < 5$
- 6 $-6 < x < 6$
- 7 $x < 3$ or $x > 7$
- 8 $x < -6$ or $x > 0$
- 9 $-6 < x < 2$
- 10 $-4 < x < 6$
- 11 $-7 \leq x \leq -3$
- 12 $-3 \leq x \leq -2$
- 13 $x < -4$ or $x > 3$
- 14 $x < -4$ or $x > 1$
- 15 $x < -4$ or $x > 2$

- 16 $x < -5$ or $x > 4$ 17 $-\frac{1}{2} \leq x \leq 2$ 18 $-4 \leq x \leq \frac{2}{3}$
 19 $x \leq -3$ or $x \geq \frac{1}{6}$ 20 $x \leq -\frac{5}{3}$ or $x \geq 4$ 21 $x \leq 0$ or $x \geq \frac{1}{4}$
 22 $x \leq -4$ or $x \geq -1$ 23 $-8 < x < 2$
 24 $-13 < \text{smaller number} < 6$ 25 $-1 < x < 1$
 26 $\frac{1}{2} < x < 1$ 27 $6 < \text{width} < 8$
 28 $0 < \text{width} < 3$ or $\text{width} > 4$

REVISION EXERCISE 31

- 1 a $x = \pm 5$ b $x = -4$ or $x = 0$
 2 a $x = 3$ or $x = -4$ b $x = 3$ or $x = -2$ c $x = \frac{2}{3}$ or $x = -1$
 3 a $x = -1.24$ or $x = 3.24$ b $x = 0.232$ or $x = 1.43$
 4 2.5 cm
 5 1.70
 6 a $x \leq -2$ or $x \geq 2$ b $-5 < x < 3$

REVISION EXERCISE 31*

- 1 a $x = \pm 4.47$ ($\pm\sqrt{20}$) b $x = 0$ or $x = 9$
 2 a $x = -9$ or $x = 8$ b $x = -4$ or $x = 6$
 c $x = -2.5$ or $x = 0.75$
 3 a $x = -0.573$ or $x = 2.91$ b $x = -4.46$ or $x = 0.459$
 4 4.63 cm
 5 width 5, length 6
 6 3.68
 7 a $4 < x < 8$ b $x \leq -2.32$ or $x \geq 4.32$

GRAPHS 2

EXERCISE 32

- 1 $x = -2.2$ or $x = 2.2$ 2 $x = -1.7$ or $x = 1.7$ 3 $x = -1$ or $x = 2$
 4 $x = -2.3$ or $x = 1.3$ 5 $x = -3.8$ or $x = 1.8$ 6 $x = -1.6$ or $x = 3.6$
 7 $x = 0.6$ or $x = 3.4$ 8 $x = -3.7$ or $x = -0.3$ 9 $x = -2.9$ or $x = 3.4$
 10 $x = -3.1$ or $x = 2.6$ 11 No solutions 12 No solutions

EXERCISE 32*

- 1 $x = -1.3$ or $x = 2.3$ 2 $x = -2.6$ or $x = 1.6$ 3 $x = -2.6$ or $x = -0.4$
 4 $x = -0.7$ or $x = 2.7$ 5 $x = 2$ 6 $x = -1$
 7 $x = -2.7$ or $x = 2.2$ 8 $x = -2$ or $x = 2.5$ 9 $x = -2.8$ or $x = 3.2$
 10 $x = -2.8$ or $x = 2.8$ 11 No solutions 12 No solutions

EXERCISE 33

- 1 a $x = 0$ or $x = 3$ b $x = -0.56$ or $x = 3.56$
 c $x = 0.38$ or $x = 2.62$ d $x = -0.24$ or $x = 4.24$
 e $x = -0.79$ or $x = 3.79$ f $x = 0.21$ or $x = 4.79$
 2 a $x = 0$ or $x = 2$ b $x = -1.45$ or $x = 3.45$
 c $x = 0.29$ or $x = 1.71$ d $x = -0.62$ or $x = 1.62$
 e $x = -0.73$ or $x = 2.73$ f $x = 0.59$ or $x = 3.41$
 3 a $x = 1$ or $x = 3$ b $x = -0.65$ or $x = 4.65$
 c $x = 0.70$ or $x = 4.30$ d $x = -0.56$ or $x = 3.56$
 4 a $x = -1$ or $x = 4$ b $x = 0.38$ or $x = 2.62$
 c $x = -1.24$ or $x = 3.24$ d $x = 0.59$ or $x = 3.41$
 5 a $2x^2 + 2x - 1 = 0$ b $x^2 + 5x - 5 = 0$
 6 a $3x^2 - x - 6 = 0$ b $x^2 - 4x - 2 = 0$
 7 a $y = 2x + 2$ b $y = x$ c $y = -3x - 3$
 8 a $y = x + 6$ b $y = 7 - x$ c $y = 8 - 4x$
 9 (2.71, 3.5), no
 10 (1.15, -2), no

EXERCISE 33*

- 1 a $x = 5$ or $x = 0$ b $x = 4.30$ or $x = 0.70$
 c $x = 3.73$ or $x = 0.27$ d $x = 0.76$ or $x = 5.24$
 2 a $x = 0.5$ or $x = 0$ b $x = -1.21$ or $x = 1.71$
 c $x = -0.82$ or $x = 1.82$ d $x = -0.62$ or $x = 1.62$
 3 a $x = -1.78$ or $x = 0.28$ b $x = -2.35$ or $x = 0.85$
 c $x = -2.28$ or $x = -0.22$
 4 a $x = -0.67$ or $x = 1$ b $x = 1.33$ or $x = -1$
 c $x = -0.26$ or $x = 1.26$
 5 a $6x^2 - 7x - 2 = 0$ b $5x^2 - 7x - 4 = 0$
 6 a $4x^2 - 7x - 5 = 0$ b $3x^2 - 7x + 2 = 0$
 7 a $y = x + 2$ b $y = -2x - 1$
 8 a $y = -3 - x$ b $y = 3x - 5$
 9 a Yes b 17.9 m, so legal
 10 As close as possible to the first step, 10 steps.

EXERCISE 34

- 1 a $x = -1.73$, $x = 0$ or $x = 1.73$ b $x = -1.53$, $x = -0.35$ or $x = 1.9$
 c $x = -1.62$, $x = 0.62$ or $x = 1$
 2 a $x = 0$ or $x = 1.59$ b $x = -1$ or $x = 1.57$
 c $x = -1.45$ or $x = 1.16$
 3 a $x = -0.53$, $x = 0.65$ or $x = 2.88$ b $x = -1$ or $x = 2$
 c $x = -1.11$, $x = 1.25$ or $x = 2.86$
 4 a $x = -2.33$, $x = 0.20$ or $x = 2.13$ b $x = -2$, $x = -0.41$ or $x = 2.41$
 c $x = -2.57$, $x = -0.41$ or $x = 2.71$
 5 $x = -1$ or $x = 3$
 6 $x = -2.11$, $x = 0.25$ or $x = 1.86$

EXERCISE 34*

- 1 a $x = 1.78$
 b $x = -3.30$, $x = -1.05$, $x = 1.05$ or $x = 3.30$
 c $x = -2.84$, $x = -1.46$ or $x = 0.96$
 2 a $x = 1.85$ or $x = 0.77$ or $x = -0.77$ or $x = -1.85$
 b $x = 2.07$ or $x = 0.68$
 c $x = 0.60$ or $x = 1.85$ or $x = -0.45$ or $x = -2$
 3 $y = 3x^2 + 8$
 4 $y = x^3 + x$
 5 $x = -1.25$, $x = 0.45$ or $x = 1.80$
 6 $x = -1.35$, $y = 0.55$
 $x = 0.6$, $y = 2.78$
 $x = 0.56$, $y = 3.18$

INVESTIGATE

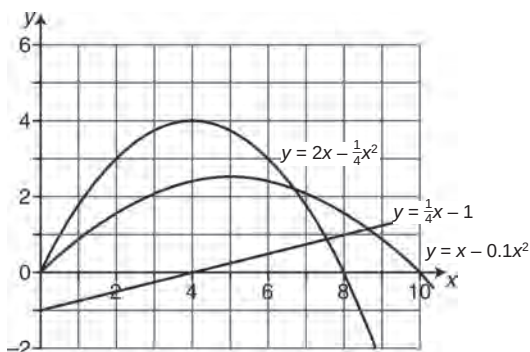
- a $k < -16$ or $k > 16$
 b $k = -16$ or $k = 16$
 c $-16 < k < 16$

ACTIVITY 10

x	0	2	4
$2x$	0	4	8
$-\frac{1}{4}x^2$	0	-1	-4
$y = 2x - \frac{1}{4}x^2$	0	3	4

x	6	8	10
$2x$	12	16	20
$-\frac{1}{4}x^2$	-9	-16	-25
$y = 2x - \frac{1}{4}x^2$	3	0	-5

x	0	2	4	6	8	10
$\frac{1}{4}x$	0	$\frac{1}{2}$	1	$1\frac{1}{2}$	2	$2\frac{1}{2}$
$y = \frac{1}{4}x - 1$	-1	$-\frac{1}{2}$	0	$\frac{1}{2}$	1	$1\frac{1}{2}$



Mary is not successful.

When angle changes, Peter is made wet.

EXERCISE 35

- 1 $x = -1.7, y = 5; x = 1.7, y = 5$
- 2 $x = -2.2, y = 4; x = 2.2, y = 4$
- 3 $x = -3, y = -5; x = 1, y = 3$
- 4 $x = -2, y = -3; x = 1, y = 0$
- 5 $x = 2, y = 7; x = -1, y = -2$
- 6 $x = -4, y = -3; x = 1, y = 2$
- 7 $x = 2, y = 2; x = 4, y = 6$
- 8 $x = 1, y = 3; x = 3, y = 7$
- 9 $x = -1.6$ and $y = 1.4$; or $x = 1.9$ and $y = 0.53$
- 10 $x = -4$ and $y = -7$; or $x = 2$ and $y = 5$
- 11 $x = -1.56$ and $y = -2.56$; or $x = 2.56$ and $y = 1.56$
- 12 $x = -2$ and $y = 4$; or $x = 3$ and $y = -1$
- 13 $x = -2$ and $y = 0$; or $x = -0.71$ and $y = 0.65$; or $x = 0.71$ and $y = 1.35$
- 14 $x = -1.53$ and $y = 2.03$; or $x = 0.26$ and $y = 0.24$; or $x = 1.27$ and $y = -0.77$
- 15 $x = 23.7$ and $y = 21.8$
- 16 $x = 2.67$ and $y = -1.78$

EXERCISE 35*

- 1 $x = 1, y = 3; x = -2, y = 3$
- 2 $x = -1, y = 2; x = 3, y = 2$
- 3 $x = 2, y = -3; x = -3, y = 7$
- 4 $x = -4, y = -5; x = 2, y = 7$
- 5 $x = -2, y = 8; x = 2.5, y = 3.5$
- 6 $x = -1.5, y = 6; x = 3, y = -3$
- 7 $x = -0.5, y = -3; x = 0.4, y = -1.2$
- 8 $x = -1.5, y = 9.5; x = 0.75, y = 2.75$
- 9 $x = -3.6$ and $y = -0.6$; or $x = 0.56$ and $y = 3.6$
- 10 $x = 0.59$ and $y = 1.8$; or $x = 3.4$ and $y = -3.8$
- 11 $x = -0.48$ and $y = 3.96$; or $x = 1.31$ and $y = 0.38$; or $x = 3.17$ and $y = -3.34$
- 12 $x = -3$ and $y = -7$; or $x = -1.41$ and $y = -3.82$; or $x = 1.41$ and $y = 1.82$
- 13 $x = -1.23$ and $y = -4.15$; or $x = 1.63$ and $y = 10.2$
- 14 $x = -1.56$ and $y = -6.12$; or $x = 2.56$ and $y = 2.12$
- 15 $x = 44$ and $y = 22$; length is 49.2 m

REVISION EXERCISE 36

- 1 (137, -50)
- 2 **a** $x = -0.4$ or $x = 2.4$
b $x = -1.2$ or $x = 3.2$
c $x = -1.3$ or $x = 2.3$
- 3 **a** $y = 4$ **b** $y = x + 1$ **c** $y = 2x - 1$

- 4 $x = -1.3, y = 1.69$ or $x = 2.3, y = 5.29$
- 5 $xy = 30, x + y = 12; x = 8.45, y = 3.55$

REVISION EXERCISE 36*

- 1 $x^2 + y^2 = 144; (-7, 9.75)(7, 9.75)$
- 2 **a** $x = -0.5, x = 2$
b $x = -1.6, x = 2.1$
c $x = -0.7, x = 2.7$
- 3 **a** $y = 1$ **b** $y = x$ **c** $y = -x - 1$
- 4 $x = -1.19, y = -1.7$ or $x = 0.9, y = 0.73$
- 5 $x + y = 5, x^2 + y^2 = 16$
 $x = 1.18, y = 3.82$ or vice versa

SHAPE AND SPACE 2

EXERCISE 37

- 1 18.8 cm, 28.3 cm²
- 2 20.6 cm, 25.1 cm²
- 3 33.6 cm, 58.9 cm²
- 4 10.7 cm, 7.07 cm²
- 5 22.3 cm, 30.3 cm²
- 6 49.1 cm, 146 cm²
- 7 50.8 cm, 117 cm²
- 8 110.6 cm, 706 cm²
- 9 46.8 cm, 39.5 cm²
- 10 38.8 cm, 31.7 cm²
- 11 37.7 cm, 37.7 cm²
- 12 34.3 cm, 42.4 cm²

	Radius in cm	Circumference in cm	Area in cm ²
13	0.955	6	2.86
14	1.27	8	5.06
15	2.11	13.3	14
16	1.69	10.6	9
17	8.28	52	215
18	12.1	76	460
19	5.17	32.5	84
20	4.65	29.2	68

- 21 2.07 km
- 22 7.54 km
- 23 6.03 m
- 24 3.77 km

EXERCISE 37*

- 1 20.6 cm, 25.1 cm²
- 2 47.0 cm, 115 cm²
- 3 37.7 cm, 92.5 cm²
- 4 82.3 cm, 265 cm²
- 5 43.7 cm, 99.0 cm²
- 6 37.7 cm, 84.8 cm²
- 7 66.8 cm, 175 cm²
- 8 10.3 cm, 1.72 cm²
- 9 37.7 cm, 56.5 cm²
- 10 37.7 cm, 62.8 cm²
- 11 29.7 cm, 63.3 cm²
- 12 37.7 cm, 103 cm²
- 13 $r = 3.19$ cm, $P = 11.4$ cm
- 14 $r = 3.74$ cm, $P = 19.2$ cm
- 15 16.0 m
- 16 607 m²
- 17 2 cm
- 18 2.64 m
- 19 **a** 40 100 km
- 20 **a** 9.42×10^8 km
- 21 7 km
- 22 12.6 m
- 23 $r = 1.79$ cm, $A = 7.55$ cm²
- 24 $r = 2.41$ cm, $A = 32.4$ cm²

EXERCISE 38

- 1 8.62 cm
- 2 16.1 cm
- 3 25.6 cm
- 4 9.24 cm
- 5 38.4 cm
- 6 23.4 cm
- 7 63.6 cm
- 8 59.3 cm
- 9 34.4°
- 10 28.6°
- 11 115°
- 12 129°
- 13 14.3 cm
- 14 13.1 cm
- 15 10.6 cm
- 16 6.45 cm

EXERCISE 38*

- | | | | |
|------------|------------|------------|------------|
| 1 10.9 cm | 2 18 cm | 3 38.3 cm | 4 26.4 cm |
| 5 25.1° | 6 57.3° | 7 121° | 8 141° |
| 9 13.4 cm | 10 16.2 cm | 11 117 cm | 12 65.7 cm |
| 13 33.0 cm | 14 23.7 cm | 15 15.5 cm | 16 36.9 cm |
| 17 4.94 cm | 18 8.17 cm | | |

EXERCISE 39

- | | | | |
|------------------------|------------------------|------------------------|------------------------|
| 1 12.6 cm ² | 2 6.28 cm ² | 3 61.4 cm ² | 4 22.3 cm ² |
| 5 170 cm ² | 6 16.5 cm ² | 7 11.9 cm ² | 8 101 cm ² |
| 9 76.4° | 10 50.1° | 11 129° | 12 138° |
| 13 5.86 cm | 14 6.52 cm | 15 8.50 cm | 16 6.77 cm |

EXERCISE 39*

- | | | | |
|-------------------------|-------------------------|-----------------------|-------------------------|
| 1 15.8 cm ² | 2 58.1 cm ² | 3 625 cm ² | 4 1180 cm ² |
| 5 53.3° | 6 69.2° | 7 103° | 8 153° |
| 9 4.88 cm | 10 11.2 cm | 11 19.7 cm | 12 20.3 cm |
| 13 11.5 cm | 14 67.2 cm ² | 15 5.08 cm | 16 27.6 cm |
| 17 1.45 cm ² | 18 16.6 cm ² | 19 7.7 cm | 20 2.58 cm ² |

EXERCISE 40

- | | | |
|--|---|--|
| 1 120 cm ³ | 2 104 cm ³ | 3 48 cm ³ , 108 cm ² |
| 4 240 cm ³ , 248 cm ² | 5 1.57 m ³ , 7.85 m ² | |
| 6 Volume = 452 cm ³ (3 s.f.); Area = 358 cm ² (3 s.f.) | | |
| 7 800 m ³ | 8 11.25 m ³ | 9 0.785 m ² |
| 10 686 m ³ (3 s.f.) | 11 16 $\frac{2}{3}$ cm | 12 9.9 cm (1 d.p.) |

EXERCISE 40*

- 1 3000 cm³
- 2 4800 cm³
- 3 1.2×10^5 cm³, 1.84×10^4 cm²
- 4 Volume = 3800 cm³; Surface area = 8038 cm²
- 5 229 cm³, 257 cm²
- 6 Volume = 7151 cm³; Surface area = 2260 cm²
- 7 1.18 cm³, 9.42 cm²
- 8 1.4 m³ (1 d.p.)
- 9 405 cm³, 426 cm²
- 10 Volume = 149.4 cm³; Surface area = 316 cm²
- 11 29.4 m
- 12 0.04 mm

EXERCISE 41

- 1 2.57×10^6 m³
- 2 8779 m³
- 3 9817 cm³, 2407 cm²
- 4 Volume = 134 cm³; Surface area = 112 cm² (3 s.f.)
- 5 2090 cm³, 628 cm²
- 6 Volume = 7069 cm³; Surface area = 1414 cm²
- 7 33.5 cm³
- 8 268 cm³
- 9 396 m³, 311 m²
- 10 Volume = 105 cm³ (3 s.f.); Surface area = 120 cm²
- 11 12 cm, 1810 cm²
- 12 $r = 3.5$ cm; Surface area = 154 cm² (3 s.f.)
- 13 61 cm
- 14 0.47 m

EXERCISE 41*

- | | |
|--|---|
| 1 3.15×10^4 cm ³ | 2 $83\frac{1}{3}$ mm ³ |
| 3 98.2 cm ³ | 4 234.6 cm ³ |
| 5 2460 cm ³ , 971 cm ² | 6 Volume = 687 cm ³ ; Surface area = 610 cm ² |
| 7 2.92×10^5 m ³ | 8 1089 cm ³ |
| 9 5.12×10^8 km ² | 10 6.08×10^{12} km ² |
| 11 0.417 cm | 12 137 |
| 13 12 cm | 14 4.5×10^{-4} mm |

EXERCISE 42

- | | |
|---------------------------------|-------------------------|
| 1 16 cm ² | 2 54 cm ² |
| 3 a Angles are the same | b 8.55 cm ² |
| 4 a Three pairs of equal angles | b 35.55 cm ² |
| 5 213 cm ² | 6 20.25 cm ² |
| 7 84.4 cm ² | 8 8.64 cm ² |
| 9 6 cm | 10 12 cm |
| 11 3 cm | 12 $6\frac{2}{3}$ cm |
| 13 3 cm | 14 3 cm |
| 15 13.3 cm | 16 24 cm |

EXERCISE 42*

- | | | | |
|------------------------|------------------------|-----------------------|------------------------|
| 1 675 cm ² | 2 384 cm ² | 3 45 cm ² | 4 12 cm ² |
| 5 7.5 cm | 6 15 cm | 7 10 cm | 8 20 cm |
| 9 1000 cm ² | 10 100 cm ² | 11 44% | 12 69% |
| 13 19% | 14 27.75% | 15 75 cm ² | 16 280 cm ² |

EXERCISE 43

- | | | | |
|------------------------|-----------------------|------------------------|------------------------|
| 1 800 cm ³ | 2 54 cm ³ | 3 675 cm ³ | 4 23.4 cm ³ |
| 5 14.1 cm ³ | 6 222 cm ³ | 7 25.3 cm ³ | 8 62.5 cm ³ |
| 9 15.1 cm | 10 36.2 cm | 11 9.64 cm | 12 9.9 mm |
| 13 5.06 cm | 14 2.35 cm | 15 27.8 cm | 16 11.7 cm |

EXERCISE 43*

- | | | | |
|------------------------|------------------------|-------------------------|----------------------|
| 1 135 cm ³ | 2 86.4 cm ³ | 3 31.25 cm ³ | 4 32 cm ³ |
| 5 25.0 cm | 6 33.4 cm | 7 11.9 cm | 8 18.6 cm |
| 9 72.8% | 10 56% | 11 \$33.75 | 12 \$40 |
| 13 a 40 m ² | b 1500 cm ³ | | |
| 14 a 270 g | b 16 cm | | |
| 15 a 25 cm | b 48 g | | |
| 16 a 270 g | b 180 cm ² | | |
| 17 a 3000 quills | b 22.5 m | c 810 cm ² | d 240 g |

REVISION EXERCISE 44

- 1 Area = 11.1 cm²; Perimeter = 15.1 cm
- 2 22.3 cm², 21.6 cm
- 3 Volume = 288; Area = 336
- 4 132 m³
- 5 98 cm²
- 6 27 litres

REVISION EXERCISE 44*

- 1 Area = 15.3; Perimeter = 29.7
- 2 Area = 6.98 cm²; Perimeter = 11 cm
- 3 Volume = 453 cm³; Area = 411 cm²
- 4 335 cm³, 289 cm²
- 5 54 cm
- 6 a \$6.75
- b 12 cm

HANDLING DATA 2

EXERCISE 45

- 1 a $\frac{1}{36}$ b $\frac{25}{36}$ c $\frac{5}{36}$ d $\frac{5}{18}$
 2 a $\frac{4}{25}$ b $\frac{9}{25}$ c $\frac{6}{25}$ d $\frac{12}{25}$
 3 a $\frac{4}{25}$ b $\frac{9}{25}$ c $\frac{6}{25}$ d $\frac{12}{25}$
 4 a $\frac{9}{49}$ b $\frac{24}{49}$
 5 a $\frac{4}{9}$ b $\frac{4}{9}$ c $\frac{1}{9}$
 6 a $\frac{13}{28}$ b $\frac{15}{28}$
 7 a $\frac{1}{169}$ b $\frac{1}{2}$ c $\frac{30}{169}$ d $\frac{1}{8}$
 8 a $\frac{4}{15}$ b $\frac{11}{15}$ c 8 days

EXERCISE 45*

- 1 a $\frac{4}{15}$ b $\frac{8}{15}$ c $\frac{3}{5}$
 2 a $\frac{9}{56}$ b $\frac{31}{56}$ c $\frac{47}{56}$
 3 a $\frac{1}{9}$ b $\frac{4}{9}$ c $\frac{5}{9}$
 4 a $\frac{1}{7}$ b $\frac{10}{21}$ c $\frac{6}{7}$
 5 a $\frac{1}{4}$ b $\frac{1}{2}$ c $\frac{15}{32}$ d $\frac{3}{16}$
 6 a $\frac{2}{3}$ b $\frac{1}{3}$
 7 a $\frac{1}{5}$ b $\frac{13}{35}$ c $\frac{4}{5}$
 8 a Right club, bad shot probability = $\frac{1}{3}$. Wrong club, good shot probability = $\frac{1}{4}$
 b $\frac{5}{9}$

ACTIVITY 11

$$p(X \text{ to } B) = \frac{1}{2}; p(A \text{ to } B) = \frac{1}{2}$$

$$p(A) = \frac{1}{2}; p(B) = \frac{1}{2} + \left(\frac{1}{2} \times \frac{1}{2}\right) = \frac{3}{4}$$

A: 30; B: 45; B not via A: 30

$$p(A) = \frac{1}{2}; p(B) = \frac{1}{2} + \left(\frac{1}{2} \times \frac{1}{3}\right) = \frac{2}{3}$$

$$p(C) = \left(\frac{1}{2} \times \frac{1}{3} \times \frac{1}{2}\right) + \left(\frac{1}{2} \times \frac{1}{3} \times \frac{1}{2}\right) + \left(\frac{1}{2} \times \frac{1}{2}\right) = \frac{5}{12}$$

$$p(D) = \frac{1}{2} \times \frac{1}{3} = \frac{1}{6}$$

A: 30; B: 40; C: 25; D: 10

Compare the theoretical figures with your observed ones and find percentage differences. Would more vehicles improve the goodness of fit? If a computer programme is used, take a much larger sample and compare.

EXERCISE 46

- 1 a $\frac{1}{9}$ b $\frac{4}{9}$
 2 a $\frac{1}{5}$ b $\frac{1}{5}$

c Let X be the number of kings dealt in the first three cards:

$$p(X \geq 1) = 1 - p(X = 0) = 1 - \frac{16}{20} \times \frac{15}{19} \times \frac{14}{18} = \frac{29}{57}$$

- 3 a $\frac{43}{63}$ b $\frac{20}{63}$ c $\frac{2}{7}$

d Let X be the number of beads added to the box:

$$p(W_2) = \frac{2}{7} \times \frac{(2+X)}{(7+X)} + \frac{5}{7} \times \frac{2}{(7+X)}$$

$$= \frac{2}{[7(7+X)]} \times [(2+X) + 5] = \frac{2}{7}$$

Therefore true!

- 4 a 0.0459 b 0.3941

EXERCISE 46*

- 1 a 0.0034 b 0.0006 c 0.0532
 2 a $\frac{9}{16}$ b $\frac{27}{64}$ c $\frac{45}{128}$
 3 a $\frac{1}{8}$ b $\frac{8}{15}$ c $\frac{13}{60}$
 4 a $\frac{5}{18}$
 b Let event X be 'clock is slow at noon on Wednesday':
 $p(\bar{X}) = 1 - p(X) = 1 - \frac{7}{24} = \frac{17}{24}$
 5 a $p(H_1) = \frac{1}{4}$
 b $p(H_2) = p(HHH) + p(\bar{H}HH) = \frac{1}{4} \times \frac{12}{51} + \frac{3}{4} \times \frac{13}{51} = \frac{1}{4}$
 c $p(H_3) = p(HHH) + p(\bar{H}\bar{H}HH) + p(\bar{H}HH\bar{H}) + p(\bar{H}\bar{H}\bar{H}H)$
 $= \frac{1}{4} \times \frac{12}{51} \times \frac{11}{50} + \frac{1}{4} \times \frac{39}{51} \times \frac{12}{50} + \frac{3}{4} \times \frac{13}{51} \times \frac{12}{50} + \frac{3}{4} \times \frac{38}{51} \times \frac{13}{50}$
 $= \frac{1}{4}$
 6 Let event A be that two people in room share the same birth date.
 $p(A) = 1 - p(\bar{A})$
 $= 1 - 1 \times \frac{364}{365} \times \frac{363}{365} \times \frac{362}{365} \times \frac{361}{365} \times \dots \times \frac{343}{365}$
 $= 0.507 \approx 50\%$

INVESTIGATE

Clearly there will always be someone left standing so this is a ludicrous example of testing for telepathy, despite the fact that the person 'selected' has a chance of $\frac{1}{1024}$ of being chosen.

ACTIVITY 12

Rank in order of least safe first:

motor racing, smoking, influenza, drinking, run over by a vehicle, football = rock climbing, tornadoes = floods, earthquakes, lightning, bites of venomous creatures, falling aircraft, meteorite.

Points for discussion:

Does the number of participants affect the table?

How do you think the 'meteorite' statistic was evaluated?

Does the ranking come out as you expected? It might be interesting to compare your table with your guessed ranking for the activities.

REVISION EXERCISE 47

- 1 a $\frac{9}{25}$ b $\frac{12}{25}$
 2 a $\frac{1}{16}$ b $\frac{3}{8}$
 3 a $\frac{9}{25}$ b $\frac{12}{25}$
 4 a $\frac{4}{5}$ b $\frac{6}{25}$

- 5 a $\frac{1}{36}$ b $\frac{5}{18}$ c $\frac{5}{9}$
 6 a 0.1 b 0.7 c 0.12

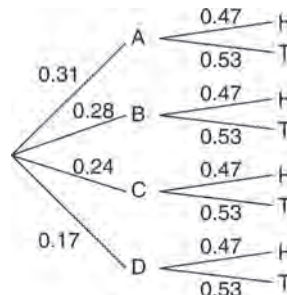
REVISION EXERCISE 47*

- 1 a $\frac{1}{6}$ b $\frac{5}{18}$ c $\frac{13}{18}$
 2 a $\frac{2}{9}$ b $\frac{8}{45}$ c $\frac{2}{45}$ d $\frac{43}{45}$
 3 a $\frac{1}{32}$ b $\frac{5}{16}$ c $\frac{3}{16}$
 4 $\frac{n}{25} \times \frac{(n-1)}{24} = 0.07$
 $n^2 - n - 42 = 0 \rightarrow n = 7$
 $p(\text{diff colours}) = \frac{7}{25} \times \frac{18}{24} + \frac{18}{25} \times \frac{7}{24} = \frac{21}{50}$
 5 a 1:3:5 b $\frac{4}{45}$
 c (i) $\frac{16}{2025}$ (ii) $\frac{164}{2025}$ (iii) $\frac{344}{2025}$
 6 a $p(\text{Win}) = \frac{6}{49} \times \frac{5}{48} \times \frac{4}{47} \times \frac{3}{46} \times \frac{2}{45} \times \frac{1}{44}$
 $= \frac{1}{13\,983\,816} \approx \frac{1}{14\,000\,000}$
 b 14 000 000 min $\approx$ 26.6 years!

EXAMINATION PRACTICE 2

- 1 a x^7 b x^3 c x^{10} d x^{-3}
 2 a $\frac{1}{9}$ b 4 c $\frac{1}{2}$ d $\frac{1}{25}$ e $\frac{1}{16}$
 3 a b b c^{-3} c b^{-2} d c e 1
 4 a 7 b -1 c $\frac{1}{2}$ d $\frac{1}{3}$
 5 a $x = 0$ or $x = 6$ b $x = -3$ or $x = 4$

- 6 a $x = 0.618$ or $x = -1.62$ (3 s.f) b $x = 1.71$ or $x = 0.293$ (3 s.f)
 7 a $x > 3$ or $x < -3$ b $-2 \leq x \leq 1$
 8 6.79 cm
 9 a $x(x+2) = 6$ b $x = 1.65$
 10 Correct proof.
 11 a $y = 0$ b $y = 1$ c $y = x$ d $y = 2 - x$
 12 a $x = 3$ cm b $y = 4$ cm c 16 cm^2
 13 a 204 cm^2 b 8.16 cm^2
 14 a 50.3 cm^2 b 4021 cm^3 c 1798 cm^2
 15 a $\frac{2}{15}$ b $\frac{8}{15}$ c $\frac{16}{45}$ d $\frac{64}{225}$
 e $\frac{64}{225}$
 16 a 0.42 b 0.46
 17 a 0.55 b



c 0.1484

Unit 3

NUMBER 3

EXERCISE 48

- 1 \$346, \$17 992
 2 \$316.75, \$16 471
 3 \$9.92
 4 \$9.88
 5 a \$108.93 b \$105.80 c \$61.76
 6 a \$17.25 b \$84.53 c \$27.51
 7 a \$15.65 b \$1.83 c \$225
 8 a \$7.76 b \$4.84 c \$49.57
 9 \$9000, \$3416.67
 10 \$11 000, \$4083.33 11 \$24 250, \$5895.83
 12 \$31 000, \$6583.33

EXERCISE 48*

- 1 a \$148.75 b \$7.875 per tonne
 2 a \$166.25 b \$6.13 per bottle
 3 a \$19.57 b \$52.17
 4 a \$326.09 b \$1173.91
 5 a \$101 000 b \$1942.31 c 32.7%
 6 a \$1 040 000 b \$11 312.50 c 43.4%
 7 a \$12 000, \$4416.67 b 19.3%
 8 a \$1016.67, \$53 800 b 29.1%
 9 \$20 000
 10 \$123 333.33
 11 a $0.25 + 0.48 = 0.73$ (fuel tax)
 $0.73 \times 1.15 = 0.8395$ (+15% purchase tax)
 b 70.2% c 235.8%
 12 a \$0.39 b 0.393

EXERCISE 49

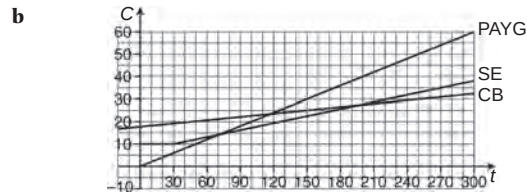
- 1 a \$20 b \$575.48
 2 a \$45 b \$382.66
 3 12.68% 4 26.82% 5 19.56%
 6 34.49% 7 0.80% 8 1.53%
 9 0.95% 10 1.81% 11 \$5
 12 a 1.2% b 15.39%
 13 a \$289.33 b \$14090.88
 14 a \$30.40 b \$939.60

EXERCISE 49*

- 1 a \$15.40 b \$245.46
 2 a \$93.38 b \$334.61
 3 15.39% 4 23.87% 5 23.14%
 6 30.60% 7 1.39% 8 2.60%
 9 1.71% 10 2.05% 11 \$9.74
 12 a 1.47% b 19.10%
 13 a 8.25% b \$278.95
 14 a 8.75% b \$124.84

ACTIVITY 13

- a C (Cost in dollars \$), t (time in minutes)
 Pay-as-you-go $C = 0.2t$ $0 \leq t \leq 300$
 Speakeasy $C = 0.1t$ $30 \leq t \leq 300$
 Chatterbox $C = 0.05t$ $240 \leq t \leq 300$



- c Cheapest tariffs: Pay-as-you-go $0 \leq t \leq 70$
 Speakeasy $70 \leq t \leq 230$
 Chatterbox $230 \leq t \leq 300$

EXERCISE 50

- 1 \$154.80 2 320 945.04 Venezuelan Bolivar
 3 HK\$1198.56 4 1251.84 Chinese yuan
 5 €159.09 6 €370.37
 7 €3.74 8 €147.77
 9 €3.26 10 €3.27
 11 €3.27 12 €3.27
 13 €6.27 14 €1263.90

EXERCISE 50*

- 1 VB200 590.65 2 363.23 Malaysian ringgit
 3 €95.11 4 €11.98
 5 6.54% 6 6.54%
 7 a €6.54 b €13.04 c 6.54%, 6.52%
 8 a €6.51 loss b €13.08 loss c 6.51%, 6.54%
 9 a €61 538 b \$73 846 c \$92 307
 10 a 400 000 South African rand
 b 375 000 South African rand
 c 500 000 South African rand
 11 a \$64.5, \$62.1 b \$129, \$131 c €79.67

REVISION EXERCISE 51

- 1 \$14 508
 2 a \$5.34 b \$8.48
 3 a \$8600 b \$24 700
 4 \$119.41
 5 14.03%
 6 a \$1962 b €91.74
 7 a \$35.40 b \$1029.60

REVISION EXERCISE 51*

- 1 \$8549.46
 2 a 0.797% b 88 months
 3 \$30 000
 4 \$259.26
 5 a €218.53 b €1 = 13.73 pesos
 6 a 6.25% b \$82.30

ALGEBRA 3

ACTIVITY 14

- (0, 6) (4, 3)
 (4, -3) one point of intersection
 No solutions

EXERCISE 52

- 1 (-2, 4), (3, 9) 2 $x = -1, y = 1$ or $x = 3, y = 9$
 3 (-1, 1), (4, 16) 4 $x = -2, y = 4$ or $x = 4, y = 16$

- 5 $x = 1, y = 2$ or $x = 2, y = 3$
 6 $x = 2, y = 1$ or $x = -3, y = -4$
 7 $x = -3.45, y = -7.90$ or $x = 1.45, y = 1.90$
 8 $x = 0.268, y = 1.80$ or $x = 3.73, y = 12.2$
 9 $x = -0.2, y = 1.4$ or $x = 1, y = -1$
 10 $x = 0.8, y = 0.6$ or $x = 0, y = 1$
 11 $x = -2, y = -1.5$ or $x = 3, y = 1$
 12 $x = -\frac{2}{3}, y = 6$ or $x = 2, y = -2$
 13 $x = -2.87, y = 4.87$ or $x = 0.87, y = 1.13$
 14 $x = 9.74, y = -6.74$ or $x = 2.26, y = 0.74$
 15 $x = 1, y = -1$
 16 $x = \frac{1}{2}, y = 1$
 17 $x = 2.17, y = 0.17$ or $x = 7.83, y = 5.83$
 18 $x = 0.785, y = 3.22$ or $x = 2.55, y = 1.45$
 19 **a** $y = 3$ **b** $x = 29.85$ and $y = 3$ **c** 29.85 cm
 20 4 cm

EXERCISE 52*

- 1 $x = -1.54, y = -4.16$ or $x = 4.54, y = 20.2$
 2 $x = 0.586, y = -0.758$ or $x = 3.41, y = -9.23$
 3 $x = 1, y = 0$ or $x = 7, y = -12$
 4 $x = \frac{5}{3}, y = -\frac{1}{3}$ or $x = -1, y = 1$
 5 $x = -2, y = 2$ or $x = -1, y = 3$
 6 $x = 3.25, y = -0.25$ or $x = 2, y = 1$
 7 $x = \frac{2}{3}, y = \frac{1}{3}$ or $x = \frac{1}{3}, y = \frac{2}{3}$
 8 $x = 10.2, y = 0.20$ or $x = -0.20, y = -10.2$
 9 (6, -6); tangent
 10 **a** (6, 1), (-2, 7) **b** $AB = 10$
 11 **a** $(x-3)^2 + y^2 = 4$
 b A (-1.68, 1.5), B (1.68, 1.5), $AB = 3.36$ cm
 12 (-2238, 5996), (2238, 5996)
 13 **a** $y = -3$ **b** (-2.65, -3), (2.65, -3), diameter is 5.30 cm
 14 **a** $x = 12$ **b** (12, -7.2), (12, 7.2), height is 14.4 cm
 15 (7.53, 0.88), No
 16 (23.7, 21.8)
 17 (2.67, -1.78)
 18 (44, -22) length 49.2 m

EXERCISE 53

- | | | | |
|----------------------------|-------------------------|-----------------------------|-------------|
| 1 a 5 | b -5 | c 2 | d 1 |
| 2 a 7 | b -13 | c 1 | d -1 |
| 3 a 4 | b -11 | c $-\frac{1}{2}$ | d -2 |
| 4 a 13 | b -12 | c $5\frac{1}{2}$ | d 3 |
| 5 a 8 | b 3 | c $1\frac{1}{4}$ | d 0 |
| 6 a 10 | b 15 | c 1 | d 0 |
| 7 a 9 | b -26 | c $1\frac{1}{8}$ | d 1 |
| 8 a 7 | b -28 | c $\frac{7}{8}$ | d -1 |
| 9 a 2 | b 0 | c 10 | |
| 10 a 3 | b 0 | c 5 | |
| 11 a $\frac{1}{5}$ | b -1 | c $\frac{1}{(1+2a)}$ | |
| 12 a $\frac{1}{3}$ | b -1 | c $\frac{1}{(2+z)}$ | |
| 13 a $1\frac{1}{2}$ | b $2\frac{1}{2}$ | c $2 - \frac{1}{y}$ | |

- | | | |
|----------------------------|------------------------|----------------------------|
| 14 a $1\frac{2}{3}$ | b $\frac{1}{3}$ | c $1 + \frac{2}{p}$ |
| 15 $x = 3$ | 16 $x = 4$ | 17 $x = 3$ |
| 18 $x = 1$ | 19 $x = 3$ | 20 $x = 4$ |

EXERCISE 53*

- | | | | |
|----------------------------|-------------------------|----------------------------------|----------------------|
| 1 a 12 | b 7 | c 8 | d $8-2p$ |
| 2 a 13 | b $5\frac{1}{2}$ | c 7 | d $7-3p$ |
| 3 a 11 | b $2\frac{1}{4}$ | c 3 | d p^2-2p+3 |
| 4 a 1 | b 1 | c -1 | d $2p^2+3p-1$ |
| 5 a 0 | b $1\frac{1}{4}$ | c 0 | d $p(p+2)$ |
| 6 a 6 | b $-\frac{1}{4}$ | c 0 | d $p(p-1)$ |
| 7 a -6 | b $2\frac{1}{8}$ | c 2 | d p^3+2 |
| 8 a -6 | b $-\frac{3}{8}$ | c 0 | d p^3-p |
| 9 a $-\frac{1}{3}$ | b $\frac{1}{5}$ | c $-\frac{1}{195}$ | |
| 10 a $\frac{1}{29}$ | b $\frac{2}{13}$ | c $\frac{1}{69}$ | |
| 11 a $\sqrt{8}$ | b 0 | c $2\sqrt{(a^2+a)}$ | |
| 12 a 1 | b $\sqrt{6}$ | c $\sqrt{(9z^2-3)}$ | |
| 13 a -4 | b $\frac{2}{3}$ | c $\frac{(9y+2)}{(3y-4)}$ | |
| 14 a -7 | b $-\frac{7}{6}$ | c $\frac{(8p-1)}{(3-4p)}$ | |
| 15 $x = 1$ | 16 $x = \frac{7}{4}$ | | |
| 17 $x = -2, x = 3$ | 18 $x = 1$ or $x = 4$ | | |
| 19 $\frac{1}{2}$ | 20 $x = -2$ | | |

EXERCISE 54

- | | | |
|-----------------------|-----------------------|------------------|
| 1 a $-2x+1$ | b $2x+5$ | c $2x+3$ |
| 2 a $-3x-2$ | b $3x+1$ | c $3x-1$ |
| 3 a $4x+1$ | b $8x-3$ | c $8x-6$ |
| 4 a $2x-6$ | b $8x-4$ | c $8x-16$ |
| 5 a $3+x$ | b $3+3x$ | c $3x-9$ |
| 6 a $5+x$ | b $5+5x$ | c $5x-25$ |
| 7 a x^2-1 | b x^2 | c $2-x^2$ |
| 8 a x^2-1 | b x^2 | c $2-x^2$ |
| 9 a $9x^2-3x$ | b $3x^2-3x$ | c x^2+x |
| 10 a $4x^2+2x$ | b $2x^2+2x$ | c x^2-x |
| 11 $x = 1$ | 12 $x = -4$ | 13 $x = 1$ |
| 14 $x = \pm 2$ | 15 $x = -\frac{1}{2}$ | 16 $x = -9$ |

EXERCISE 54*

- | | | |
|-----------------------|-------------------|--------------------------|
| 1 a $2+x$ | b $2+2x$ | c $2x-4$ |
| 2 a $4+x$ | b $4+4x$ | c $4x-16$ |
| 3 a x^2+4x+5 | b x^2+3 | c x^2+1 |
| 4 a x^2+2x+3 | b x^2+3 | c x^2+2 |
| 5 a $2x^2+x$ | b $x-2x^2$ | c $8x^2-2x$ |
| 6 a $4x^2+x$ | b $x-4x^2$ | c $64x^2-4x$ |
| 7 a $3-9x^2$ | b $9-3x^2$ | c $3x^2-9$ |
| 8 a $2-4x^2$ | b $4-2x^2$ | c $2x^2-4$ |
| 9 a x^2 | b x^2 | c $\frac{1}{x^2}$ |
| 10 a x | b x | c $\frac{1}{x}$ |

- 11 $x = \pm 4, 24$ 12 $x = \pm 2$ 13 $x = -6, x = -1$
 14 $x = 2$ or $x = 3$ 15 $x = 4$ 16 $x = -2$ or $x = 3$

EXERCISE 55

- | | |
|----------------------------|--------------------------|
| 1 a $0 \leq x \leq 2$ | b $-2 \leq x \leq 2$ |
| 2 a $0 \leq x \leq 10$ | b $-10 \leq x \leq 10$ |
| 3 a $1 \leq x \leq 4$ | b $-2 \leq x \leq 4$ |
| 4 a $-3 \leq x \leq 5$ | b $-11 \leq x \leq 5$ |
| 5 a $-1 \leq x \leq 0$ | b $-2 \leq x \leq 0$ |
| 6 a $11 \leq x \leq 20$ | b $2 \leq x \leq 20$ |
| 7 a $0 \leq x \leq 4$ | b $0 \leq x \leq 8$ |
| 8 a $4 \leq x \leq 6$ | b $-5 \leq x \leq 15$ |
| 9 a $-0.5 \leq x \leq 1.5$ | b $-4.5 \leq x \leq 5.5$ |
| 10 a $12 \leq x \leq 18$ | b $-15 \leq x \leq 45$ |

EXERCISE 55*

- | | |
|--|--|
| 1 a $\{8, 5, 2, -1\}$ | b All real numbers |
| 2 a $\{1, 5, 9, 13\}$ | b All real numbers |
| 3 a $\{0, 0, 8, 24\}$ | b $\{y: y \geq 0, y \text{ a real number}\}$ |
| 4 a $\{6, 2, 0, 0\}$ | b $\{y: y \geq 12, y \text{ a real number}\}$ |
| 5 a $\{27, 11, 3, 3\}$ | b $\{y: y \geq 2, y \text{ a real number}\}$ |
| 6 a $\{7, -1, -1, 7\}$ | b $\{y: y \geq -2, y \text{ a real number}\}$ |
| 7 a $\{-10, 0, 10, 68\}$ | b $\{y: y \geq 2, y \text{ a real number}\}$ |
| 8 a $\{-125, -27, -1, 1\}$ | b $\{y: y \geq -1, y \text{ a real number}\}$ |
| 9 a $\{1, \frac{1}{2}, \frac{1}{3}, \frac{1}{4}\}$ | b $\{y: 0 > y \geq 1, y \text{ a real number}\}$ |
| 10 a $\{8, 7, 8, 13\}$ | b $\{y: y \geq 8, y \text{ a real number}\}$ |

EXERCISE 56

- | | |
|---|---|
| 1 $x = -1$ | 2 $x = 1$ |
| 3 $\{x: x < 2, x \text{ a real number}\}$ | 4 $\{x: x > 2, x \text{ a real number}\}$ |
| 5 $x = 0$ | 6 $x = 0$ |
| 7 None | 8 None |
| 9 $-2 \leq x \leq 2$ | 10 $x \leq -3$ and $x \geq 3$ |

EXERCISE 56*

- | | |
|---|---|
| 1 $x = \frac{1}{2}$ | 2 $x = \frac{3}{4}$ |
| 3 $\{x: x > 9, x \text{ a real number}\}$ | 4 $\{x: x \leq -4, x \text{ a real number}\}$ |
| 5 $x = -1$ | 6 $x = 1$ |
| 7 $x = \pm 1$ | 8 None |
| 9 $\{x: x \leq -2, x \text{ a real number}\}$ | 10 $\{x: x \geq 2, x \text{ a real number}\}$ |

EXERCISE 57

- | | |
|---|---|
| 1 $fg(3) = 6, gf(3) = 6$ | 2 $fg(2) = 5, gf(2) = 4$ |
| 3 $fg(1) = 9, gf(1) = 3$ | 4 $fg(-1) = -27, gf(-1) = -3$ |
| 5 $fg(4) = 5, gf(4) = \frac{4}{5}$ | 6 $fg(3) = \frac{1}{3}, gf(3) = -\frac{5}{9}$ |
| 7 a $x - 1$ b $x - 1$ c $x - 8$ d $x + 6$ | |
| 8 a $x - 4$ b $x - 4$ c $x + 2$ d $x - 10$ | |
| 9 a $2x + 4$ b $2x + 2$ c $4x$ d $x + 4$ | |
| 10 a $4x + 4$ b $4x + 16$ c $x + 8$ d $16x$ | |
| 11 a $(x + 2)^2$ b $x^2 + 2$ c x^4 d $x + 4$ | |
| 12 a $(2x + 2)^2$ b $2(x + 2)^2$ c $[(x + 2)^2 + 2]^2$ d $4x$ | |
| 13 a x b x c $x - 12$ d $x + 12$ | |
| 14 a x b x c $9x$ d $\frac{x}{9}$ | |
| 15 a $x = 7$ b $x = 6$ | |
| 16 a $x = 6$ b $x = 8$ | |

EXERCISE 57*

- | | |
|--|--|
| 1 $fg(-3) = 19, gf(-3) = 8$ | 2 $fg(5) = 74, gf(5) = 56$ |
| 3 $fg(2) = 82, gf(2) = 36$ | 4 $fg(-1) = 26, gf(-1) = 6$ |
| 5 $fg(-3) = -4.5, gf(-3) = -\frac{3}{7}$ | 6 $fg(4) = \frac{2}{5}, gf(4) = -\frac{6}{11}$ |
| 7 a $x - 2$ b $x - 4$ c $\frac{(x-12)}{4}$ d $4x$ | |
| 8 a $x - 4$ b $\frac{(3x-4)}{3}$ c $9x + 4$ d $\frac{(x-20)}{9}$ | |
| 9 a $2(x-2)^2$ b $2x^2 - 2$ c $8x^4$ d $x - 4$ | |
| 10 a $16x^2 + 4$ b $4x^2 + 16$ c $(x^2 + 4)^2 + 4$ d $16x$ | |
| 11 a $\frac{1}{x}$ b $\frac{1}{(x-2)} + 2$ c $\frac{(x-2)}{(5-2x)}$ d $x + 4$ | |
| 12 a $6 - (x^2 - 6)^2$ b $(6 - x^2)^2 - 6$ c $6 - (6 - x^2)^2$ d $(x^2 - 6)^2 - 6$ | |
| 13 a $4\sqrt{\frac{(x+4)}{4}}$ b $\sqrt{(x+4)}$ c $16x$ | |
| d $\sqrt{\frac{1}{4}\sqrt{\frac{x}{4} + 4} + 4}$ | |
| 14 a $\sqrt{(x+1)}$ b $\frac{1}{3}\sqrt{(3x+1)}$ c $\sqrt{[3\sqrt{(3x+1)} + 1]}$ d $\frac{x}{9}$ | |
| 15 a $x = \frac{5}{4}$ b $x = -\frac{1}{2}$ | |
| 16 a $x = -3\frac{8}{9}$ b $x = 5$ | |
| 17 a $\{x: x \neq 5, x \text{ a real number}\}$ b $\{x: x \neq \pm 2, x \text{ a real number}\}$ | |
| 18 a $\{x: x \neq -1, x \text{ a real number}\}$ b $\{x: x \neq 0, x \text{ a real number}\}$ | |
| 19 a $\{x: x > -1, x \text{ a real number}\}$ b $\{x: x \geq -2, x \text{ a real number}\}$ | |
| 20 a $\{x: x^2 \geq \frac{3}{2}, x \text{ a real number}\}$ b $\{x: x \text{ a real number}\}$ | |

ACTIVITY 15

$$x = y + 1, y = x - 1$$

$$x = 2y, y = \frac{x}{2}$$

$$x = 4 - y, y = 4 - x$$

EXERCISE 58

- | | | | |
|---|----------------------|--|----------------------|
| 1 $\frac{7}{(x-4)}$ | 2 11 | 3 4 | 4 $\frac{3}{(12-x)}$ |
| 5 $\frac{(x-4)}{6}$ | 6 $2(x+3)$ | 7 $27-3x$ | 8 $\frac{(12-x)}{5}$ |
| 9 $\frac{x}{3} + 6$ | 10 $\frac{x}{6} - 5$ | 11 $\frac{1}{3}\left(\frac{1}{x} - 4\right)$ | 12 $5 - \frac{2}{x}$ |
| 13 $\frac{3}{(4-x)}$ | 14 $\frac{5}{(x-2)}$ | 15 $\sqrt{(x-7)}$ | 16 $\sqrt{x} - 4$ |
| 17 a 4 b $\frac{5}{2}$ c 1 | | | |
| 18 a $2\frac{2}{3}$ b 2 c $\frac{1}{3}$ | | | |
| 19 $x = -5$ | | | |
| 20 $x = \frac{9}{15}$ | | | |

EXERCISE 58*

- | | | | |
|--|--------------------------------|---------------------------|--------------------------------|
| 1 17 | 2 13 | 3 3.2 | 4 2.5 |
| 5 $\frac{4}{3} - \frac{x}{24}$ | 6 $\frac{x}{10} - \frac{9}{2}$ | 7 $2 - \frac{3}{2x}$ | 8 $\frac{5}{3x} - \frac{1}{3}$ |
| 9 $\frac{7}{(4-x)}$ | 10 $\frac{6}{(x+5)}$ | 11 $\sqrt{(x^2-7)}$ | 12 $\sqrt{(x^2-2)} - 1$ |
| 13 $\sqrt{\frac{(x-16)}{2}}$ | 14 $\sqrt{(x-5)} - 3$ | 15 $\frac{(4x-3)}{(x+2)}$ | 16 $\frac{(5-2x)}{(x+7)}$ |
| 17 a 4 b 7 c 0 | | | |
| 18 a 2 b 0 c 5 | | | |
| 19 $x = 2$ 20 $x = -3$ 21 $x = 1$ or $x = 2$ | | | |
| 22 $x = -3$ or $x = 1$ | | | |

REVISION EXERCISE 59

- 1 a 13 b -2 c 7
 2 a -0.5 b 1.25
 3 a $5x-1$ b $5x+3$
 4 $x=10$
 5 $x=-2, x=3$
 6 a 1 b $\frac{1}{2}$ c $x < -1$ d $x < 2$
 7 a all x b $x \geq 1$ c $x \geq 0$ d all x
 8 a (i) $\frac{1}{x^2} + 1$ (ii) $\frac{1}{x^2 + 1}$
 b (i) 0 (ii) none
 c x
 9 a $\frac{1}{2}(\frac{x}{4} - 3)$ b $7-x$ c $\frac{1}{x} - 3$ d $\sqrt{(x-4)}$
 10 a x b inverse of each other c $\sqrt{3}$
 11 $(-3, 9), (4, 16)$
 12 $(0, 0), (4, 8)$
 13 $x=2, y=4$ or $x=-5, y=-3$
 14 $x=1.82, y=-0.82; x=-0.82, y=1.82$ (symmetry)
 15 a $x=1.7$
 b A $(1.7, 1.05)$, B $(1.7, -1.05)$, 2.11 m

REVISION EXERCISE 59*

- 1 a 4 b 3 c 0
 2 a -2, 3 b -7, 8
 3 a $4-2x$ b $7-2x$
 4 2
 5 -4, 2
 6 a $\frac{4}{3}$ b -2 c $x < -\frac{2}{5}$ d $-3 < x < 3$
 7 a $x \geq 3$ b $x \geq 0$ c $x \geq 0$
 d all real numbers
 8 a (i) $\frac{1}{(x-8)^3}$ (ii) $\frac{1}{x^3-8}$
 b (i) 8 (ii) 2
 c $\frac{x-8}{65-8x}$
 9 a $\frac{1}{2}(1-\frac{x}{4})$ b $4-\frac{3}{2-x}$ c $\frac{x^2+3}{2}$ d $2+\sqrt{x}$
 10 a x b Inverse of each other c $\sqrt{7}$
 11 $(-\frac{1}{2}, \frac{1}{2}), (3, 18)$
 12 $(-2, -2), (1, 4)$
 13 $x=-4, y=-9$ or $x=1.5, y=2$
 14 $x=\frac{1}{3}, y=1\frac{2}{3}; x=2, y=0$
 15 $(15, -1.658), (15, 1.658)$

GRAPHS

EXERCISE 60

- 1 a 2 b 3 c -1 d -2 e $x=1$
 2 a 2 b 2 c 0.1 d 5.8
 e $x=0.18$ or 1.8
 3 a -0.25 b -1 c -0.44 d -4 e $x=\pm 0.71$
 4 a 0.75 b -3 c -3 d 0.56 e $x=\pm 1$
 5 a 4 b 2 c -4 d $x=3$
 6 a -4 b 0 c 2 d $x=4$

EXERCISE 60*

- 1 a 2 b 4 c -1 d -3 e $x=1.5$
 2 a -2.75 b 1.25 c -0.75 d -4
 e $x=-1$ or 0.33

- 3 a 1 b -0.37 or 1.37 c -1.3, 0.17 or 1.13
 d -1.13, 0.17, 1.3
 4 a 4.06 b -0.34 or 0.37 c -0.47, 0.69 or 1.54
 d -0.45, 0.6, 1.86

5 b

x coordinate	-4	-3	-2	-1	0	1	2	3	4
Gradient	-8	-6	-4	-2	0	2	4	6	8

c Straight line gradient 2 passing through the origin

6 a

x coordinate	-2	-1	0	1	2	3
e^x	-4	-2	0	2	4	6

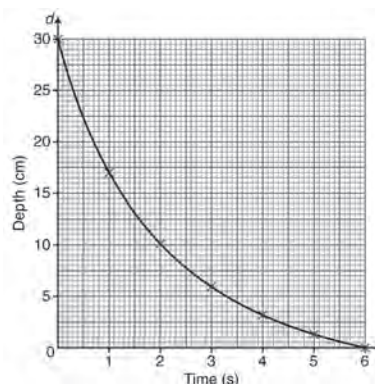
b

x coordinate	-2	-1	0	1	2	3
Gradient	0.14	0.37	1	2.7	7.4	20

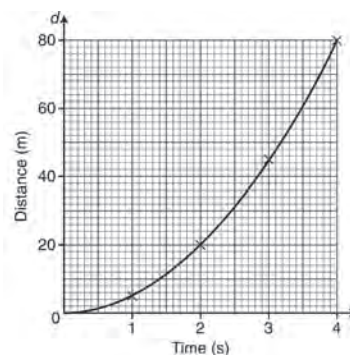
c $x=4.1, y=17$ (2 s.f.)

EXERCISE 61

- 1 a (i) 1 m/s (ii) 0 m/s (iii) 2 m/s
 b 0-20 s gradually increased speed then slowed down to a stop
 20-30 s stationary
 30-40 s speed increasing
 40-50 s travelling at a constant speed of 2 m/s
 50-60 s slowing down to a stop
 2 a (i) $\frac{1}{4}$ m/s² (ii) 0 m/s² (iii) $\frac{1}{4}$ m/s²
 b 0-20 s accelerating up to a speed of 5 m/s
 20-30 s running at a constant speed of 5 m/s
 30-50 s decelerating to a speed of 2.5 m/s
 50-60 s running at a constant speed of 2.5 m/s
 60-80 s decelerating to a stop
 3 b (i) -9.6 °C/min (ii) -6.7 °C/min (iii) 2 m/s
 4 a



- b (i) -12.8 cm/min (ii) -4 cm/min (iii) -1.4 cm/min
 5 b (i) 0.5 m/s² (ii) -6.7 °C/min (iii) 2.5 m/s²
 6 a



- b (i) 10 m/s² (ii) 20 m/s² (iii) 30 m/s²

EXERCISE 61*

- 1 a
- | | | | | | | | |
|----------------|----|----|-----|-----|------|--------|--------|
| t (min) | 0 | 20 | 40 | 60 | 80 | 100 | 120 |
| N | 10 | 40 | 160 | 640 | 2560 | 10 240 | 40 960 |
- b (i) 0.7 (ii) 44 (iii) 710
- 2 a
- | | | | | | |
|---------------------|---|-----|------|------|------|
| m (months) | 0 | 1 | 2 | 3 | 4 |
| N (millions) | 2 | 2.1 | 2.21 | 2.32 | 2.43 |
- | | | | | | |
|---------------------|------|------|------|------|-----|
| m (months) | 5 | 6 | 7 | 8 | 9 |
| N (millions) | 2.55 | 2.68 | 2.81 | 2.95 | 3.1 |
- b (i) 97 000 (ii) 119 000 (iii) 144 000
- 3 a
- | | | | | | |
|---------------------------|------|------|------|------|------|
| t (min) | 0 | 10 | 20 | 30 | 40 |
| V (cm³) | 2000 | 1700 | 1445 | 1228 | 1044 |
- | | | | | | |
|---------------------------|-----|-----|-----|-----|-----|
| t (min) | 50 | 60 | 70 | 80 | 90 |
| V (cm³) | 887 | 754 | 641 | 545 | 463 |
- b (i) $-27 \text{ cm}^3/\text{min}$ (ii) $-8.9 \text{ cm}^3/\text{min}$
c $t = 0, -30.8 \text{ cm}^3/\text{min}$
- 4 a
- | | | | | | |
|--------------|-----|----|------|------|------|
| t (s) | 0 | 10 | 20 | 30 | 40 |
| M (g) | 120 | 96 | 76.8 | 61.4 | 49.2 |
- | | | | | | |
|--------------|------|------|------|------|------|
| t (s) | 50 | 60 | 70 | 80 | 90 |
| M (g) | 39.3 | 31.5 | 25.2 | 20.1 | 16.1 |
- b (i) -1.71 (ii) -0.56
c At $t = 0, 2.68 \text{ g/s}$
- 5 a (i) 1.67 (ii) -1.67 (iii) 0
b Max at $t = 0, 4, 8, 12$ at $\pm 2.36 \text{ mph}$
- 6 a (i) -9.44 (ii) 0.075 (iii) 1.56
b max $t = 1.75, -11.7 \text{ m/s}$

REVISION EXERCISE 62

- 1 b $-3, 0, 5$
- 2 a
-
- gradient = 11 when $x = -1$; 3 when $x = 3$
b $x = 2\frac{2}{3}, y = -9.5$ also $(0, 0)$
- 3 b 2.6 mm/s, 6.3 mm/s
Height increases at an increasing rate

- 4 a
-
- b $t = 15, 13 \text{ cm/year (approx.)}$
 $t = 30, 140 \text{ cm/year (approx.)}$

REVISION EXERCISE 62*

- 1 a
- | | | | | | |
|----------|---|---|---|----|----|
| x | 0 | 1 | 2 | 3 | 4 |
| y | 1 | 3 | 9 | 27 | 81 |
- b 3.3, 9.9
- 2 a $(3, 75), (4, 80), (5, 75), (6, 60), (7, 35), (8, 0)$
-
- b
- | | | | | | |
|----------------|----|----|----|----|---|
| t (s) | 0 | 1 | 2 | 3 | 4 |
| V (m/s) | 40 | 30 | 20 | 10 | 0 |
- | | | | | |
|----------------|-----|-----|-----|-----|
| t (s) | 5 | 6 | 7 | 8 |
| V (m/s) | -10 | -20 | -30 | -40 |
- c Straight line graph passing through $(0, -40)$ and $(8, -40)$
d Acceleration is constant (-10 m/s) , i.e. constant deceleration (10 m/s)
- 3 a 2 b $y = 2x + 1$
4 a $(2, -14)$ and $(-2, 18)$ b $y = -9x$

SHAPE AND SPACE 3

ACTIVITY 16

Vectors: acceleration, a pass in hockey, velocity, rotation of 180° , force, 10 km on a bearing of 075°

Scalars: volume, area, temperature, price, length, density

ACTIVITY 17

- b** $\begin{pmatrix} 2 \\ -2 \end{pmatrix}$; 2.8; 135° **c** $\begin{pmatrix} 4 \\ -2 \end{pmatrix}$; 4.5; 116.6°
d $\begin{pmatrix} 6 \\ 1 \end{pmatrix}$; 6.1; 080.5° **e** $\begin{pmatrix} -2 \\ 1 \end{pmatrix}$; 2.2; 296.6°
 $\vec{OH} = \begin{pmatrix} 8 \\ 0 \end{pmatrix}$; $\vec{OH} = \mathbf{a} + \mathbf{b} = \mathbf{c} + \mathbf{d} + \mathbf{e}$

EXERCISE 63

- 1 a** $\vec{XY} = \mathbf{x}$ **b** $\vec{EO} = 4\mathbf{y}$ **c** $\vec{WC} = -8\mathbf{y}$ **d** $\vec{TP} = -4\mathbf{x}$
2 a $\vec{KC} = 2\mathbf{x} - 4\mathbf{y}$ **b** $\vec{VC} = \mathbf{x} - 8\mathbf{y}$ **c** $\vec{CU} = -2\mathbf{x} + 8\mathbf{y}$
d $\vec{AS} = 3\mathbf{x} + 6\mathbf{y}$
3 a $\vec{HJ}$ **b** $\vec{HN}$ **c** $\vec{HL}$ **d** $\vec{HO}$
4 a $\vec{HT}$ **b** $\vec{HP}$ **c** $\vec{HD}$ **d** $\vec{HY}$
5 a $\vec{DC} = \mathbf{x}$ **b** $\vec{DB} = \mathbf{x} + \mathbf{y}$ **c** $\vec{BC} = -\mathbf{y}$ **d** $\vec{AC} = \mathbf{x} - \mathbf{y}$
6 a $\vec{AC} = 2\mathbf{x} - \mathbf{y}$ **b** $\vec{DB} = \mathbf{x} + \mathbf{y}$ **c** $\vec{BC} = \mathbf{x} - \mathbf{y}$ **d** $\vec{CB} = \mathbf{y} - \mathbf{x}$
7 a $\vec{DC} = \mathbf{x}$ **b** $\vec{AC} = \mathbf{x} + \mathbf{y}$ **c** $\vec{BD} = \mathbf{y} - \mathbf{x}$ **d** $\vec{AE} = \frac{1}{2}(\mathbf{x} + \mathbf{y})$
8 a $\vec{BD} = \mathbf{y} - \mathbf{x}$ **b** $\vec{BE} = \frac{1}{2}(\mathbf{y} - \mathbf{x})$ **c** $\vec{AC} = \mathbf{x} + \mathbf{y}$ **d** $\vec{AE} = \frac{1}{2}(\mathbf{x} + \mathbf{y})$
9 a $\vec{AB} = \mathbf{x} - \mathbf{y}$ **b** $\vec{AD} = 3\mathbf{x}$ **c** $\vec{CF} = 2\mathbf{y} - 3\mathbf{x}$ **d** $\vec{CA} = \mathbf{y} - 3\mathbf{x}$
10 a $\vec{PQ} = \mathbf{x} - \mathbf{y}$ **b** $\vec{PC} = 2\mathbf{x} - \mathbf{y}$ **c** $\vec{QB} = 2\mathbf{y} - \mathbf{x}$ **d** $\vec{BC} = 2\mathbf{x} + 2\mathbf{y}$
11 a $2\mathbf{x} + 4\mathbf{y}$ **b** $4\mathbf{y} - 2\mathbf{x}$ **c** $2\mathbf{y} - 2\mathbf{x}$ **d** $3\mathbf{x} - 4\mathbf{y}$
12 a $\vec{OE} = \mathbf{x} + \mathbf{z}$ **b** $\vec{OB} = \mathbf{x} + \mathbf{y}$ **c** $\vec{OF} = \mathbf{x} + \mathbf{y} + \mathbf{z}$
d $\vec{EC} = -\mathbf{z} + \mathbf{y} - \mathbf{x}$

EXERCISE 63*

- 1 a** $\vec{AB} = \mathbf{y} - \mathbf{x}$ **b** $\vec{AM} = \frac{1}{2}(\mathbf{y} - \mathbf{x})$ **c** $\vec{OM} = \frac{1}{2}(\mathbf{x} + \mathbf{y})$
2 a $\vec{AB} = \mathbf{y} - \mathbf{x}$ **b** $\vec{AM} = \frac{1}{3}(\mathbf{y} - \mathbf{x})$ **c** $\vec{OM} = \frac{1}{3}(2\mathbf{x} + \mathbf{y})$
3 a $\vec{AB} = \mathbf{y} - \mathbf{x}$; $\vec{OD} = 2\mathbf{x}$; $\vec{DC} = 2\mathbf{y} - 2\mathbf{x}$
b DC = 2AB and they are parallel lines
4 a $\vec{AB} = \mathbf{y} - \mathbf{x}$; $\vec{OD} = 3\mathbf{x}$; $\vec{DC} = 2\mathbf{y} - 3\mathbf{x}$ **b** $\vec{OM} = \frac{1}{2}(2\mathbf{y} - 3\mathbf{x})$
5 a $\vec{AB} = \mathbf{y} - \mathbf{x}$; $\vec{OC} = -2\mathbf{x}$; $\vec{OD} = -2\mathbf{y}$; $\vec{DC} = 2\mathbf{y} - 2\mathbf{x}$
b DC = 2AB and they are parallel lines
6 $\vec{AB} = \mathbf{y} - \mathbf{x}$; $\vec{OD} = \frac{1}{3}(\mathbf{y} - \mathbf{x})$; $\vec{BD} = -\frac{1}{3}(\mathbf{x} + 2\mathbf{y})$; $\vec{DE} = -\frac{1}{6}(\mathbf{x} + 2\mathbf{y})$; $\vec{OE} = -\frac{1}{2}\mathbf{x}$
7 $\vec{AB} = \mathbf{y} - \mathbf{x}$; $\vec{BC} = \mathbf{y} - 2\mathbf{x}$; $\vec{AD} = 2\mathbf{y} - 4\mathbf{x}$; $\vec{BD} = \mathbf{y} - 3\mathbf{x}$
8 a $\vec{OX} = 2\mathbf{x}$; $\vec{AB} = \mathbf{y} - \mathbf{x}$; $\vec{BP} = 2\mathbf{x} - \mathbf{y}$ **b** $\vec{OX} = \mathbf{x} + \frac{1}{2}\mathbf{y}$
9 a $\vec{MA} = \frac{3}{5}\mathbf{x}$; $\vec{AB} = \mathbf{y} - \mathbf{x}$; $\vec{AN} = \frac{3}{5}(\mathbf{y} - \mathbf{x})$; $\vec{MN} = \frac{3}{5}\mathbf{y}$
b OB and MN are parallel; $\vec{MN} = \frac{3}{5}\vec{OB}$
10 a $\vec{AB} = \mathbf{y} - \mathbf{x}$; $\vec{MN} = \frac{2}{3}\mathbf{x}$
b OA and MN are parallel and $\vec{MN} = \frac{2}{3}\vec{OA}$

EXERCISE 64

- 1** $\mathbf{p} + \mathbf{q} = \begin{pmatrix} 6 \\ 8 \end{pmatrix}$; $\mathbf{p} - \mathbf{q} = \begin{pmatrix} -2 \\ -2 \end{pmatrix}$; $2\mathbf{p} + 3\mathbf{q} = \begin{pmatrix} 16 \\ 21 \end{pmatrix}$
2 $\mathbf{u} + \mathbf{v} + \mathbf{w} = \begin{pmatrix} -1 \\ 0 \end{pmatrix}$; $\mathbf{u} + 2\mathbf{v} = \begin{pmatrix} -13 \\ 23 \end{pmatrix}$; $3\mathbf{u} - 2\mathbf{v} - \mathbf{w} = \begin{pmatrix} 9 \\ 5 \end{pmatrix}$
3 $\mathbf{p} + \mathbf{q} = \begin{pmatrix} 4 \\ 6 \end{pmatrix}$; $\mathbf{p} - \mathbf{q} = \begin{pmatrix} -2 \\ -2 \end{pmatrix}$; $2\mathbf{p} + 5\mathbf{q} = \begin{pmatrix} 17 \\ 24 \end{pmatrix}$
4 $\mathbf{s} + \mathbf{t} + \mathbf{u} = \begin{pmatrix} 7 \\ -5 \end{pmatrix}$; $2\mathbf{s} - \mathbf{t} + 2\mathbf{u} = \begin{pmatrix} 8 \\ -19 \end{pmatrix}$; $2\mathbf{u} - 3\mathbf{s} = \begin{pmatrix} 5 \\ -1 \end{pmatrix}$
5 $\mathbf{v} + \mathbf{w} = \begin{pmatrix} 4 \\ 5 \end{pmatrix}$; $\sqrt{41}$
 $2\mathbf{v} - \mathbf{w} = \begin{pmatrix} 5 \\ -2 \end{pmatrix}$; $\sqrt{29}$
 $\mathbf{v} - 2\mathbf{w} = \begin{pmatrix} 1 \\ -7 \end{pmatrix}$; $\sqrt{50}$

- 6** $\mathbf{p} + \mathbf{q} = \begin{pmatrix} 5 \\ 4 \end{pmatrix}$; $\sqrt{41}$
 $3\mathbf{p} + \mathbf{q} = \begin{pmatrix} 9 \\ 2 \end{pmatrix}$; $\sqrt{85}$
 $\mathbf{p} - 3\mathbf{q} = \begin{pmatrix} -7 \\ -16 \end{pmatrix}$; $\sqrt{305}$
7 a Chloe $\begin{pmatrix} 5 \\ 7 \end{pmatrix}$; Leo $\begin{pmatrix} 4 \\ 5 \end{pmatrix}$; Max $\begin{pmatrix} 3 \\ 2 \end{pmatrix}$
b Chloe: $\sqrt{74}$ km, 2.9 km/h
Leo: $\sqrt{41}$ km, 2.1 km/h
Max: $\sqrt{13}$ km, 1.2 km/h
8 a Chloe: $\sqrt{20}$ km $\approx$ 4.5 km
Leo: 3 km
Max: $\sqrt{13}$ km $\approx$ 3.6 km
b Chloe: 243°; Leo 279°; Max: 326°

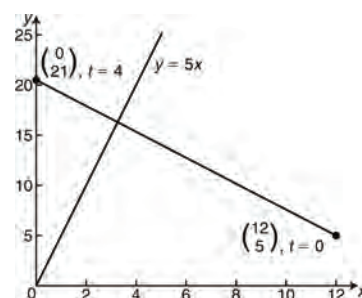
EXERCISE 64*

- 1** $\mathbf{p} + \mathbf{q} = \begin{pmatrix} 5 \\ 0 \end{pmatrix}$, 5, 090°
 $\mathbf{p} - \mathbf{q} = \begin{pmatrix} -1 \\ 2 \end{pmatrix}$, $\sqrt{5}$, 333°
 $2\mathbf{p} - 3\mathbf{q} = \begin{pmatrix} -5 \\ 5 \end{pmatrix}$, $\sqrt{50}$, 315°
2 $2(\mathbf{r} + \mathbf{s}) = \begin{pmatrix} 10 \\ -4 \end{pmatrix}$, $\sqrt{116}$, 112°
 $3(\mathbf{r} - 2\mathbf{s}) = \begin{pmatrix} -21 \\ -15 \end{pmatrix}$, $\sqrt{666}$, 234°
 $(4\mathbf{r} - 6\mathbf{s}) \sin 30^\circ = \begin{pmatrix} -10 \\ -9 \end{pmatrix}$, $\sqrt{181}$, 228°
3 $m = -1$, $n = -2$
4 $m = -4\frac{1}{2}$, $n = 2\frac{2}{3}$
5 a $\begin{pmatrix} 10.4 \\ 6 \end{pmatrix}$ km **b** $\begin{pmatrix} 13 \\ -7.5 \end{pmatrix}$ km
6 a $\begin{pmatrix} -5 \\ 8.7 \end{pmatrix}$ km **b** $\begin{pmatrix} -8.5 \\ -3.1 \end{pmatrix}$ km
7 a $m = 1$, $n = 3$ **b** $p = 3$, $q = 10$
8 a The $t = 0$ position vector is $\begin{pmatrix} -2 \\ 1 \end{pmatrix}$ and every 1 second vector $\begin{pmatrix} 2 \\ 1 \end{pmatrix}$ is added to give Anne's position vector.
b $\sqrt{5} \approx 2.2$ m/s
c $a = \frac{8}{3}$, $b = 2$ so speed = 2 m/s

ACTIVITY 18

Time	$t = 0$	$t = 1$	$t = 2$	$t = 3$	$t = 4$
$\mathbf{r}$	$\begin{pmatrix} 12 \\ 5 \end{pmatrix}$	$\begin{pmatrix} 9 \\ 9 \end{pmatrix}$	$\begin{pmatrix} 6 \\ 13 \end{pmatrix}$	$\begin{pmatrix} 3 \\ 17 \end{pmatrix}$	$\begin{pmatrix} 0 \\ 21 \end{pmatrix}$

$d = \sqrt{12^2 + 16^2} = 20$ km
 $V = \frac{20 \text{ km}}{4 \text{ min}} = 300 \text{ km/h}$, 323.1°
About 12:03
 $x = 12 - 3t$
 $y = 5 + 4t$
 $y = 5x$
so
 $5 + 4t = 5(12 - 3t) \therefore t = \frac{55}{19}$
Boundary is crossed at 12:02:54



REVISION EXERCISE 65

- 1** $\mathbf{p} + \mathbf{q} = \begin{pmatrix} 1 \\ 5 \end{pmatrix}$, $\sqrt{26}$
 $\mathbf{p} - \mathbf{q} = \begin{pmatrix} 5 \\ 3 \end{pmatrix}$, $\sqrt{34}$
 $3\mathbf{p} - 2\mathbf{q} = \begin{pmatrix} 13 \\ 10 \end{pmatrix}$, $\sqrt{269}$

- 2 $\mathbf{r} + \mathbf{s} = \begin{pmatrix} 5 \\ -1 \end{pmatrix}, \sqrt{26}$
 $\mathbf{r} - \mathbf{s} = \begin{pmatrix} -1 \\ -9 \end{pmatrix}, \sqrt{82}$
 $3\mathbf{s} - 2\mathbf{r} = \begin{pmatrix} 5 \\ 22 \end{pmatrix}, \sqrt{509}$
- 3 a $\overrightarrow{AB} = 3\mathbf{y} + \mathbf{x}$ b $\overrightarrow{AC} = 2\mathbf{y} + 2\mathbf{x}$ c $\overrightarrow{CB} = -\mathbf{x} + \mathbf{y}$
- 4 a $\overrightarrow{AB} = \mathbf{w} - \mathbf{v}$ b $\overrightarrow{AM} = \frac{1}{2}(\mathbf{w} - \mathbf{v})$ c $\overrightarrow{OM} = \frac{1}{2}(\mathbf{v} + \mathbf{w})$
- 5 a $\overrightarrow{AB} = \mathbf{y} - \mathbf{x}$ b $\overrightarrow{FB} = 2\mathbf{y} - \mathbf{x}$ c $\overrightarrow{FD} = \mathbf{y} - 2\mathbf{x}$
- 6 a $\overrightarrow{OP} = 2\mathbf{a}; \overrightarrow{OQ} = 2\mathbf{b}; \overrightarrow{AB} = \mathbf{b} - \mathbf{a}; \overrightarrow{PQ} = 2(\mathbf{b} - \mathbf{a})$
 b PQ is parallel to AB and is twice the length of AB.
- 7 a $\begin{pmatrix} 4 \\ 1 \end{pmatrix}$ b $\begin{pmatrix} 6 \\ -4 \end{pmatrix}$ c $\sqrt{29}$ d $v = 1, w = 2$

REVISION EXERCISE 65*

- 1 $m = 3, n = 1$
- 2 $m = -2, n = 5$
- 3 a $\overrightarrow{XM} = \begin{pmatrix} -1 \\ 3 \end{pmatrix}$
 $\overrightarrow{XZ} = \begin{pmatrix} -10 \\ 6 \end{pmatrix}$
 b $v \begin{pmatrix} 7 \\ 3 \end{pmatrix}$
 c $\begin{pmatrix} 8 \\ 0 \end{pmatrix} + w \begin{pmatrix} -10 \\ 6 \end{pmatrix}$
 d $v = \frac{2}{3}, w = \frac{1}{3}$
- 4 a $\overrightarrow{AC} = \mathbf{x} + \mathbf{y}; \overrightarrow{BE} = \frac{1}{3}\mathbf{y} - \mathbf{x}$
 b (i) $\overrightarrow{BF} = v \begin{pmatrix} 1 \\ 3 \end{pmatrix} \mathbf{y} - \mathbf{x}$
 (ii) $\overrightarrow{AF} = \mathbf{x} + \overrightarrow{BF} = \mathbf{x} + v \begin{pmatrix} 1 \\ 3 \end{pmatrix} \mathbf{y} - \mathbf{x}$
 (iii) $v = \frac{3}{4}$
- 5 a
- | t | $t = 0$ | $t = 1$ | $t = 2$ | $t = 3$ |
|--------------|---|---|---|---|
| $\mathbf{r}$ | $\begin{pmatrix} 12 \\ 7 \end{pmatrix}$ | $\begin{pmatrix} 1 \\ 10 \end{pmatrix}$ | $\begin{pmatrix} -10 \\ 13 \end{pmatrix}$ | $\begin{pmatrix} -21 \\ 16 \end{pmatrix}$ |
- c 41 000 km/h, 285.3°
- 6 a (i) $\mathbf{r} = \begin{pmatrix} 3 \\ 1 \end{pmatrix}, \mathbf{s} = \begin{pmatrix} 0 \\ 5 \end{pmatrix}$ (ii) $\mathbf{r} = \begin{pmatrix} 4 \\ 3 \end{pmatrix}, \mathbf{s} = \begin{pmatrix} 3 \\ 6 \end{pmatrix}$
 b $\begin{pmatrix} 3 \\ 1 \end{pmatrix}; \sqrt{10}$
 c $\sqrt{5}; \sqrt{10}$

HANDLING DATA 3

EXERCISE 66

- 1 f.d.: 0.20, 0.40, 0.90, 0.60, 0.45, 0.05
- 2 f.d.: 4.0, 2.0, 2.8, 3.0, 2.6, 1.8, 1.7
- 3 a f.d.: 3.5, 7, 10, 24, 38, 16, 9
 b 6.5–7 kg c 55%
- 4 a f.d.: 0.8, 1.2, 1.7, 2.8, 2.2, 1.3, 0.45
 b 100–105 g c 33%
- 5 a f.d.: 3.5, 9.5, 12, 13.6, 10.4, 2.5
 c $\bar{x} = 25.3$ years
- 6 a f.d.: 3.0, 4.5, 11, 12.5, 5.0, 2.0
 c $\bar{x} = 16$ min 40 s

EXERCISE 66*

- 1 a f.d.: 0.04, 0.07, 0.087, 0.113, 0.024, 0.012
 b 51.4% c $\bar{x} = 368.5$

- 2 a f.d.: 12, 8.4, 4.8, 1.6, 3.0, 3.0, 1.7
 b 36.5% c $\bar{x} = 40.0$ years
- 3 a f.d.: 10, 13, 15, 15, 13, 7, 7
 b $\bar{x} = 9.67$ years
 c 6.5 cm, 7.5 cm, 7.5 cm, 6.5 cm, 3.5 cm, 3.5 cm
- 4 a f.d.: 15, 11.4, 13.8, 8.4, 7.2, 3.6, 3.0
 b $\bar{x} = 32.45$ years
 c 3.8 cm, 4.6 cm, 2.8 cm, 2.4 cm, 1.2 cm, 1 cm
- 5 a 522 customers
 b \$1566
 c $\bar{x} = 52.5$ customers per hour. Not a useful statistic
 d 10.00–12.00, 1 staff; 12.00–14.00, 4 staff; 14.00–18.00, 2 staff;
 18.00–20.00, 3 staff
- 6 a 27 200 cars
 b 1700 cars per hour
 c 300 cars
 d Rate of flow – number of lanes
 Total flow – ageing of road surface
- 7 a 6, 8
 b f.d.: 3.6, 1.7, 0.6, 0.1
 c $\bar{x} = 97.7$ min
- 8 a 3, 4
 b f.d.: 10, 18, 32, 36
 c $\bar{x} = 6.01$ h

REVISION EXERCISE 67

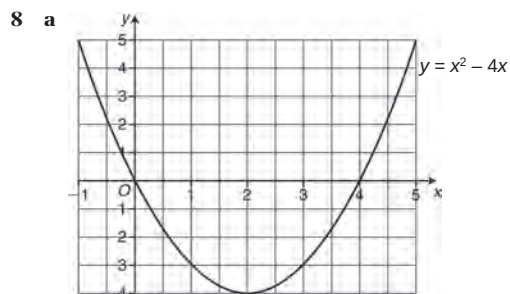
- 1 a f.d.: 2.8, 8, 14.32, 20.64, 6, 1.56
 b 9 cm
 c 2.34 cm
- 2 a f.d.: 1.2, 2.3, 1.6, 0.9, 0.3, 0.2
 b 2
 c 100 pupils, $\bar{t} = 35.7$
 d 20.5%

REVISION EXERCISE 67*

- 1 a f.d.: 4, 0.5, 0.267, 1.2, 1.5, 0.7, 0.267, 0.133
 b 2105 min – 35 h 5 min
 c 30 min 30s d 67 min 54 s
 e \$16.84
- 2 a 87, 285 b 2, 11, 4, 2.3
 c $\bar{t} = 69.1$ days, median = 64 days

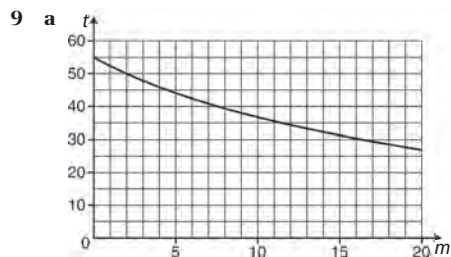
EXAMINATION PRACTICE 3

- 1 \$4900
- 2 a \$48 000 b 12.5%
- 3 (4.73, 6.46), (1.27, -0.464)
- 4 (0, -4), (3.2, 2.4)
- 5 a $\frac{1}{2}$ b $x = 1$
 c $f^{-1}: x \rightarrow \frac{1}{x} + 1$ d $x = 0$
- 6 a Domain is all real numbers, range is $\{y: y \geq 0, y \text{ a real number}\}$
 b $gf(x) = (x - 3)^2$ c $f^{-1}(x) = x + 3$
 d 1, 6
- 7 a (i) 5 (ii) -3
 b $x = -0.39$ or $x = 1.72$

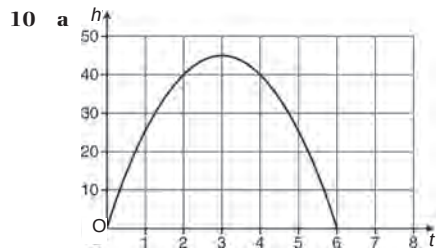


b (i) -4 (ii) 2

c when $x = 2$



b $2 \leq t \leq 11.4$ c -1.5



b (i) 30 m/s (ii) 0 m/s (iii) -20 m/s

11 a $2n$ b $2m$ c $2m - 2n$ d $m - n$

e NM is parallel to AB and half the length.

12 a $\overrightarrow{OM} = \frac{1}{3}\mathbf{v}$ b $\overrightarrow{AM} = -\mathbf{u} + \frac{1}{3}\mathbf{v}$ c $\overrightarrow{MD} = \frac{2}{3}\mathbf{v} + \mathbf{w}$

13 a $\begin{pmatrix} 10 \\ 25 \end{pmatrix}$ b 26.9 c 68.2°

d $\begin{pmatrix} 25 \\ 27.5 \end{pmatrix}$

14 a $\overrightarrow{OP} = \frac{2}{3}\mathbf{b}$ b $\overrightarrow{OQ} = \mathbf{a} + \frac{1}{4}\mathbf{b}$ c $\overrightarrow{PQ} = \mathbf{a} - \frac{5}{12}\mathbf{b}$

d $\overrightarrow{OR} = 1\frac{3}{5}\mathbf{a}$ e $\overrightarrow{QR} = -\frac{1}{4}\mathbf{b} + \frac{3}{5}\mathbf{a}$

f $\overrightarrow{PQ} = \mathbf{a} - \frac{5}{12}\mathbf{b} = \frac{1}{12}(12\mathbf{a} - 5\mathbf{b})$

$\overrightarrow{QR} = -\frac{1}{4}\mathbf{b} + \frac{3}{5}\mathbf{a} = \frac{3}{5}\mathbf{a} - \frac{1}{4}\mathbf{b} = \frac{1}{20}(12\mathbf{a} - 5\mathbf{b})$

$\therefore \overrightarrow{PQ}$ and $\overrightarrow{QR}$ are parallel because they have the same direction vector. They both pass through the same point Q $\therefore$ PQR is a straight line.

15 a Frequency densities: 16, 36, 38, 12, 12

b 0.368

c 22.25 kg

16 a freq. 20, 70, 58, 60, 44, 16

b $\frac{2x}{5}, \frac{y}{2}$

Unit 4

NUMBER 4

ACTIVITY 19

Investigate this how you wish. A typical method might be to use percentage errors from $\pi = 3.141\ 592\ 654$ (to 10 s.f.)

Rank		Percentage error (2 s.f.)
1	Ramanujan	-3.3×10^{-8}
2	Tsu Chung-Chih	$+8.5 \times 10^{-6}$
3	Hipparchus	$+2.4 \times 10^{-3}$
4	Fibonacci	$+7.2 \times 10^{-3}$
5	Archimedes	$+0.040$
6	Babylon	-0.53
7	Egypt	$+0.60$
8	Brahmagupta	$+0.66$
9	Bible	-4.5
10	Wallis (as printed!)	-5.4

Investigate Wallis's expression further.

EXERCISE 68

- 1 $\frac{57}{10}$
- 2 $\frac{73}{10}$
- 3 $\frac{47}{99}$
- 4 $\frac{23}{99}$
- 5 $\frac{7}{1}$
- 6 $\frac{5}{1}$
- 7 Irrational
- 8 Irrational
- 9 $\frac{3}{1}$
- 10 $\frac{5}{1}$
- 11 $\frac{1}{1}$
- 12 $\frac{1}{1}$
- 13 Irrational
- 14 Irrational
- 15 0
- 16 0
- 17 e.g. 2.5
- 18 2, for example (answers may vary)
- 19 e.g. $\sqrt{53}$
- 20 $\sqrt{11}$, for example (answers may vary)
- 21 $\frac{2}{\pi}$
- 22 $\frac{3}{\sqrt{\pi}}$

EXERCISE 68*

- 1 Irrational
- 2 Irrational
- 3 $\frac{2}{5}$
- 4 $\frac{3}{4}$
- 5 $\frac{3}{5}$
- 6 $\frac{9}{10}$
- 7 $\frac{3}{2}$
- 8 $\frac{5}{3}$
- 9 Irrational
- 10 Irrational
- 11 $\frac{1}{1}$
- 12 $\frac{13}{1}$
- 13 Irrational
- 14 $\frac{3}{1}$
- 15 e.g. 3.5
- 16 4.2, for example (answers may vary)
- 17 e.g. $\sqrt{7}$
- 18 $\sqrt{\frac{1}{2}}$, for example (answers may vary)
- 19 e.g. $\sqrt{2} \times \sqrt{8}$
- 20 $\sqrt[3]{2}$, for example (answers may vary)
- 21 $\frac{9}{\pi}$
- 22 $\frac{8\pi}{\sqrt{\pi}}$
- 23 a e.g. 3:4:5 b e.g. $\sqrt{2}:\sqrt{2}:2$ c e.g. 1:2: $\sqrt{5}$ d e.g. 1: $\sqrt{3}:2$

EXERCISE 69

- 1 $6\sqrt{5}$
- 2 $5\sqrt{7}$
- 3 $4\sqrt{3}$
- 4 $3\sqrt{2}$
- 5 32
- 6 75
- 7 20
- 8 63
- 9 8
- 10 9
- 11 105
- 12 80
- 13 $2\sqrt{2}$
- 14 $5\sqrt{5}$
- 15 4
- 16 3
- 17 8
- 18 $\frac{1}{2}$

EXERCISE 69*

- 1 $5\sqrt{11}$
- 2 $5\sqrt{13}$
- 3 $4\sqrt{7}$
- 4 $7\sqrt{17}$
- 5 99
- 6 52
- 7 96
- 8 105
- 9 $56\sqrt{7}$
- 10 $135\sqrt{5}$
- 11 $120\sqrt{2}$
- 12 $72\sqrt{3}$
- 13 9
- 14 49
- 15 4
- 16 5
- 17 6
- 18 $\frac{1}{3}$

EXERCISE 70

- 1 $2\sqrt{3}$
- 2 $2\sqrt{5}$
- 3 $3\sqrt{2}$
- 4 $3\sqrt{3}$
- 5 $4\sqrt{3}$
- 6 $4\sqrt{2}$
- 7 $3\sqrt{5}$
- 8 $5\sqrt{3}$
- 9 $3\sqrt{3}$
- 10 $5\sqrt{5}$
- 11 $6\sqrt{2}$
- 12 $4\sqrt{5}$
- 13 $\sqrt{50}$
- 14 $\sqrt{18}$
- 15 $\sqrt{27}$
- 16 $\sqrt{20}$
- 17 $\sqrt{54}$
- 18 $\sqrt{28}$
- 19 $\frac{1}{2}$
- 20 $\frac{1}{3}$
- 21 $\frac{2}{5}$
- 22 $\frac{3}{4}$
- 23 $\frac{2}{3}$
- 24 $\frac{7}{8}$
- 25 12, $10\sqrt{2}$, $\sqrt{26}$
- 26 18, $10\sqrt{3}$, $\sqrt{39}$

EXERCISE 70*

- 1 $2\sqrt{7}$
- 2 $3\sqrt{7}$
- 3 $3\sqrt{11}$
- 4 $2\sqrt{11}$
- 5 $4\sqrt{5}$
- 6 $5\sqrt{5}$
- 7 $3\sqrt{13}$
- 8 $2\sqrt{13}$
- 9 $5\sqrt{3}$
- 10 $7\sqrt{3}$
- 11 $5\sqrt{3}$
- 12 $6\sqrt{5}$
- 13 $\sqrt{75}$
- 14 $\sqrt{24}$
- 15 $\sqrt{80}$
- 16 $\sqrt{32}$
- 17 $\sqrt{63}$
- 18 $\sqrt{275}$
- 19 $\frac{1}{6}$
- 20 $\frac{1}{7}$
- 21 $\frac{9}{10}$
- 22 $\frac{11}{12}$
- 23 $\frac{7}{13}$
- 24 $\frac{14}{15}$
- 25 $8, 8\sqrt{2}$
- 26 $2\sqrt{2}, 8 + 2\sqrt{2}, 2 + 3\sqrt{2}$

ACTIVITY 20

- a (i) $\sqrt{2}$ (ii) 45°
- | | | |
|--------------------------------------|--------------------------------|---------------|
| (iii) $\sin 45 = \frac{1}{\sqrt{2}}$ | $\cos 45 = \frac{1}{\sqrt{2}}$ | $\tan 45 = 1$ |
|--------------------------------------|--------------------------------|---------------|
- b (i) $\sqrt{3}$ (ii) $60^\circ, 30^\circ$
- | | | |
|--------------------------------|--------------------------------|--------------------------------|
| (iii) $\sin 30 = \frac{1}{2}$ | $\cos 30 = \frac{\sqrt{3}}{2}$ | $\tan 30 = \frac{1}{\sqrt{3}}$ |
| $\sin 60 = \frac{\sqrt{3}}{2}$ | $\cos 60 = \frac{1}{2}$ | $\tan 60 = \sqrt{3}$ |

EXERCISE 71

- 1 $3 + 2\sqrt{2}$
- 2 $4 + 2\sqrt{3}$
- 3 $4 - 2\sqrt{3}$
- 4 $3 - 2\sqrt{2}$
- 5 $21 + 12\sqrt{3}$
- 6 $31 + 12\sqrt{3}$
- 7 $27 - 18\sqrt{2}$
- 8 $16 - 8\sqrt{3}$
- 9 -4
- 10 -2
- 11 $5 + 2\sqrt{6}$
- 12 $7 - 2\sqrt{10}$
- 13 $1 + \sqrt{2} - \sqrt{5} - \sqrt{10}$
- 14 $1 + \sqrt{2} - \sqrt{3} - \sqrt{6}$

EXERCISE 71*

- 1 $9 + 4\sqrt{5}$
- 2 $12 + 6\sqrt{3}$
- 3 $18 - 8\sqrt{2}$
- 4 $30 - 10\sqrt{5}$
- 5 13
- 6 20
- 7 $36 + 16\sqrt{2}$
- 8 $91 - 40\sqrt{3}$
- 9 $10 - 2\sqrt{21}$
- 10 $7 + 2\sqrt{10}$
- 11 2
- 12 8
- 13 $15 + 10\sqrt{2} - 6\sqrt{7} - 4\sqrt{14}$
- 14 $8 + 12\sqrt{3} - 6\sqrt{5} - 9\sqrt{15}$
- 15 $4\sqrt{3}, 2, 2\sqrt{2}$
- 16 $1 + \sqrt{2}, 1.5 + \sqrt{2}$

EXERCISE 72

- 1 $\frac{\sqrt{3}}{3}$
- 2 $\frac{\sqrt{2}}{2}$
- 3 $\frac{\sqrt{5}}{5}$
- 4 $\frac{\sqrt{7}}{7}$
- 5 $\sqrt{3}$
- 6 $\sqrt{2}$
- 7 $2\sqrt{2}$
- 8 $2\sqrt{3}$
- 9 $\frac{2\sqrt{3}}{3}$
- 10 $\frac{3\sqrt{2}}{2}$
- 11 $\frac{3\sqrt{2}}{4}$
- 12 $\frac{5\sqrt{3}}{6}$
- 13 $\frac{(2 + \sqrt{2})}{2}$
- 14 $\frac{(3 + \sqrt{3})}{3}$

ACTIVITY 21

- a By long division b $\frac{\sqrt{2}}{2}$ c 0.707 107
d $\sqrt{2} + 1$ e $\sqrt{2} - 1$

EXERCISE 72*

- 1 $\frac{\sqrt{13}}{13}$ 2 $\frac{\sqrt{11}}{11}$ 3 $\sqrt{a}$ 4 $b\sqrt{b}$
5 $2\sqrt{3} - 1$ 6 $2\sqrt{2} - 1$ 7 $\frac{\sqrt{3}}{3}$ 8 $\frac{\sqrt{6}}{3}$
9 $2 + \sqrt{5}$ 10 $3 + 2\sqrt{7}$ 11 $\frac{-(1 + \sqrt{5})}{4}$ 12 $\frac{-(1 - \sqrt{7})}{6}$
13 $\frac{(5 - 4\sqrt{2})}{7}$ 14 $7 + 4\sqrt{3}$

REVISION EXERCISE 73

- 1 $0.\dot{3}$ and $\sqrt{25}$
2 2, for example (answers may vary)
3 e.g. $\sqrt{11}$ 4 $\sqrt{45}$ 5 $5\sqrt{3}$ 6 $\sqrt{3}$ 7 18
8 1.5 9 $2\sqrt{2}$ 10 $3\sqrt{7}$ 11 $3\sqrt{3}$ 12 $\frac{2}{3}$
13 $6 + 2\sqrt{5}$ 14 $6 - 4\sqrt{2}$ 15 -1 16 $\sqrt{5}$ 17 $2\sqrt{3}$
18 $\frac{3}{2}$ 19 $1 + \sqrt{3}$ 20 $16\sqrt{2}, 30, 2\sqrt{17}$

REVISION EXERCISE 73*

- 1 $(\sqrt{3})^2$ and $0.\dot{2}\dot{3}$
2 3, for example (answers may vary)
3 e.g. $\sqrt{40}$ 4 $\sqrt{176}$ 5 $8\sqrt{5}$ 6 $2\sqrt{5}$
7 75 8 $\frac{5}{3}$ 9 $4\sqrt{3}$ 10 $11\sqrt{2}$
11 $19\sqrt{6}$ 12 $\frac{3}{5}$ 13 8 14 $6 - 4\sqrt{2}$
15 $-5 + \sqrt{14}$ 16 $\frac{\sqrt{5}}{10}$ 17 $2\sqrt{6}$ 18 $2 + \sqrt{6}$
19 2 20 $\frac{(2 + 3\sqrt{2})}{4}$ 21 $5\sqrt{3}, 18$ 22 $\sqrt{3}, \frac{1}{2}, \sqrt{3}$

ALGEBRA

EXERCISE 74

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

EXERCISE 74*

- 1 $\frac{3}{5}$ 2 $\frac{7}{3}$ 3 $\frac{y}{x}$ 4 $\frac{1}{y}$
5 $\frac{(x - 4)}{(x + 3)}$ 6 $\frac{(x - 3)}{(x + 5)}$ 7 $\frac{(x + 3)}{(x + 4)}$ 8 $\frac{(x - 2)}{(x - 5)}$
9 $\frac{(r - 3)}{(r + 1)}$ 10 $\frac{(t - 2)}{(t + 2)}$ 11 $\frac{(a - b)}{(a + b)}$ 12 $\frac{(b - a)}{b(a + b)}$
13 $\frac{2(x + 8)}{y}$ 14 $\frac{3(x + 2)}{y}$

EXERCISE 75

- 1 $\frac{5x + 3}{6}$ 2 $\frac{5x + 4}{6}$ 3 $\frac{x - 2}{4}$ 4 $\frac{x - 3}{12}$
5 $\frac{8x + 12}{15}$ 6 $\frac{7x + 15}{10}$ 7 $\frac{5x + 3}{4}$ 8 $\frac{4x - 2}{3}$
9 $\frac{1 - 4x}{5}$ 10 $\frac{3 - x}{2}$ 11 $\frac{7x + 2}{12}$ 12 $\frac{5x - 1}{6}$
13 $\frac{3x - 17}{10}$ 14 $\frac{-x - 8}{6}$ 15 $\frac{3x + 2}{6}$ 16 $\frac{4x + 3}{12}$
17 $\frac{39 - 2x}{12}$ 18 $\frac{27 - 19x}{14}$ 19 $\frac{23x - 11}{10}$ 20 $\frac{31x - 38}{20}$

EXERCISE 75*

- 1 $\frac{9x + 13}{10}$ 2 $\frac{11x + 5}{12}$ 3 $\frac{1 - 2x}{12}$ 4 $\frac{1 - 12x}{15}$
5 $\frac{16 - 3x}{14}$ 6 $\frac{5x}{12}$ 7 $\frac{6x - 2}{35}$ 8 $\frac{2x + 9}{8}$
9 $\frac{x - 230}{15}$ 10 $\frac{84 - 7x}{24}$ 11 $\frac{x - 6}{72}$ 12 $\frac{7x + 1}{100}$
13 $\frac{47x - 22}{60}$ 14 $\frac{13x - 23}{12}$ 15 $\frac{5x - 8}{6}$ 16 $\frac{1}{15}$
17 $\frac{23x + 7}{18}$ 18 $\frac{-x - 5}{12}$ 19 $\frac{59 - 78x}{10}$ 20 $\frac{17x - 13}{5}$

EXERCISE 76

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

EXERCISE 76*

- 1 $\frac{17}{15x}$ 2 $\frac{5}{12x}$ 3 $\frac{x - 1}{(x + 3)(x + 2)}$
4 $\frac{3(x + 6)}{(x + 1)(x + 4)}$ 5 $\frac{x^2 + x + 1}{1 + x}$ 6 $\frac{x}{(1 + x)}$
7 $\frac{1}{(x + 1)}$ 8 $\frac{1}{x}$ 9 $\frac{2x + 3}{(x + 1)(x + 2)}$
10 $\frac{2x}{(x + 2)(x - 2)}$ 11 $\frac{1}{(x + 1)}$ 12 $\frac{1}{(x - 1)}$
13 $\frac{x + 2}{(x + 1)^2}$ 14 $\frac{2x + 4}{(x + 3)(x - 1)}$ 15 $\frac{8}{(x - 3)(x + 1)}$
16 $\frac{8 - x}{(x - 4)(x + 1)(x - 2)}$

EXERCISE 77

- 1 21 2 12 3 2 4 3 5 $\frac{1}{2}$
6 $\frac{1}{4}$ 7 3 8 1 9 -8 10 10
11 $-\frac{2}{3}$ 12 $-\frac{3}{4}$ 13 $\frac{1}{2}$ 14 $\frac{1}{12}$ 15 230
16 12 17 -6 18 3 19 0 20 0

EXERCISE 77*

- 1 $\frac{2}{3}$ 2 $\frac{2}{3}$ 3 15 4 1 5 $\frac{1}{3}$
6 $-\frac{1}{2}$ 7 0 8 $\frac{2}{17}$ 9 15 10 4

- 11 7 12 -3 13 1 14 3 15 $\frac{7}{5}$
 16 $-\frac{2}{9}$ 17 $-\frac{8}{3}$ 18 7 19 $-\frac{5}{13}$ 20 $-\frac{227}{33}$
 21 6 km 22 30 km

EXERCISE 78

- 1 -7, 2 2 -5, 3 3 1, 2 4 2, 3 5 6
 6 2 7 $\frac{2}{3}$ 8 $\frac{3}{4}$ 9 -4, 5 10 4, -3
 11 0, 6 12 -3, 7 13 -1, 4 14 -6, 3 15 $-\frac{1}{3}, 2$
 16 $\frac{1}{6}, 4$

EXERCISE 78*

- 1 -3.5, 1 2 $\frac{1}{4}, 7$ 3 -4, 1 4 -2, 5
 5 4 6 3 7 -6, 6 8 -4, 7
 9 $-\frac{7}{3}, 2$ 10 -3, 3 11 -0.768, 0.434
 12 -8.28, 0.785 13 -2, 6 14 3.2, 5 15 60
 16 10.47 17 -2.5 18 $\frac{2}{5}, 2$ 19 $-\frac{2}{3}, 5$

REVISION EXERCISE 79

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

REVISION EXERCISE 79*

- 1 $\frac{2}{3}$ 2 $\frac{(x-11)}{(x+5)}$ 3 $\frac{(x+4)}{(x-7)}$ 4 $\frac{(x-1)}{(x+1)}$
 5 $\frac{x-11}{12}$ 6 $\frac{5x-13}{18}$ 7 $\frac{5x+7}{12}$ 8 $\frac{7x+6}{10}$
 9 $\frac{3x^2+7x+24}{(x+3)(3x-1)}$ 10 $\frac{2x+3}{(x+1)(x+2)}$ 11 $\frac{-1}{(x-4)(x+1)}$ 12 $\frac{3x}{x^2-4}$
 13 -1 14 5 15 $\frac{15}{61}$ 16 5
 17 $\frac{1}{3}$ or 2 18 $-\frac{2}{3}$ or 1 19 -0.464 or 6.46
 20 -9.16 or 3.16

GRAPHS

EXERCISE 80

- 1 $\frac{dy}{dx} = 3x^2$ 2 $\frac{dy}{dx} = 4x^3$ 3 $\frac{dy}{dx} = 5x^4$ 4 $\frac{dy}{dx} = 6x^5$
 5 $\frac{dy}{dx} = 8x^7$ 6 $\frac{dy}{dx} = 7x^6$ 7 $\frac{dy}{dx} = 10x^9$ 8 $\frac{dy}{dx} = 11x^{10}$
 9 $\frac{dy}{dx} = -x^{-2}$ 10 $\frac{dy}{dx} = -2x^{-3}$ 11 $\frac{dy}{dx} = -x^{-2}$ 12 $\frac{dy}{dx} = -2x^{-3}$
 13 4 14 8 15 32 16 80
 17 448 18 192

EXERCISE 80*

- 1 $\frac{dy}{dx} = 12x^{11}$ 2 $\frac{dy}{dx} = 9x^8$ 3 $\frac{dy}{dx} = 1$ 4 $\frac{dy}{dx} = 1$

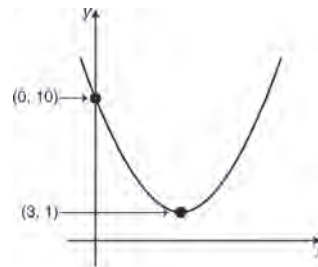
- 5 $\frac{dy}{dx} = -3x^{-4}$ 6 $\frac{dy}{dx} = -4x^{-5}$ 7 $\frac{dy}{dx} = -6x^{-7}$ 8 $\frac{dy}{dx} = -5x^{-6}$
 9 $\frac{dy}{dx} = \frac{1}{2}x^{-\frac{1}{2}}$ 10 $\frac{dy}{dx} = \frac{1}{3}x^{-\frac{2}{3}}$ 11 $\frac{dy}{dx} = \frac{1}{2}x^{-\frac{1}{2}}$ 12 $\frac{dy}{dx} = 0$
 13 $-\frac{3}{16}$ 14 $-\frac{1}{8}$ 15 $\frac{1}{4}$ 16 $-\frac{1}{4}$
 17 $-\frac{1}{4}$ 18 $\frac{1}{12}$ 19 0 20 1

EXERCISE 81

- 1 $\frac{dy}{dx} = 8x$ 2 $\frac{dy}{dx} = 3x^0 = 3$ 3 $\frac{dy}{dx} = 6x^2$
 4 $\frac{dy}{dx} = 20x^3$ 5 $\frac{dy}{dx} = 15x^4$ 6 $\frac{dy}{dx} = 24x^5$
 7 $\frac{dy}{dx} = -6x^{-3}$ 8 $\frac{dy}{dx} = -6x^{-4}$ 9 $\frac{dy}{dx} = 2x^{-2}$
 10 $\frac{dy}{dx} = 2x^{-3}$ 11 $\frac{dy}{dx} = 5x^4 + 2x$ 12 $\frac{dy}{dx} = 4x^3 + 3x^2$
 13 $\frac{dy}{dx} = 6x^2 + 4$ 14 $\frac{dy}{dx} = 20x^3 - 3$ 15 $\frac{dy}{dx} = 9x^2 + 8x^3$
 16 $\frac{dy}{dx} = 10x - 3x^2$ 17 $\frac{dy}{dx} = 4x$ 18 $\frac{dy}{dx} = 18x^2$
 19 $\frac{dy}{dx} = -x^{-2}$ 20 $\frac{dy}{dx} = -2x^{-3}$ 21 $\frac{dy}{dx} = -6x^{-4}$
 22 $\frac{dy}{dx} = -20x^{-5}$ 23 $\frac{dy}{dx} = 2x - 2x^{-3}$ 24 $\frac{dy}{dx} = 3x^2 - x^{-2}$
 25 $\frac{dy}{dx} = 3x^2 + 3x^{-4}$ 26 $\frac{dy}{dx} = 1 + x^{-2}$

EXERCISE 81*

- 1 $\frac{dy}{dx} = 3x^2 + 4x$ 2 $\frac{dy}{dx} = 3x^2 + 2$ 3 $\frac{dy}{dx} = 2x + 4$
 4 $\frac{dy}{dx} = 2x + 6$ 5 $\frac{dy}{dx} = 2x - 1$ 6 $\frac{dy}{dx} = 2x + 4$
 7 $\frac{dy}{dx} = 4x + 7$ 8 $\frac{dy}{dx} = 6x + 10$ 9 $\frac{dy}{dx} = 2x$
 10 $\frac{dy}{dx} = 2x$ 11 $\frac{dy}{dx} = 2x + 6$ 12 $\frac{dy}{dx} = 2x + 10$
 13 $\frac{dy}{dx} = 8x - 4$ 14 $\frac{dy}{dx} = 18x - 30$ 15 $\frac{dy}{dx} = 8x - 2x^{-3}$
 16 $\frac{dy}{dx} = 2x - 2x^{-3}$ 17 $\frac{dy}{dx} = -6x^{-4}$ 18 $\frac{dy}{dx} = \frac{3}{2}x^{-4}$
 19 $\frac{dy}{dx} = 8x^3 + 2x^{-3}$ 20 $\frac{dy}{dx} = 3 + x^{-2}$ 21 $\frac{dy}{dx} = 5$
 22 $\frac{dy}{dx} = 7$ 23 (3, -9) 24 (0.5, 4)
 25



- 26 A = (0.5, 4) B = (-0.5, -4)

EXERCISE 82

- 1 a $2x + 4$ b (-2, 6)
 2 a $2x + 2$ b (-1, -9)
 3 a $x = 3$ b $y = 24$
 4 a $x = -5$ b $y = 31$
 5 a 15 b 6 c $y = 6x + 9$

- 6 **a** 7 **b** 8 **c** $y = 8x - 17$
 7 **a** -1 **b** 10 **c** $y = 10x + 19$
 8 **a** 15 **b** -8 **c** $y + 8x = 7$
 9 **a** $8t + 8$ **b** 16° per minute **c** 48° per minute
 10 **a** $200t + 200$ **b** 400 voters per month
 c 1000 voters per month
 11 **a** $3x^2 - 24x$ **b** $x = 0$ or 8 **c** (0, 5), (8, -251)
 d Maximum: (0, 5), minimum: (8, -251); curve shape
 12 **a** $3x^2 - 12x$ **b** $x = 0, 4$ **c** (0, 10), (4, -22)
 d curve shape
 13 **a** $6 - 2x$ **b** (1, 20) **c** $y - 4x = 16$
 14 **a** $-4 - 2x$ **b** (1, 4) **c** $y + 6x = 10$
 15 **a** $6 - 2x$ **b** 20
 16 **a** $2x - 10$ **b** -15
 17 **a** $-2 - 2x$ **b** 9
 18 **a** $8 + 2x$ **b** -1
 19 **a** $4 - x^{-2}$ **b** $x = -\frac{1}{2}, \frac{1}{2}$ **c** $(-\frac{1}{2}, -4), (\frac{1}{2}, 4)$
 20 **a** $x^{-2} - 9$ **b** $x = -\frac{1}{3}, \frac{1}{3}$ **c** $(-\frac{1}{3}, 7), (\frac{1}{3}, -5)$

EXERCISE 82*

- 1 **a** $6x - 7$ **b** $y = 5x - 7$
 2 **a** $2x + 4x^{-2} + 1$ **b** $y = 3x + 7$
 3 **a** -1, -3 **b** $2x + 4$ **c** -2, 2
 d $y = -2x - 6$ and $y = 2x + 2$
 4 **a** -3, 1 **b** $-2 - 2x$ **c** -4, 4
 d $y = -4x + 4$ and $y = 4x + 12$
 5 Minimum at (-3, -54), maximum at (3, 54)
 6 Maximum at (0, 0), minimum at (4, -32)
 7 **a** 11 150 **b** 305 per year
 8 **a** \$490 000 **b** \$22 000 per month
 9 **a** $80 - 40t$ **b** $t = 2$ **c** 350°
 d 120° per hour
 10 **a** $6 - \frac{t}{2}$ **b** 12 minutes **c** 24 m per minute
 11 **a** $6x^2 - 2x - 4$ **b** $-\frac{2}{3}$ **c** $(-\frac{2}{3}, 11\frac{17}{27}), (1, 7)$
 d Maximum $(-\frac{2}{3}, 11\frac{17}{27})$, minimum (1, 7); curve shape
 12 **a** $6x^2 + 4x - 16$ **b** $\frac{4}{3}$ **c** (-2, 12), $(\frac{4}{3}, -25\frac{1}{27})$
 13 **a** $2x - 16x^{-2}$ **b** $x = 2$ **c** (2, 12)
 14 **a** $2x - 2x^{-3}$ **b** $x = -1, 1$ **c** (-1, 4), (1, 4)
 15 $(-\frac{1}{3}, 10\frac{5}{27}), (1, 9)$. Both y coordinates are positive
 16 $y = 3x + 5$ and $y = 3x - 5$
 17 **a** $3 - 27t^{-2}$ **b** 18°C **c** 1.92°C/month
 18 **a** $6t - 48t^{-2}$ **b** 36 **c** 21 per year
 19 40
 20 **a** $x(80 - 2x)(50 - 2x) = 4x^3 - 260x^2 + 4000x$
 b 10 **c** $60 \times 30 \times 10$: 18 000 cm^3

EXERCISE 83

- 1 $10t$
 2 $48 - 32t$
 3 **a** $40 + 10t$ **b** 70 m/s
 4 **a** $30 - 10t$ **b** 0 m/s
 5 32
 6 -32
 7 **a** $3t^2 + 8t - 5$ **b** $6t + 8$ **c** $v = 6 \text{ m/s}; a = 14 \text{ m/s}^2$

- 8 **a** $v = 3t^2 - 4t + 3$ **b** $a = 6t - 4$ **c** $v = 7 \text{ m/s}; a = 8 \text{ m/s}^2$
 9 **a** $2t + 10$ **b** 14 m/s^2
 10 **a** $6 - 2t$ **b** 2 m/s

EXERCISE 83*

- 1 **a** $v = 8t + \frac{2}{t^2}$ **b** $a = 8 - \frac{4}{t^3}$
 2 **a** $v = 6 + \frac{4}{t^2}$ **b** $a = \frac{8}{t^3}$
 3 **a** $20 + 10t$ **b** 30 m/s, 40 m/s, 50 m/s **c** 10 m/s^2
 4 **a** $8t + 5$ **b** 13 m/s, 21 m/s, 29 m/s **c** 8 m/s^2
 5 **a** $40 - 10t$ **b** 30 m/s, 20 m/s, 10 m/s, 0 m/s **c** 80 m
 6 **a** $25 - 2t$ **b** 12.5 **c** 156.25 m
 7 **a** $\frac{ds}{dt} = -2 + \frac{18}{t^2}; \frac{dv}{dt} = -\frac{36}{t^3}$ **b** 3 s **c** 28 m
 8 $\frac{ds}{dt} = -t + \frac{8}{t^2}; \frac{dv}{dt} = -1 - \frac{16}{t^3}$ **b** 7 m/s **c** 2 s **d** 44 m
 9 **a** 8 s **b** 3 s **c** 170 m
 10 **a** 5 s **b** 50 m

REVISION EXERCISE 84

- 1 $\frac{dy}{dx} = 5x^4 + 6x^2$
 2 $\frac{dy}{dx} = 3x^2 + 4x - 1$
 3 **a** $y = 4; \frac{dy}{dx} = 3$ **b** $y = 3x - 5$
 4 -1
 5 **a** $3x^2 + 6x - 9$ **b** $x = 1, -3$
 c Maximum (-3, 32), minimum (1, 0)
 6 **a** $v = 9t^2 - 4; a = 18t$ **b** $t = \frac{2}{3} \text{ s}$

REVISION EXERCISE 84*

- 1 $\frac{dy}{dx} = 8x^3 - 6x$
 2 20
 3 0
 4 **a** $\frac{dy}{dx} = 4 - 2x$ **b** $y = 2x + 2; y = -4x + 17$
 c (2.5, 7)
 5 **a** $\frac{dy}{dx} = 6x^2 + 6x - 36$ **b** (-3, 81), (2, -44)
 6 **a** 1600 hairs per year **b** 2000 hairs per year **c** 40 years
 7 **a** $v = 3t^2 + 5; a = 6t$ **b** 18, 42 **c** 32 m/s

SHAPE AND SPACE 4

ACTIVITY 22

Sine ratio

x	36°	72°	108°	144°	180°
$\sin x$ (calc)	0.588	0.951	0.951	0.588	0
$\sin x$	0	0.2	0.5	0.8	1
x (calc)	0°	11.5°	30°	53.1°	90°

Cosine ratio

x	36°	72°	108°	144°	180°
$\cos x$ (calc)	0.809	0.309	-0.309	-0.809	-1
$\cos x$	0	0.2	0.5	0.8	1
x (calc)	90°	78.5°	60°	36.9°	0°

Tangent ratio

x	0°	60°	85°	95°	180°
$\tan x$ (calc)	0	1.73	11.4	-11.4	0
$\tan x$	0	0.5	5	10	-10
x (calc)	0°	26.6°	78.7°	84.3°	-84.3°

EXERCISE 85

- 1** $x = 17.5^\circ, 163^\circ$ **2** $x = 44.4^\circ, 136^\circ$ **3** $x = 72.5^\circ$
4 $x = 53.1^\circ$ **5** $x = 71.6^\circ$ **6** $x = 63.4^\circ$
7 no solution **8** $x = 127^\circ$ **9** $x = 198^\circ$
10 no solution **11** $x = 108^\circ$ **12** $x = 117^\circ$

EXERCISE 85*

- 1** $x = 27.4^\circ, 153^\circ$ **2** $x = 44.4^\circ, 135.5^\circ$
3 No solutions for $0^\circ \leq x \leq 180^\circ$
4 No solutions for 0° to 180°
5 $x = 75.5^\circ$ **6** $x = 50.2^\circ$ **7** $x = 112^\circ$
8 $x = 147^\circ$ **9** $x = 67.9^\circ$ **10** $x = 34.2^\circ$
11 $x = 125^\circ$ **12** $x = 144^\circ$

EXERCISE 86

- 1** $x = 5.93$ cm **2** $y = 11.1$ cm **3** $MN = 39.0$ cm
4 $RT = 8.75$ cm **5** $AC = 37.8$ cm **6** $YZ = 33.0$ cm
7 $x = 37.3^\circ$ **8** $y = 37.8^\circ$ **9** $\angle ABC = 38.8^\circ$
10 $\angle XYZ = 26.0^\circ$ **11** $\angle ACB = 62.2^\circ$ **12** $\angle DCE = 115^\circ$

EXERCISE 86*

- 1** $x = 29.7$ cm **2** $y = 8.35$ cm **3** $\angle LMN = 67.4^\circ$
4 $\angle RST = 71.9^\circ$ **5** $EF = 10.4$ cm, $\angle DEF = 47.5^\circ$, $\angle FDE = 79.0^\circ$
6 $MN = 10.8$ cm, $\angle MLN = 68.3^\circ$, $\angle LNM = 49.7^\circ$
7 13 km **8** 388 m **9** $BC = 261$ km
10 $XY = 3.26$ km **11** $PR = 115$ m, 112 m
12 $YT = 53.3$ m, 17.35 m

EXERCISE 87

- 1** $x = 7.26$ cm **2** $b = 8.30$ cm **3** $AB = 39.1$ cm
4 $AB = 32.9$ cm **5** $RT = 24.2$ cm **6** $MN = 6.63$ cm
7 $X = 73.4^\circ$ **8** $Y = 70.5^\circ$ **9** $\angle ABC = 92.9^\circ$
10 $\angle XYZ = 110^\circ$

EXERCISE 87*

- 1** $x = 9.34$ **2** $y = 13.3$ **3** $\angle XYZ = 95.5^\circ$
4 $\angle ABC = 59.0^\circ$ **5** $\angle BAC = 81.8^\circ$ **6** $\angle RST = 27.8^\circ$
7 $QR = 4.18$ cm, $\angle PQR = 39.2^\circ$, $\angle QRP = 62.8^\circ$
8 $LM = 11.4$ cm, $\angle NLM = 35^\circ$, $\angle LMN = 28^\circ$
9 11.6 km
10 **a** $VWU = 36.3^\circ$ **b** 264°

EXERCISE 88

- 1** **a** 9.64 **b** 38.9°
2 **a** 6.6 **b** 49.3°
3 **a** 54.9° **b** 92.1° **c** 33.0°
4 **a** 24.1° **b** 125.1° **c** 30.8°
5 **a** 7.88 **b** 6.13
6 **a** 4.1 **b** 4.9
7 **a** 79.1° **b** 7.77
8 **a** 44.7° **b** 4.1

- 9** **a** 16.8 km **b** 168°
10 **a** 8.9 km **b** 062.9°

EXERCISE 88*

- 1** 247 km, 280°
2 14.7 km/h, 088.9°
3 **a** 50.4° **b** 7.01 m **c** 48.4°
4 $x = 5.3$ cm, $y = 8.7$ cm
5 $\angle BXA = 75.9^\circ$
6 $BC = 23.4$ km, 186.3°
7 $CS = 2.64$ km, 040.2°
8 **a** 38.1° **b** 29.4 cm
9 **a** 20.9 cm **b** 38.6°
10 9.2 cm
11 32°

EXERCISE 89

- 1** 7.39 cm² **2** 29.7 cm² **3** 36.2 cm²
4 8.46 cm² **5** 121 cm² **6** 77.0 cm²

EXERCISE 89*

- 1** 173 cm² **2** 48.1 cm **3** 16.5 cm
4 64.3° **5** 53.5 cm² **6** 65.8 cm

EXERCISE 90

- 1** **a** 11.7 cm **b** 14.2 cm **c** 34.4°
2 **a** 18.6 cm **b** 28.1 cm **c** 48.5°
3 **a** 14.1 cm **b** 17.3 cm **c** 35.3°
4 **a** 28.3 cm **b** 34.6 cm **c** 35.1° **d** 19.5°
5 **a** 4.47 m **b** 4.58 m **c** 29.2° **d** 12.6°
6 **a** 407 m **b** 402 m **c** 8.57° **d** 13.3°
7 **a** 43.3 cm **b** 68.7 cm **c** 81.2 cm
8 **a** 28.9 cm **b** 75.7 cm **c** 22.4°

EXERCISE 90*

- 1** **a** 16.2 cm **b** 67.9° **c** 55.3 cm²
2 **a** 26.5 cm **b** 61.8° **c** 1530 cm²
3 **a** 30.3° **b** 31.6° **c** 68.9°
4 **a** 36.9° **b** 828 cm²
5 **a** 15 m **b** 47.7° **c** €91 300
6 **a** 66.4° **b** 32.9°
7 46.5 m
8 **a** $OW = 4290$ m, $OS = 2760$ m
b 36.0° **c** 197 km/h

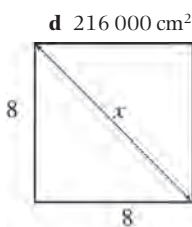
REVISION EXERCISE 91

- 1** **a** 22.9° **b** 22.9
2 148 cm²
3 **a** $50^\circ, 60^\circ, 70^\circ$ **b** $AB = 4.91$ km
4 $\angle A = 22.3^\circ$
5 **a** $AC = 42.4$ cm **b** 33.9 cm **c** 68.0° **d** 58.0°
6 **a** 18.4° **b** 500 m **c** 11.3°

REVISION EXERCISE 91*

- 1** $BH = 506$ m
2 6.32 cm and 9.74 cm

- 3 One diagonal is $\sqrt{(a^2 + b^2)}$ and the height is c so using Pythagoras the long diagonal = $\sqrt{(\sqrt{(a^2 + b^2)})^2 + c^2} = \sqrt{(a^2 + b^2 + c^2)}$
- 4 4.68 m^2
- 5 a $AC = 70.7 \text{ cm}$ b 98.7 cm c 27.9°
- 6 a x is the length of the diagonal of the square that is the bottom face of the cube.
Using Pythagoras
 $x^2 = 8^2 + 8^2$
 $= 128$
 $x = \sqrt{128} = \sqrt{64 \times 2} = \sqrt{64} \times \sqrt{2} = 8\sqrt{2}$
- b 36.9°



HANDLING DATA 4

EXERCISE 92

- 1 a 0.655 b 0.345
- 2 a 0.1 b 0.7 c 0.36 d 0.147
- e 0.441
- 3 a $\frac{1}{36}$ b $\frac{5}{18}$
- 4 a (i) $\frac{1}{15}$ (ii) $\frac{1}{15}$ (iii) $\frac{1}{30}$
- b $\frac{104}{105}$
- 5 a $\frac{2}{9}$ b $\frac{5}{9}$ c $\frac{1}{9}$
- 6 a $\frac{2}{15}$ b $\frac{5}{21}$ c $\frac{41}{441}$

EXERCISE 92*

- 1 a $\frac{1}{11}$ b $\frac{1}{3}$ c $\frac{3}{11}$ d $\frac{9}{55}$
- 2 a $\frac{19}{66}$ b $\frac{13}{33}$ c $\frac{15}{22}$
- 3 a $\frac{1}{16}$ b $\frac{1}{4}$ c $\frac{15}{16}$
- 4 a 0.6 b 0.025 c 0.725
- 5 a $p(RR) = \frac{3}{5} \times \frac{5}{9} = \frac{1}{3}$

Outcome		Probability
Bag X	Bag Y	
4R + 4W	5R + 5W	$\frac{1}{3}$
5R + 3W	4R + 6W	$\frac{8}{15}$
6R + 2W	3R + 7W	$\frac{2}{15}$

- c (i) $p(i) = p(WY \rightarrow X) = \frac{1}{3} \times \frac{1}{2} = \frac{1}{6}$
- (ii) $p(ii) = p(RY \rightarrow X) = \frac{2}{15} \times \frac{3}{10} = \frac{1}{25}$
- (iii) $p(iii) = p(RY \rightarrow X \text{ or } WY \rightarrow X) = \frac{8}{15} \times \frac{4}{10} + \frac{2}{15} \times \frac{7}{10} = \frac{23}{75}$
- (iv) $p(iv) = p(RY \rightarrow X \text{ or } WY \rightarrow X) = \frac{1}{3} \times \frac{1}{2} + \frac{8}{15} \times \frac{6}{10} = \frac{73}{150}$
- 6 a $\frac{6}{11}$ b $\frac{5}{11}$

ACTIVITY 24

It is important to tell the respondents that they should keep their die score secret and to tell the truth to all the questions. Clearly, the greater the sample the more likely the chance of the final results reflecting those of the parent population. Suggestions for possible questions:
Do you like mathematics?
Have you ever played truant from school?
Have you ever cheated in a test at school?

INVESTIGATE

Obviously the answers to both situations could be guessed by knowing the probabilities. These investigations are to try to prove the results practically. Also, an IT application should be used to simulate a larger sample than can be generated manually and to find the sum of an infinite series!

For one die, practically, simply use

$$\bar{x} = \frac{\sum fx}{\sum f}$$

Theoretically, the frequencies that arise are directly related to their associated probabilities. So, given that f is equivalent to the probability of x occurring, p , we can write down:

$$\begin{aligned}\bar{x} &= \frac{\sum px}{\sum p} = \sum px \text{ as } \sum p = 1 \\ &= \frac{1}{6} \times 1 + \frac{5}{6} \times \frac{1}{6} \times 2 + \frac{5}{6} \times \frac{5}{6} \times \frac{1}{6} \times 3 + \dots\end{aligned}$$

This can be investigated using a spreadsheet. The theoretical proof is an infinite geometric progression, which requires subtle manipulation!

The result is $\bar{x} = 6$.

For two dice, practically, this data collection will prove too tedious. A computer simulation would prove a better use of time.

Again, using the same logic as above

$$\begin{aligned}\bar{x} &= \frac{\sum px}{\sum p} = \sum px \text{ as } \sum p = 1 \\ &= \frac{1}{36} \times 1 + \frac{35}{36} \times \frac{1}{36} \times 2 + \frac{35}{36} \times \frac{35}{36} \times \frac{1}{36} \times 3 + \dots\end{aligned}$$

This can be investigated using a spreadsheet. The theoretical proof is again an infinite geometric progression, which requires subtle manipulation.
The result is $\bar{x} = 36$.

REVISION EXERCISE 93

- 1 a (i) $\frac{4}{9}$ (ii) $\frac{4}{9}$ b $\frac{7}{27}$
- 2 a 0.36 b 0.42 c 0.256
- 3 a $\frac{6}{25}$ b $\frac{19}{25}$ c $\frac{12}{43}$ d $\frac{31}{43}$ e 0.320
- 4 a 0.1 b 0.3 c 0.69
- 5 a 0.9 b 0.1 c 0.35

REVISION EXERCISE 93*

- 1 a $\frac{48}{125}$ b $\frac{12}{125}$ c $\frac{61}{125}$
- 2 a 0.614 b 0.0574 c 0.0608
- 3 a $\frac{19}{45}$ b (i) $\frac{2}{15}$ (ii) $\frac{8}{105}$
- 4 $0.243 = 3p(1-p)^2, \therefore p = 0.1$
- 5 a (i) $\frac{9}{16}$ (ii) $\frac{7}{16}$ b $\frac{1}{4}$

EXAMINATION PRACTICE 4

- 1 **a** R **b** I **c** R **d** R **e** R
- 2 **a** The easiest examples are the square roots of any prime between 25 and 36 or $\sqrt{26}$, $\sqrt{27}$, $\sqrt{28}$, etc.
b For example 1.732 and 2.236
- 3 **a** $5\sqrt{2}$ **b** 18 **c** 12 **d** $2\sqrt{2}$
- 4 **a** $4\sqrt{3}$ **b** $6\sqrt{3}$ **c** $5\sqrt{2}$ **d** $\frac{3}{2}$
- 5 **a** $21 + 12\sqrt{3}$ **b** -3
- 6 **a** $\frac{1}{2}\sqrt{2}$ **b** $2\sqrt{3}$
- 8 **a** $x + 1$ **b** x **c** $\frac{(x+2)}{2}$
- 9 **a** $x + 3$ **b** $\frac{(x+2)}{(x-2)}$ **c** $\frac{(x-1)}{(x+2)}$
- 10 **a** $\frac{x}{6}$ **b** $\frac{(x+5)}{12}$ **c** $\frac{(x-2)}{2}$
- 11 **a** $\frac{1}{2x}$ **b** $\frac{5}{(x-2)(x+3)}$ **c** $\frac{-1}{(x+1)(x-4)}$
- 12 **a** -7 **b** 4 **c** 2
- 13 **a** -3 or 2 **b** $\frac{1}{3}$ or 2 **c** -2.24 or 6.24
- 14 **a** $\frac{dy}{dx} = 6x^2 - 12x$ **b** $\frac{dy}{dx} = 6x^2 - 2x + 2$ **c** $\frac{dy}{dx} = 2x - 1 - \frac{2}{x^3}$

- 15 **a** $\frac{dy}{dx} = x^2 + 2x - 7$ **b** $(-4, 17\frac{2}{3}), (2, -12\frac{1}{3})$
- 16 **a** Minimum **b** Intersections at (2, 0), (6, 0), (0, 12)
- 17 **a** $v = 40 - 10t$ **b** $t = 4$ s **c** 80 m
- 18 10.4 cm, 35.5°
- 19 **a** 47.1° **b** 131 cm^2
- 20 **a** 43.3 cm **b** 35.3°
- 21 61.1°
- 22 17.4 times
- 23 Let p = no pink beads
 $P(\text{Two pink beads}) = \frac{p}{10} \times \frac{p-1}{9} = \frac{2}{15}$
then,
 $p(p-1) = 12$
 $p^2 - p - 12 = 0$
 $(p+3)(p-4) = 0$
 $p = 4$ i.e. there are 4 pinks!
 $P(\text{At least 1 pink}) = 1 - P(\text{No pinks})$
 $= 1 - P(\text{Two whites})$
 $= 1 - P(\text{WW})$
 $= 1 - \frac{6}{10} \times \frac{5}{9} = \frac{2}{3}$

Unit 5

NUMBER 5

REVISION EXERCISE 94

- 1 a $\frac{7}{12}$ b $1\frac{1}{3}$ c 24 d 12
- 2 a 9 b $1\frac{22}{35}$
- 3 14.235, 14.25, 14.3, 14.532
- 4 $3^3 \times 5 \times 7$
- 5 a $504 = 2^3 \times 3^2 \times 7$ b LCM = 210 HCF = 3
- 6 a $\frac{34}{99}$ b 0.375 c \$1.12 d 2
- 7 $\frac{181}{333}$
- 8 a 29 581 mph b 26 733 mph
- 9 49.3
- 10 a 10^3 b 2×10^{10} c 7×10^{-5} d 6×10^{-3}
- 11 a 37.625 b 37.62 c 1.398 d 1.40
- 12 a 52.4 b 0.57 c 38 500 d 0.0026
- 13 a 5×10^4 b 4×10^1
- 14 a $0.351; \frac{1}{3}$ b 5.93; 7 c 1.52; 1
- 15 3.05×10^{-3} mm
- 16 8.57
- 17 a 16 b $\frac{1}{3}$ c $\frac{1}{4}$ d 9
- 18 a 0.5 or $\frac{1}{2}$ b 5 c 0.5 or $\frac{1}{2}$
- 19 a $4\sqrt{3}$ b 1 c 12
- 20 a $\sqrt{24}$ b $5\sqrt{5}$ c $\sqrt{5}$ d $\frac{2\sqrt{2}}{2}$
- 21 a \$68 000 b 5.9%
- 22 a 41.0 m b 39.0 m
- 23 a 9.39 billion people b 1.40%
- 24 a 655 m^2 b 536 m^2
- 25 3.2 kg
- 26 \$11.06
- 27 45%
- 28 \$670
- 29 15%
- 30 a 3.2×10^{15} molecules b 1 cell/mm³
- 31 a 329 blocks b 820 tonnes c 12.5 ears
- 32 a 10.5 days b 4.55 km
- 33 a 8565 gallons/s b $39 \text{ m}^2/\text{s}$
- 34 2000
- 35 6429 dominos
- 36 \$15.20: \$11.40
- 37 \$408
- 38 a €89.7 b €71.07
- 39 a \$5.29 b \$4.36
- 40 a \$2400 b \$2404.68

REVISION EXERCISE 94*

- 1 $\frac{2}{3} = \frac{24}{36}, \frac{13}{18} = \frac{26}{36}, \frac{3}{4} = \frac{27}{36}, \frac{14}{18} = \frac{28}{36}$
- 2 a $180 = 2^2 \times 3^2 \times 5, 84 = 2^3 \times 3 \times 7$
b LCM = 1260 HCF = 12
- 3 $\frac{8}{37}$

- 4 a 8×10^{-3} b 9×10^{-3}
- 5 a 0.0116%
b ... about one part in 10 000
- 6 24
- 7 a 6.4 b 2.8
- 8 a 93.5 cm b 73.2 cm
- 9 a $a^4, a = 2$ b $a^{-1}, a = 8$ c $2a^{-2}, a = \frac{1}{4}$
- 10 a 216 b 13 c 27
- 11 a $\frac{5\sqrt{2}}{2}$ b $3(2 - \sqrt{3})$
- 12 1.5
- 13 $\sqrt{10}$ or $\sqrt{11}$ or $\sqrt{12}$ or $\sqrt{13}$ or $\sqrt{14}$ or $\sqrt{15}$
- 14 1.95
- 15 a 0.0290 b 0.409% c 4.07; 3
- 16 a 2.41; 2.5 b 48.2; 48
- 17 30 tonnes
- 18 48 kph
- 19 a 33.3% b (i) 38.5°C (ii) 37°C
- 20 €9.98
- 21 €146 625
- 22 20%
- 23 149 million (3 s.f.)
- 24 9 metres
- 25 a 16.4 cm/day b $4.17 \times 10^{10} \text{ m}^3$ c 110 m
- 26 160
- 27 5.50 g/cm^3
- 28 3.6 km/h
- 29 112 mph
- 30 a 19 230 769 b 520 m

ALGEBRA 5

REVISION EXERCISE 95

- 1 a x^{10} b x^2 c y^2 d $4x^6y^4$
- 2 a $x^2 + 2x - 3$ b $2x^2 + 7x - 4$
- 3 a $z^2 + 3z$ b $14 - x$
- 4 a $4(p - 2)$ b $x(x + 3)$ c $3ab(b + 2a)$
- 5 a $(x + 2)(x - 2)$ b $(x + 1)(x + 2)$
- 6 a $\frac{7x}{12}$ b $\frac{(x + 1)}{6}$
- 7 a $v - \frac{I}{m}$ b $\sqrt{\frac{12}{\pi h}}$
- 8 a -14 b $\frac{(v - u)}{t}$
- 9 a 3.14 b $g\left(\frac{T}{2\pi}\right)^2$
- 10 a \$114 b $C = 30 + 0.15t$ c $\frac{C - 30}{0.015}$
- 11 a 3 b 2 c 2
- 12 a 3 b 5
- 13 a $5(x + 3) - 8 = 42$ b 7
- 14 15
- 15 $x = 6, y = 3; 216 \text{ cm}^2$
- 16 a $y = 4x$ b 8 c 2
- 17 a $y = 3x^2$ b 48 c 3
- 18 a $y = \frac{24}{x}$ b 12 c 4
- 19 a $y = \frac{36}{\sqrt{x}}$ b 12 c 16
- 20 (3, 5)

21 a $x + y = 17$, $4x + 2y = 58$

22 (3, 4), (-4, -3)

23 -1.78, 0.281

24 (1, 2), (-2, -1)

25 a Area = $x(x + 4) = 32$

$x^2 + 4x = 32$

$x^2 + 4x - 32 = 0$

b -8, 4

c 24 cm

26 $x = 5$, area 48

27 a $x > 1$

b $x \geq 3$

28 -2, -1, 0, 1

29 a $-3 < x < 3$

b $-2 \leq x \leq 1$

30 a (i) 4

(ii) $\frac{(x+2)}{3}$

(iii) $9x - 8$

b 3

c 1

31 a (i) 5

(ii) 4

(iii) $\frac{2}{5}$

b -3

c -1

32 a No

b (i) all reals

(ii) $y \geq 0$

c (i) 3

(ii) $x^2 - 1$

d 0, 3

b 5

b -6, 4

c 5

23 (2, -1), (-7, 4)

24 (3, 1), (2, -1)

25 (1, 2.5), (4, 1)

26 a (3, 4)

b tangent

27 a (0.911, 0.823), (-0.411, -1.823)

b (-0.911, 0.823), (0.411, -1.823)

28 -1, 0, 1, 2

29 a $x < -4$ or $x > 4$

b $0 < x < 16$

30 a $1 \leq x \leq 3$

b $x < -1$ or $x > 2$

31 a $x > -\frac{1}{3}$

b $x \leq 2$

32 a $2.5x + 3 > 3x$, $4x + 1 > 1.5x + 2$, $4.5x + 2 > x + 1$

b $\frac{2}{5} < x < 6$

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

b -1

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

d $-\frac{5}{2}$

34 a -2

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

c -1 or 0

35 a $x \geq -2$

b (i) $2 + x$

(ii) $\sqrt{2 + x^2}$

c all real numbers

d -1, 2

REVISION EXERCISE 95*

1 a $\frac{11a}{12}$

b $\frac{3}{8}$

c b

d $\frac{(21-2x)}{15}$

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

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

3 a $x + 1$

b x

4 a $(x-9)(x+8)$

b $\frac{(x+9)}{(x+8)}$

5 a $(3x-1)(x+11)$

b $\frac{(3x-1)}{(x-11)}$

6 a $\frac{(2x-7)}{(x-3)}$

b $\frac{2(x+2)}{x+1}$

7 a 27.6

b $a = \sqrt{\left(\frac{3I}{M} - b^2\right)}$

8 a 3024

b $\frac{2(S-an)}{n(n-1)}$

9 a $\frac{15}{8}$

b $u = \frac{fv}{(v-f)}$

c 12

10 -1

11 $\frac{x+123}{x+456} = \frac{1}{2}$, 210

12 a $(160^\circ - 3x)$

b $x = 20^\circ, 32^\circ, 35^\circ$

13 a $x^2 + 25 = l^2$

b $(x+2)^2 + 16 = l^2$

c 5.15 m to 3 s.f.

14 a $v = 2\sqrt{d}$

b 14 m/s

c 25 m

15 a $y - \frac{40}{x^2}$

b 640

c 12.6

16 a $T = \frac{120}{\sqrt{m}}$

b 40

c 5.76 min

17 $x = 2$, $y = 1$

18 a $2x + 3y = 180$

b $2x + 2y = 140$

c $x = 30$, $y = 40$

19 a $x + y = 14$, $12x + 18y = 204$

b $x = 8$, $y = 6$

20 a $x^2 - 2x - 3 = 0$

b $x = -1$ or $x = 3$, $\therefore 3, 4, 5$ triangle

21 b -8, 2

c 6

22 a $(x-1)(x+1) + \frac{1}{2}((x+5) - (x+1))(x+1) = 21$

$x^2 - 1 + 2x - 2 = 21$

$x^2 + 2x - 24 = 0$

GRAPHS AND SEQUENCES 5

REVISION EXERCISE 96

1 a 27, 33, 39

b 297

c $6n - 3$

2 a 16, 22, 29

b $a = -5$, $b = 30$

3 a 30 terms

b $a = 3$

4 a

Number of white tiles (w)	1	2	3	4	5
Number of blue tiles (b)	8	10	12	14	16

b $b = 2w + 6$

c 56 blue tiles

d 60 white tiles

5 a 1, 4, 8, 13, 19, 26

b Add one more than before

c Size 12

6 a (i)

b (iii)

c (iv)

d (ii)

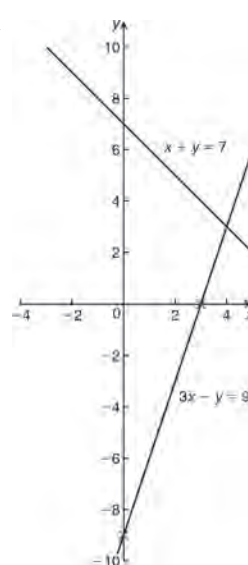
7 a AB, $\frac{1}{2}$:BC, $-\frac{3}{4}$:AC, -2

b AB perpendicular to AC

c $AB = \sqrt{5}$, $BC = \sqrt{25}$

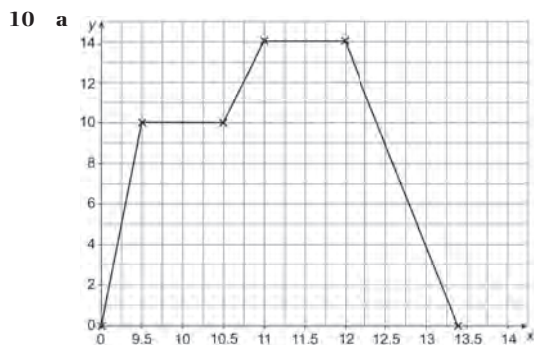
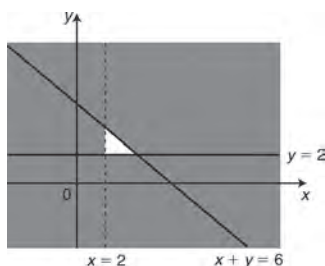
d Area = 5 units squared

8 a



b $x = 4$, $y = 3$

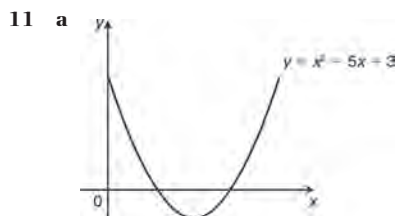
9



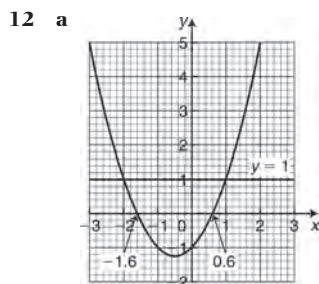
b 8 km/h

c 13:24

d $11\frac{2}{3}$ km/h



b $x \approx 0.7, x \approx 4.3$



b $x = -1.6$ or 0.6

c $x = -2, x = 1$

d -1.25

13 a $y = 1$

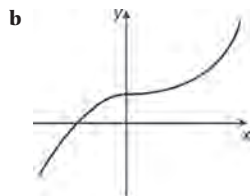
b $y = x + 2$

14 a $x^2 - 4x + 2 = 0$

b $x = 0.6$ or $x = 3.4$

15 a

x	-2	-1	1	2	3
y	-3	2	6	17	42

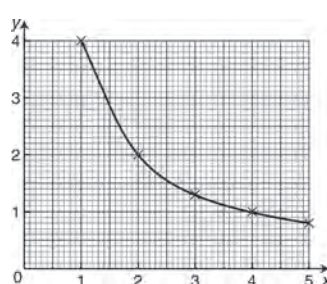


c 6

16 a

x	1	2	3	4	5
y	4	2	$1\frac{1}{3}$	1	0.8

b



17 a $2x$

b 3

c $3x^2 + 6x$

18 a 7

b 24

c 0

19 a $2x - 4$

b $x = 2, y = -3$

c $(2, -3)$ is a minimum

20 a 13 m/s

b 4 m/s^2

REVISION EXERCISE 96*

1 a 185, 181, 177

b 5

c $205 - 4n$

2 a 62, 82, 105

b $a = 1, b = 91$

3 a 20 terms

b $a = 2, b = 1$

4 a $w = 5c + 1$

No. of cells (c)	1	2	3	4	5
No. of walls (w)	6	11	16	21	26

b

No. of rows (r)	1	2	3	4	5
No. of cells (c)	1	3	6	10	15
No. of walls (w)	6	15	27	42	60
$r + c$	2	5	9	14	20

c $w = 3(r + c)$

d $w = \frac{1}{2}(3r^2 + 9r)$

e 195 walls

5 a A: $y + 2x = 4$

B: $y = x$

C: $2y = x + 4$

D: $y + 2x = -2$

b same gradient; -2

6 a m is gradient, c is y -intercept

b $y = x - 3$

7 $x + y = 5$ and $y - 2x = 2$

8 a

x	0	4	8	12	16	20
y	0	8.8	11.2	7.2	-3.2	-20

b 31.3 m

c 15 m

9 a (iii)

b (ii)

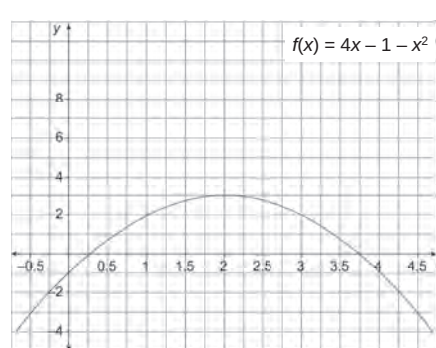
c (iv)

d (i)

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

b $x = -0.86$ or $x = -0.75$ or $x = 3.12$

11 a



b $x \approx 4.24$ or $x \approx -0.24$

c $x \approx 4.30$ or $x \approx 0.70$

12 a $y = 3$

b $y = 2 - 2x$

13 a 7.04 m/s

b 8.20 m/s

c 2.05 m/s

d No. Sidd takes 15 s to run 100 m so gets beaten by 0.8 s.

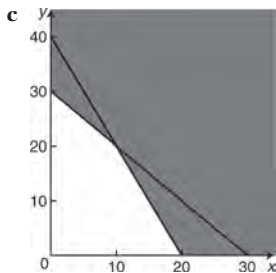
14 a	t (s)	0	2	4	6	8	10
	d (m)	86.6	55.5	36.3	22.3	10.6	0

b Graph shows that hare's speed is very gradually decreasing as it reaches the bush.

c Gradient at $t = 6$ s is approx. -6.25 m/s: Velocity.

15 a 1.2 m/s^2 **b** 2.4 m/s^2 **c** 15 m/s

16 a $x + y \leq 30$ **b** $50x + 25y \leq 1000$



c $(10, 10)$ and $(10, 20)$
10 peak and 20 off-peak recommended as it costs exactly £10.

17 a $2 - \frac{3}{x^2}$ **b** $8x + 4$ **c** $\frac{4}{x^3}$

18 min at $(3, 6)$; max at $(-3, -6)$

19 a Long side of fence = $150 - x - x = 150 - 2x$
Area = long side $\times$ short side = $x(150 - 2x)$

b $\frac{dA}{dx} = 150 - 4x$, $A_{\max} = 2812 \text{ m}^2$, $x = 37.5 \text{ m}$

20 a $t = 0.5$, $t = 4$ **b** 3 m/s^2

SHAPE AND SPACE 5

REVISION EXERCISE 97

- 1 b** 215 km
- 2 a** $(3, -5)$ **b** $(5, -3)$ **c** $(-1, 9)$ **d** $(7, 5)$
- 3 a** $(-1, -1)$, $(1, -1)$, $(1, -2)$
b $(-4, 3)$, $(-4, 5)$, $(-3, 5)$
c Rotation $+90^\circ$ about the point $(-4.5, -1.5)$
- 4 a** 026.6° **b** 206.6°
- 5** $p = 5.40 \text{ cm}$, $q = 11.9 \text{ cm}$, $r = 65.4^\circ$, $s = 41.8^\circ$
- 6** $x = 15$; $y = 4$
- 7 a** $160^\circ - 7x$
b $4x = 3x + 20^\circ$, $4x = 160^\circ - 7x$, $160^\circ - 7x = 3x + 20^\circ$
c $x = 20^\circ$, 14.5° , 14°
- 8 a** 45° **b** 1080°
c each interior angle has size 135° , $\frac{360}{135}$ does not give a whole number
- 9 a** 2.4 cm **b** $1\frac{1}{3} \text{ cm}$
- 10 a** $\frac{h + OT}{OT} = \frac{2r}{r}$, $\therefore 2 \times OT = h + OT$ and $OT = h$
b $V = (\frac{1}{3} \times \pi r^2 \times 2h) - (\frac{1}{3} \times \pi r^2 \times h)$
 $= \frac{8\pi r^2 h}{3} - \frac{\pi r^2 h}{3} = \frac{7\pi r^2 h}{3}$
c $V = 7.3304r^2 h$ **d** $r = 1.68 \text{ cm}$
- 11** 6200 cm^3
- 12** 11 cm
- 13 a** $x = 100^\circ$, $y = 90^\circ$ **b** $x = 70^\circ$, $y = 76^\circ$
c $x = 110^\circ$, $y = 35^\circ$ **d** $x = 65^\circ$, $y = 35^\circ$
- 14 a** $x = 25^\circ$, $y = 65^\circ$, $z = 115^\circ$ **b** triangle ECF

- 15 a** $\angle TPQ = 66^\circ$ (triangle TPQ is isosceles)
 $\angle OPT = 90^\circ$ (TP is tangent)
 $\therefore \angle QPO = 24^\circ$
b $OPS = 42^\circ$ (isosceles triangle)
 $\therefore \angle QPS = 66^\circ$
c $\angle QRS = 114^\circ$ (opposite angles of a cyclic quadrilateral)

16 $(\frac{-2}{10})$; $(\frac{1}{8})$; $(\frac{3}{-2})$; 11.4

17 $\overrightarrow{AB} = \mathbf{y} - \mathbf{x}$; $\overrightarrow{OM} = \frac{1}{2}(\mathbf{x} + \mathbf{y})$; $\overrightarrow{OM} = \frac{1}{2}(\mathbf{y} - \mathbf{x})$
 $\overrightarrow{MN} = -\mathbf{x}$ ($\overrightarrow{MN}$ is parallel to AC)

18 $x = 8.7$; $y = 43.4^\circ$, $z = 73.4^\circ$

19 a SA = 2.63 km, BS = 6.12 km **b** 28 min 5 sec

20 a PQ = 8.7 m **b** QR = 5 m **c** RS = 8.4 m

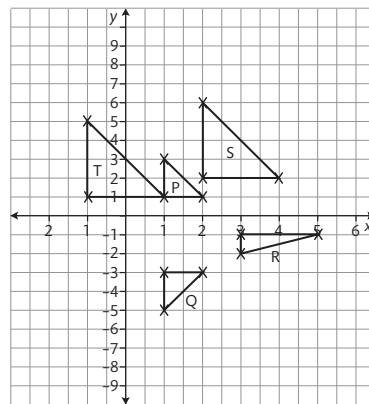
d Area PQRS = $63.8 \text{ m}^2 = 60 \text{ m}^2$ (to 2 s.f.)

21 a 40 m **b** 26.5 m **c** 4.68 m

22 a 25.5 cm **b** 27.3 cm **c** 21.4°

REVISION EXERCISE 97*

- 1 a** PQ = 10.7 m **b** QR = 9 m **c** RS = 8.1 m
d Area PQRS = $104.8 \text{ m}^2 = 105 \text{ m}^2$ (to 3 s.f.)
- 2 a** $x = 29.7^\circ$, $y = 1.2$ **b** $x = 61.1^\circ$, $y = 23.2$
c $x = 40.3^\circ$, $y = 16.5$
- 3 a** CP = 30 m **b** QB = 4 m **c** 10 m
- 4 a** BC = 1.81 m; 10.1 m
b No, because the gap when $b = 35^\circ$ is 5.43 m
- 5** $x = 6\frac{2}{3}$, $y = 9$
- 6 a** OBA, OAC **b** $2\frac{1}{2}$ (2.08) **c** 13
- 7 a, b**



- c** 90° clockwise around $(1, -1)$ **d** Scale factor = 2, centre $(3, 1)$
- 8 a** $V = \pi R^2 h - \pi r^2 h = \pi h(R^2 - r^2) = \pi h(R - r)(R + r)$
b 5280 cm^3 **c** $h = 4.5 \text{ cm}$
- 9** Perimeter = $18(1 + \sqrt{3}) \text{ cm}$
- 10 a** 8π **b** 4 cm **c** 9.2 cm **d** $r = \sqrt[3]{36.8} \text{ cm}$
- 11** $x = y = 51^\circ$, $z = 78^\circ$
- 12 a** $AB = 2r$ **b** $\frac{s}{360} \times 2\pi r$, $\therefore s = 114.6^\circ$ **c** $0.545r^2$
- 13 a** $x^2 + 2x - 24 = 0$ **b** $x = 4 \text{ cm}$ **c** 4.90 cm
- 14 (i)** **a** 100° **b** 80°
(ii) $\angle TQX = \angle QPX$ (angles in alternate segments)
 $\therefore \angle XQA = \angle QPB$
 $\angle QAB = \angle QPB$ (angles in same segment)
 $\therefore XQ$ is parallel to AB
- 15** 5 cm
- 16 a** $\sqrt{13}$ or 3.6 **b** $p = 1$, $q = 2$
- 17 a (i)** $\frac{1}{2}\mathbf{b}$, $\frac{1}{2}\mathbf{a}$ **(ii)** $\frac{1}{2}\mathbf{a} - \frac{1}{2}\mathbf{b}$

(iii) $a + \frac{1}{2}c, \frac{1}{2}a + \frac{1}{2}b + \frac{1}{2}c$

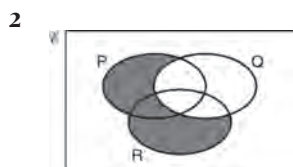
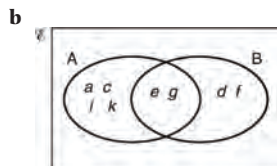
(iv) $\frac{1}{2}a - \frac{1}{2}b$

- 18 a 5.8 cm b 2.9 cm c 8.2 cm
 19 a CD = 14.4 m b CE = 142 m c 12.7 m/s
 20 a $h = 2$ m b π m/s c $\frac{1}{2}\pi$ m/s, so 50% decrease

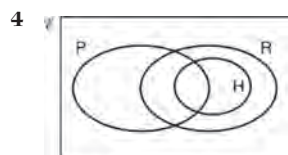
HANDLING DATA 5

REVISION EXERCISE 98

- 1 a (i) $A \cap B = \{e, g\}$
 (ii) $A \cup B = \{a, c, d, e, f, g, i, k\}$



- 3 a 4 b 14



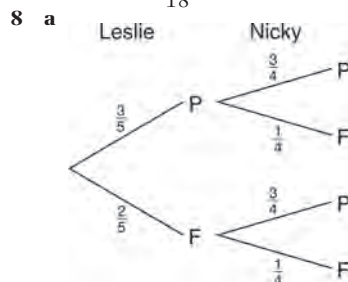
- 5 a $\frac{1}{3}$ b $\frac{2}{3}$ c $\frac{1}{12}$ d $\frac{1}{3}$

- 6 a 0.64 b 0.32

7 a

X	1	2	3	4	5	6
1	0	1	2	3	4	5
2	1	0	1	2	3	4
3	2	1	0	1	2	3
4	3	2	1	0	1	2
5	4	3	2	1	0	1
6	5	4	3	2	1	0

- b $p(X=1) = \frac{5}{18}$ c $p(X>2) = \frac{1}{3}$



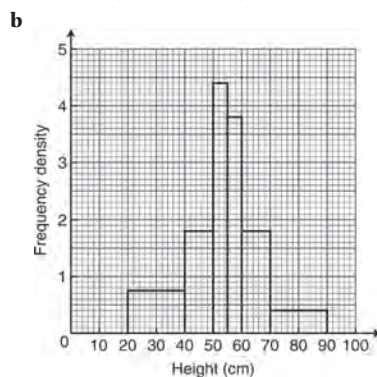
- b 0.45 c $\frac{9}{10}$

- 9 a $\frac{1}{7}$ b $\frac{5}{21}$ c $\frac{16}{21}$

- 10 a 24 years b 24.6 years

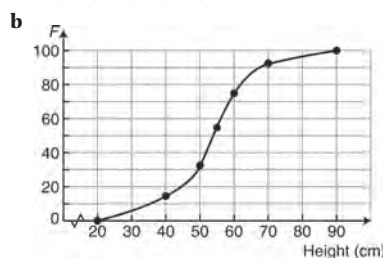
- 11 a 60 matches b 149 points c 0.6

- 12 a 0.75, 1.8, 4.4, 3.8, 1.8, 0.4



- c 53.2 cm

- 13 a 15, 33, 55, 74, 92, 100



- c 53 cm, 47 cm, 61 cm, 14 cm

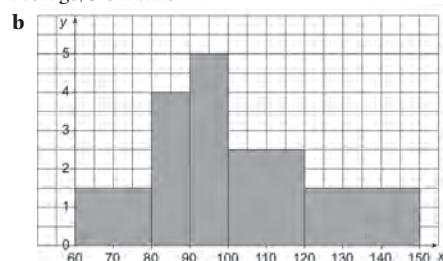
- 14 a 10 750 (approx.); 8000, 13 000, 5000

- b 87%

- 15 a $m = 159$, $IQR = 14$; $m = 168$, $IQR = 14$

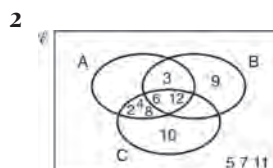
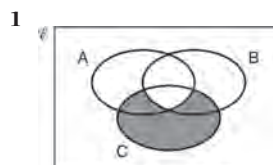
- b Tribe B are, on average, 9 cm taller

- 16 a 30, 40



- c 97.5

REVISION EXERCISE 98*



- 3 17

- 4 a 34.6

- b 33.5

5 a

size (KB)	1	2	3	4	5	6	7
f	18	16	9	6	6	4	1

b mean = 2.7 KB, median = 2 KB, mode = 1 KB

c Angle sizes shown in table

size (KB)	1	2	3	4	5	6	7
Angle size	108°	96°	54°	36°	36°	24°	6°

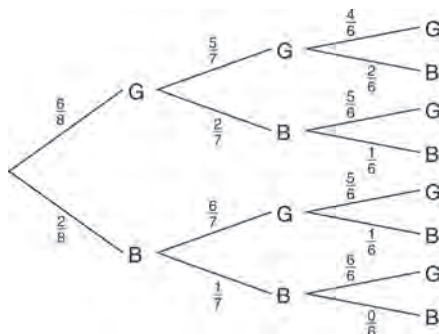
6 a $\frac{9}{50}$ b $\frac{27}{50}$

7 a $\frac{1}{5}$ b $\frac{4}{5}$

8 0.12

9 b $\frac{5}{18}$

10 a

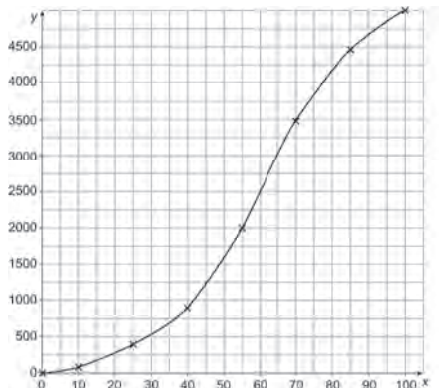


b $\frac{9}{14}$

11 a $(x-5)(x+4) = 0$ so $x = 5$

b $\frac{13}{24}$

12 a



b Median = 60, IQR = 74 - 45 = 29 c 68%

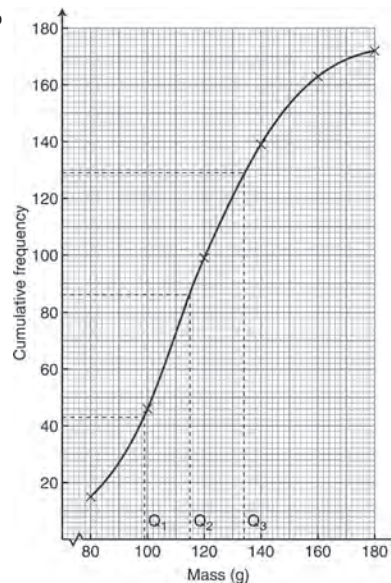
13 a Before: 41; 29; 57; 28

After: 48; 33; 63; 30

b Diet improves fitness

14 a 116.3 g

b



c $Q_1 = 99$, $Q_2 = 115$ g, $Q_3 = 134$ g, IQR = 35 g

15 a $f = 16, 15, 19, 14, 24, 12$

b 100 responses

c 29.95 years

16 a $f = 6, 12, 15, 12, 10, 6, 3$

b f.d. = 0.4, 0.8, 1.5, 1.2, 1, 0.2, 0.1

c 72.1 min