# Answers

Note
- For questions that do not stipulate a specific level of rounding the answers given here have been rounded to a level considered appropriate for the question.
- If a question asks for an answer to be given "to the nearest centimetre" it does not necessarily have to be given "in centimetres" (unless that too is requested). In such a situation an answer of 234·822 centimetres could be written as 235 cm or as 2·35 m, both answers being to the nearest centimetre.

**Exercise 1B. Page 27.**

**1.** (a) 24° (b) 49° (c) 53° **2.** (a) 168° (b) 163° (c) 147°
**3.** (a) 30°, 150° (b) 9°, 171° (c) 46°, 134°
**4.** 11·2 $cm^2$ **5.** 19·3 $cm^2$ **6.** 18·1 $cm^2$ **7.** 27·7 $cm^2$
**8.** 17·4 $cm^2$ **9.** 138·6 $cm^2$ **10.** 8·7 **11.** 5·9
**12.** 8·0 **13.** 8·6 **14.** 84·9 or 95·1 **15.** 84·7 or 95·3

**Exercise 1C. Page 36.**

**1.** 58 **2.** 12·3 **3.** 54 or 126 **4.** 14
**5.** 75 or 105 **6.** 126 **7.** 6·7 **8.** 75
**9.** The pole is of length 614 cm, to the nearest centimetre.
**10.** The two shot journey is 38 metres further than the direct route, to the nearest metre.
**11.** 59 **12.** 14·4 **13.** 43 **14.** 111
**15.** 44 **16.** 62 **17.** 11·9 **18.** 146
**19.** The boat is then 13·4 km from its initial position, correct to one decimal place.
**20.** After eight seconds Jim and Toni are 10·7 metres apart, correct to one decimal place.
**21.** 75 or 105 **22.** 99 **23.** 617 **24.** 5·39
**25.** 135 **26.** 80 **27.** 160 **28.** 54
**29.** The lengths of AC and BC are 672 cm and 824 cm respectively, each answer given to the nearest cm.
**30.** The smallest angle of the triangle is of size 42°, to the nearest degree.
**31.** AB is of length 8·1 cm, correct to one decimal place.
**32.** $a \approx 9{\cdot}9$ cm, $\angle B \approx 79°$, $\angle C \approx 58°$.
**33.** Ship B is approximately 15·9 km from ship A.
**34.** Ship Q is approximately 21·0 km from the lighthouse.
**35.** To the nearest metre the height of the tower is 21 metres.
**36.** The parallelogram has diagonals of length 5·1 cm and 9·7 cm, correct to one decimal place.
**37.** The parallelogram has sides of length 6·8 cm and 10·8 cm, correct to one decimal place.
**38.** (a) When AC is 2·6 metres $\angle CAB = 20°$, to the nearest degree.
(b) When AC is 2·1 metres $\angle CAB = 28°$, to the nearest degree.
**39.** (a) 479 cm (b) 239 cm (c) 111 cm (d) 222 cm
**40.** (a) At 5 o'clock the distance between the tip of the hour hand and the tip of the minute hand is 155 mm, to the nearest mm.
(b) At 10 minutes past 5 the distance between the tip of the hour hand and the tip of the minute hand is 119 mm, to the nearest mm.
**41.** (a) The ship is 1·77 km from the lighthouse, correct to 2 decimal places.
(b) The ship is 1·17 km from the coastal observation position, correct to 2 decimal places.
**42.** The largest of the three angles is 98°, to the nearest degree.
**43.** The height of the tower is 30 metres, to the nearest metre.
**44.** Point B is 92 metres from point C (nearest metre).
**45.** $h \approx 20{\cdot}0$ cm, $\angle H \approx 64°$, $\angle I \approx 61°$ or $h \approx 2{\cdot}3$ cm, $\angle H \approx 6°$, $\angle I \approx 119°$
**46.** To the nearest metre B is 141 metres from C.
**47.** (a) 80° (b) 96° (nearest degree) (c) 29·2 cm (1 dp) (d) 52·6 $cm^2$ (1 dp)
**48.** (a) $x^2 = 244 - 240\cos\theta$ (b) $x^2 = 277 - 252\cos\phi$ (c) 94°
**50.** The second block has the greater area, by 15 $m^2$ (nearest square metre).

**Exercise 1D. Page 44.**

Answers to numbers **1** to **27** not given here. (You should have checked each one on a calculator.)

**28.** $6\sqrt{3}$ **29.** $2\sqrt{10}$ **30.** $\frac{5\sqrt{6}}{2}$ **31.** $2\sqrt{13}$ **32.** $5\sqrt{2}$

**Exercise 1E. Page 45.**

**1.** (a) 30° (b) $\frac{\sqrt{3}}{3}$ **2.** (a) 45° (b) 1

**3.** (a) 60° (b) $\sqrt{3}$ **4.** (a) 120° (b) $-\sqrt{3}$

**5.** (a) 135° (b) $-1$ **6.** (a) 150° (b) $-\frac{\sqrt{3}}{3}$

**7.** Gradient of line = tan θ, where θ is the angle or inclination of the line.

**Miscellaneous Exercise One. Page 46.**

**1.** (a) $11x - 7$ (b) $x + 23$ (c) $10x - 3$ (d) $13 - 10x$
(e) $7x + 11$ (f) $1 - 23x$ (g) $x^2 + 8x + 15$ (h) $x^2 - 2x - 15$
(i) $2x^2 + 11x + 15$ (j) $2x^2 - 11x + 15$

**2.** (a) $2(x + 4)$ (b) $3(2y + 3)$ (c) $4a(4b + 3c + 2a)$ (d) $a(a + 1)$
(e) $(x + 8)(x - 1)$ (f) $(x - 8)(x - 1)$ (g) $(x + 7)(x - 2)$ (h) $(x - 2)(x - 6)$
(i) $(x + 4)(x - 4)$ (j) $2(a + 3)(a - 3)$

**3.** (a) $2\sqrt{5}$ (b) $3\sqrt{5}$ (c) $10\sqrt{2}$ (d) 30
(e) $3\sqrt{5}$ (f) $18\sqrt{2}$ (g) $21\sqrt{10}$ (h) $19 + 6\sqrt{2}$

**4.** 0·41, 2·35 m

**5.** From ship B, ship A is 9·4 km away on a bearing of 315°.

**6.** No it does not mean that both C and r and A and r are in direct proportion. C and r are in direct proportion because a relationship of the form C = kr for constant k does exist (in this case k = 2π). A and r are not in direct proportion because the rule linking them is not of the form A = kr. (In this case $A = \pi r^2$ and so A and $r^2$ are in direct proportion.)

**7.** Twelve of the steel frameworks would require a total of 260 metres of steel (to the next 10 metres).

**Exercise 2A. Page 50.**

**1.** 10·8 cm **2.** 60·3 cm **3.** 8·2 cm **4.** $\frac{32\pi}{3}$ cm **5.** $\frac{25\pi}{3}$ cm

**6.** $\frac{28\pi}{3}$ cm **7.** $24\pi$ cm$^2$ **8.** $11\pi$ cm$^2$ **9.** $\frac{128\pi}{3}$ cm$^2$ **10.** 321 cm$^2$

**11.** 108 cm$^2$ **12.** 214 cm$^2$ **13.** 86 cm$^2$ **14.** 30 cm$^2$ **15.** 41 cm$^2$

**16.** $12(2\pi - 3\sqrt{3})$ cm$^2$ **17.** $\frac{9}{2}(3\pi - 2\sqrt{2})$ cm$^2$ **18.** $\frac{25}{3}(5\pi - 3)$ cm$^2$

**19.** (a) 29·7 cm (1 dp) (b) 65·8 cm (1 dp) **20.** 18·3 cm

**21.** 98 cm$^2$ to nearest cm$^2$ **22.** 292 cm$^2$ to nearest cm$^2$

**23.** 59° **24.** 7·3 cm$^2$

**25.** Tip of minute hand travels $12\pi$ cm, tip of hour hand travels $\frac{2\pi}{3}$ cm.

**26.** 180, 1·85 km **27.** $\frac{10\sqrt{5}}{3}$ cm, $6\frac{2}{3}$ cm

**Exercise 2B. Page 55.**

**1.** 3 rads **2.** 1·5 rads **3.** 5 rads **4.** 2·5 rads **5.** 4 rads **6.** 4 rads

**7.** $\frac{\pi}{2}$ rads **8.** $\frac{\pi}{6}$ rads **9.** $\frac{5\pi}{6}$ rads **10.** $\frac{3\pi}{4}$ rads **11.** $\frac{\pi}{36}$ rads **12.** $\frac{\pi}{10}$ rads

**13.** $\frac{4\pi}{9}$ rads **14.** $\frac{13\pi}{18}$ rads **15.** 45° **16.** 60° **17.** 120° **18.** 180°

**19.** 15° **20.** 36° **21.** 35° **22.** 70° **23.** 0·56 rads **24.** 1·10 rads

**25.** 2·01 rads **26.** 2·97 rads **27.** 0·28 rads **28.** 1·47 rads **29.** 1·82 rads **30.** 0·45 rads

**31.** 86° **32.** 132° **33.** 80° **34.** 34° **35.** $\frac{1}{\sqrt{2}}$ **36.** $\frac{1}{2}$

**37.** $-\frac{1}{\sqrt{2}}$ **38.** 1 **39.** $\frac{\sqrt{3}}{2}$ **40.** $\frac{1}{\sqrt{2}}$ **41.** $\frac{1}{\sqrt{2}}$ **42.** $-\sqrt{3}$

**43.** 0 **44.** Undefined **45.** $-\frac{1}{2}$ **46.** $-\frac{1}{\sqrt{3}}$ **47.** $-\frac{\sqrt{3}}{2}$ **48.** 0

**49.** $\frac{1}{2}$ **50.** 0 **51.** 0·84 **52.** −0·42 **53.** −0·75 **54.** 0·14

**55.** 0·83 **56.** 0·99 **57.** 3·60 **58.** 0·75 **59.** 0·20 rads **60.** 1·37 rads

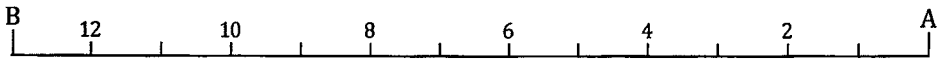
**61.** 0·34 rads **62.** 1·04 rads **63.** (a) 6π rad/sec (b) $\frac{\pi}{2}$ rad/sec (c) $\frac{\pi}{2}$ rad/sec

**64.** (a) 1rev/min (b) 22·5 rev/min (c) 10 rev/min

**65.** 7·1 **66.** 3·1 **67.** 12·8 **68.** 12·8 **69.** 16·2 **70.** 1·4

**71.** (a) $\frac{\pi}{2}$ rad (b) $\frac{4\pi}{3}$ rad (c) $\frac{5\pi}{3}$ rad (d) $\frac{11\pi}{6}$ rad **72.** (a) $\frac{\pi}{4}$ rad (b) $\frac{3\pi}{8}$ rad (c) $\frac{\pi}{20}$ rad (d) $\frac{13\pi}{20}$ rad

**73.** (a)




(The units on the line AB occur every 0·915 cm, starting with zero at A.)

(b) Yes. Each 1 cm on AB would represent 2 cm diameter, making calibration easier.

**Exercise 2C. Page 59.**

**1.** 4 cm **2.** 25 cm **3.** 13·9 cm (1 dp)

**4.** 8 $cm^2$ **5.** 45 $cm^2$ **6.** 114 $cm^2$

**7.** 276 $cm^2$ (nearest $cm^2$) **8.** 31·6 $cm^2$ (1 dp) **9.** 39·1 $cm^2$ (1 dp)

**10.** 18 cm **11.** (a) 90 $cm^2$ (b) 617 $cm^2$ **12.** (a) 8 cm (b) 5·1 $cm^2$

**13.** (a) 6 cm (b) 3·35 $cm^2$ **14.** 80 $cm^2$ **15.** 0·37 $cm^2$

**16.** 81 $cm^2$ **17.** 84 $cm^2$ **18.** 26·6 $cm^2$

**19.** 16·6 $cm^2$ **20.** 14·6 $cm^2$ **21.** 11·65 $cm^2$

**22.** (a) 120 cm (b) 16 mm **23.** 770 $mm^2$ **24.** 16·4 cm

**25.** 35% **26.** 269 $m^2$ **27.** 233 $m^2$

**28.** 125 cm **29.** 16410 $cm^2$ **30.** 177 cm

**31.** (a) 5 cm (b) 2 cm **32.** 20·6 $cm^2$ **33.** 8·6 %

**Miscellaneous Exercise Two. Page 64.**

**1.** (a) $2x^2 + 5x - 3$ (b) $3x^2 + 17x - 28$
(c) $x^3 + 7x^2 + 7x - 15$ (d) $2x^3 - 9x^2 + 7x + 6$

**2.** (a) $\frac{\sqrt{2}}{2}$ (b) $\frac{\sqrt{3}}{3}$ (c) $\frac{5\sqrt{2}}{2}$ (d) $2\sqrt{3}$
(e) $\frac{3-\sqrt{5}}{4}$ (f) $\frac{3+\sqrt{2}}{7}$ (g) $\frac{\sqrt{5}-1}{2}$ (h) $\sqrt{5}-\sqrt{2}$

**3.** The topmost point is 35 metres above ground (to the nearest metre).

**4.** (a) 2·26 m (b) 1·26 m

**5.** Ship B is approximately 30·8 km from ship A, on a bearing N69°W.

**6.** The block has an area of 5270 $m^2$ and a perimeter of 298 metres, both answers given to the nearest integer.

**Exercise 3A. Page 68.**

**1.** a, c, e

**2.** a, b, e

**3.** (a) {5, 7, 9, 11} (b) {8, 10, 12, 14} (c) {1} (d) $\{y \in \mathbb{R}: y \geq 0\}$

**4.** (a) 18 (b) −7 (c) 13 (d) 4 (e) 21 (f) 23
(g) −27 (h) $5a - 2$ (i) $10a - 2$ (j) $5a^2 - 2$ (k) 24 (l) $5(a + b) - 2$
(m) 7 (n) −2

**5.** (a) 9 (b) −7 (c) −3 (d) −3 (e) 43 (f) 13
(g) 13 (h) $3(4a - 7)$ (i) $12a - 7$ (j) $3(a^2 - 12)$ (k) $9a^2 - 12$ (l) ±6
(m) 5 (n) −2 or 9

**6.** (a) Function cannot cope with $x < 1$.
(b) There are no numbers the function cannot cope with.
(c) Function cannot cope with $x = 0$.
(d) Function cannot cope with $x = 1$.

**7.** (a) Function cannot output numbers less than zero.
(b) Function cannot output numbers less than one.
(c) Function cannot output zero.
(d) Function cannot output zero.

**8.** $\{y \in \mathbb{R}: 5 \leq y \leq 8\}$ **9.** $\{y \in \mathbb{R}: -3 \leq y \leq 0\}$ **10.** $\{y \in \mathbb{R}: -6 \leq y \leq 15\}$

**11.** $\{y \in \mathbb{R}: 20 \leq y \leq 40\}$ **12.** $\{y \in \mathbb{R}: -1 \leq y \leq 9\}$ **13.** $\{y \in \mathbb{R}: -4 \leq y \leq 1\}$

**14.** $\{y \in \mathbb{R}: 0 \leq y \leq 9\}$ **15.** $\{y \in \mathbb{R}: 0 \leq y \leq 16\}$ **16.** $\{y \in \mathbb{R}: 1 \leq y \leq 10\}$

**17.** $\{y \in \mathbb{R}: 0{\cdot}25 \leq y \leq 1\}$ **18.** $\{y \in \mathbb{R}: y \geq 1\}$ **19.** $\{y \in \mathbb{R}: y \geq -1\}$

**20.** $\{y \in \mathbb{R}: y \geq 4\}$ **21.** $\{y \in \mathbb{R}: y \neq 0\}$ **22.** $\{y \in \mathbb{R}: y \neq 1\}$

**23.** one-to-one **24.** one-to-one **25.** many-to-one

**26.** many-to-one **27.** one-to-one **28.** one-to-one

| | Domain | Range | | Domain | Range |
|---|---|---|---|---|---|
| **29.** | $\mathbb{R}$ | $\mathbb{R}$ | **30.** | $\mathbb{R}$ | $\{y \in \mathbb{R}: y \geq 0\}$ |
| **31.** | $\{x \in \mathbb{R}: x \geq 0\}$ | $\{y \in \mathbb{R}: y \geq 0\}$ | **32.** | $\{x \in \mathbb{R}: x \geq 3\}$ | $\{y \in \mathbb{R}: y \geq 0\}$ |
| **33.** | $\{x \in \mathbb{R}: x \geq -3\}$ | $\{y \in \mathbb{R}: y \geq 0\}$ | **34.** | $\{x \in \mathbb{R}: x \geq 3\}$ | $\{y \in \mathbb{R}: y \geq 5\}$ |
| **35.** | $\{x \in \mathbb{R}: x \neq 3\}$ | $\{y \in \mathbb{R}: y \neq 0\}$ | **36.** | $\{x \in \mathbb{R}: x > 3\}$ | $\{y \in \mathbb{R}: y > 0\}$ |

**Miscellaneous Exercise Three. Page 71.**

**1.** (a) $x = 11$ (b) $x = -5$

**2.** $\{1, -1, -3, -5\}$

**3.** For the domain $-2 \le x \le 3$ the range is $-1 \le y \le 4$.
For the domain $\{-2, -1, 0, 1, 2, 3\}$ the range is $\{-1, 0, 1, 2, 3, 4\}$.

**4.** (a) $a^2 + 2ab + b^2$ (b) $a^3 + 3a^2b + 3ab^2 + b^3$
(c) $a^3 + 6a^2b + 12ab^2 + 8b^3$ (d) $a^3 - 6a^2b + 12ab^2 - 8b^3$

**5.** (a) A function. One-to-one.
(b) A function. Many-to-one.
(c) Not a function.
(d) A function. Many-to-one.
(e) A function. One-to-one.
(f) Not a function.

**6.** That part of triangle ABC not lying in any of the circles has an area of 4·3 $cm^2$ (correct to the nearest 0·1 $cm^2$).

**7.** Ship B is approximately 7·3 km from C on a bearing of 064°.

**8.** The block has an area of 6399 $m^2$, to the nearest square metre.

**9.** 240 litres

**Exercise 4A. Page 78.**

**1.**

| | | | |
|---|---|---|---|
| A: | (a) (0, 1) | (b) 1 | (c) $y = x + 1$ |
| B: | (a) (0, −1) | (b) 2 | (c) $y = 2x - 1$ |
| C: | (a) (0, 0) | (b) 0·5 | (c) $y = 0{\cdot}5x$ |
| D: | (a) (0, 0) | (b) −1 | (c) $y = -x$ |
| E: | (a) (0, 6) | (b) 3 | (c) $y = 3x + 6$ |
| F: | (a) (0, 2) | (b) 0 | (c) $y = 2$ |
| G: | (a) (0, −3) | (b) 1 | (c) $y = x - 3$ |
| H: | (a) (0, −3) | (b) −2 | (c) $y = -2x - 3$ |
| I: | (a) (0, 4) | (b) 0 | (c) $y = 4$ |
| J: | (a) (0, −3) | (b) −0·5 | (c) $y = -0{\cdot}5x - 3$ |
| K: | (a) (0, −0·5) | (b) 1·5 | (c) $y = 1{\cdot}5x - 0{\cdot}5$ |
| L: | (a) $(0, \frac{4}{3})$ | (b) $\frac{1}{3}$ | (c) $y = \frac{1}{3}x + \frac{4}{3}$ |

**2.** (a) Points lie in a straight line. Equation of line is $y = 2x + 5$.
(b) Points lie in a straight line. Equation of line is $y = 5x - 7$.
(c) Points do not lie in a straight line.
(d) Points lie in a straight line. Equation of line is $y = x - 4$.
(e) Points lie in a straight line. Equation of line is $y = -2x + 10$.
(f) Points lie in a straight line. Equation of line is $y = 5$.
(g) Points do not lie in a straight line.
(h) Points lie in a straight line. Equation of line is $y = 5x - 13$.

**3.**

| Equation | Gradient | $y$-axis intercept |
|---|---|---|
| $y = 2x + 3$ | 2 | (0, 3) |
| $y = 3x + 4$ | 3 | (0, 4) |
| $y = -2x - 7$ | −2 | (0, −7) |
| $y = 6x + 3$ | 6 | (0, 3) |

**4.** $y = 4x + 6$

**5.** $y = -x - 5$

**6.** Lines B, D, E, F and G are in the family, the others are not.

**7.** Lines A, D, E, G and H are in the family, the others are not.

**8.** $y = -4x - 3$. Yes

**9.** $y = 2x - 3$. A, C, D

**10.**

| Equation | Written as $y = mx + c$ | Gradient | $y$-axis intercept |
|---|---|---|---|
| $2y = 4x - 5$ | $y = 2x - 2{\cdot}5$ | 2 | $(0, -2{\cdot}5)$ |
| $4y = 3x + 7$ | $y = 0{\cdot}75x + 1{\cdot}75$ | $0{\cdot}75$ | $(0, 1{\cdot}75)$ |
| $3y - 2x = 6$ | $y = \frac{2}{3}x + 2$ | $\frac{2}{3}$ | $(0, 2)$ |
| $4x + 3y - 6 = 0$ | $y = -\frac{4}{3}x + 2$ | $-\frac{4}{3}$ | $(0, 2)$ |
| $3x + 5y = 8$ | $y = -0{\cdot}6x + 1{\cdot}6$ | $-0{\cdot}6$ | $(0, 1{\cdot}6)$ |

**11.** $a = 26, b = 40, c = -2$

**12.** $d = 0{\cdot}5$ , $e = -1, f = -6, g = 1{\cdot}5$ , $h = 1, i = -5$

**13.** (a) $P$ and $t$ are directly proportional. The rule is $P = t$.
(b) $P$ and $t$ are not directly proportional.
(c) $P$ and $t$ are directly proportional. The rule is $P = 4t$.
(d) $P$ and $t$ are not directly proportional.
(e) $P$ and $t$ are directly proportional. The rule is $P = 0{\cdot}25t$.
(f) $P$ and $t$ are directly proportional. The rule is $P = 0{\cdot}75t$.
(g) $P$ and $t$ are directly proportional. The rule is $P = 0{\cdot}5t$.
(h) $P$ and $t$ are not directly proportional.

**Exercise 4B. Page 83.**

**1.** (a) (7, 9) (b) (5, 10) (c) (3, 5) (d) (−2, 1) (e) (−2, 3·5)
(f) (12, 1) (g) (8, −5·5) (h) (0, 7·5) (i) (1, 1)

**2.** (a) 2 (b) −4 (c) 2 (d) 0·5 (e) −0·25
(f) −1 (g) −2 (h) 2·5 (i) 0·5

**3.** (a) 5 units (b) 5 units (c) 13 units (d) 25 units (e) 17 units (f) 10 units
(g) $5\sqrt{2}$ units ($\approx 7{\cdot}07$ units) (h) $\sqrt{58}$ units ($\approx 7{\cdot}62$ units) (i) $\sqrt{61}$ units ($\approx 7{\cdot}81$ units)

**4.** (a) 2 (b) $\sqrt{5}$ units ($\approx 2{\cdot}24$ units) (c) (3·5, 7)

**5.** (a) 1·6 (b) $\sqrt{89}$ units ($\approx 9{\cdot}43$ units) (c) (1·5, 5)

**6.** −4 or 12

**7.** (a) $\sqrt{82}$ km ($\approx 9{\cdot}06$ km) (b) $7\sqrt{2}$ km ($\approx 9{\cdot}90$ km) (c) $2\sqrt{10}$ km ($\approx 6{\cdot}32$ km)

**8.** Stage 1 gradient is 0·2, stage 2 gradient is $\frac{5}{9}$, stage 3 gradient is 2·5.

**Exercise 4C. Page 86.**

**1.** A: $y = -3$ B: $y = 1$ C: $y = -0{\cdot}5x + 5$ D: $x = 5$ E: $y = x + 3$
F: $y = 9$ G: $x = -3$ H: $y = 3x + 2$ I: $x = 7$ J: $y = x$

**2.** $y = 0$

**3.** $x = 0$

**4.** $y = 3x + 4$, Yes

**5.** $y = 0{\cdot}5x + 2$, D and E

**6.** (a) $y = x + 2$ (b) $y = -x + 5$ (c) $y = -2x + 8$ (d) $y = 5x + 8$
(e) $y = 0{\cdot}5x + 5$ (f) $y = -0{\cdot}5x - 1{\cdot}5$ (g) $y = 1{\cdot}5x - 11{\cdot}5$ (h) $y = -\frac{1}{3}x + \frac{4}{3}$

**7.** (a) $y = x + 3$ (b) $y = -4x - 1$ (c) $y = -3x + 43$ (d) $y = 2x - 1$
(e) $y = \frac{1}{3}x + \frac{5}{3}$ (f) $y = -2x + 4$ (g) $y = \frac{5}{3}x + 4$ (h) $y = -5x + 5$

**8.** $y = 2x - 1$, B and E.

**9.** $y = 0{\cdot}5x + 2{\cdot}5$, $f = 7$, $g = -2$, $h = 13$, $i = -2$, $j = 4{\cdot}4$.

**10.** (4, 0), $y = -2x + 8$

**11.** (6, 0), $y = 4x - 24$

**12.** $F = 1{\cdot}8C + 32$ (a) 131°F (b) 257°F (c) 14°F (d) 15°C (e) 30°C (f) −40°C
**13.** $A = 0{\cdot}24N + 40$
**14.** A: (−80, 20) B: (120, 120) C: (−100, 60) D: (−60, −20) E: (100, 160) F: (140, 80)
(b) ~224 m (c) $y = 0{\cdot}5x + 60$ (d) $y = -2x - 140$ (e) $y = -2x + 360$
**15.** When $t = 2$, $A = 3970$. When $A = 3850$, $t = 10$. $A = -15t + 4000$
**16.** $C = 120T + 85$
**17.** $P = 4{\cdot}5N - 3650$ (a) \$3100 (b) \$6925 (c) 812
**18.** (a) 110, 540 (b) \$1660
**19.** $k = 0{\cdot}2$, $L_0 = 0{\cdot}45$, 5cm.

**Exercise 4D. Page 91.**

**1.** A and E, B and J, C and H, F and K, G and I.
**2.** $y = 2x - 5$
**3.** A and D, B and G, C and E, F and K, I and J.
**4.** $y = -\frac{1}{2}x + 5$
**5.** $y = 3x + 5$
**6.** (a) Point B has coordinates (2, −1) (b) The required equation is $y = 2x - 5$.

**Miscellaneous Exercise Four. Page 92.**

**1.** A, C, E, F, H, I, J, L
**2.** A does not, B does not, C does, D does not, E does.
**3.** F does, G does, H does not, I does not, J does.
**4.** (a) 11 (b) −1 (c) 23 (d) −8 (e) −28 (f) 14·5 (g) 12
(h) −21 (i) 7m − 15 (j) m = 6 (k) p = 5 (l) q = 7 (m) r = −3 (n) s = 4·5
**5.** (a) (3, −5) (b) (−1, 4)
**6.** (a) Domain $\mathbb{R}$ Range $\mathbb{R}$
(b) Domain $\{x \in \mathbb{R}: x \geq 5\}$ Range $\{y \in \mathbb{R}: y \geq 0\}$
(c) Domain $\mathbb{R}$ Range $\{y \in \mathbb{R}: y \geq 0\}$
(d) Domain $\{x \in \mathbb{R}: x \neq 5\}$ Range $\{y \in \mathbb{R}: y \neq 0\}$
(e) Domain $\{x \in \mathbb{R}: x \neq 5\}$ Range $\{y \in \mathbb{R}: y > 0\}$
(f) Domain $\{x \in \mathbb{R}: x > 5\}$ Range $\{y \in \mathbb{R}: y > 0\}$
**8.** $a = -1$, $b = 4$, $c = 9$, $d = 19$, $e = 29$, $f = 11$, $g = 99$.
**9.** $\frac{25}{2}(2\sqrt{3} - \pi)$ cm$^2$

**Exercise 5B. Page 98**

**1.** A: $y = x^2 + 1$ B: $y = x^2 - 2$
C: $y = x^2 - 4$ D: $y = (x-3)^2 + 1$
E: $y = (x+3)^2 - 4$ F: $y = (x-2)^2 - 3$
**2.** G: $y = -x^2$ H: $y = -x^2 + 3$
I: $y = -(x-3)^2$ J: $y = -(x+3)^2 + 1$
**3.** K: $y = 2x^2 - 2$ L: $y = 2(x-3)^2$
M: $y = 2(x+2)^2$ N: $y = 2(x-3)^2 - 2$
**4.** (a) $y = 3(x+1)^2 - 4$ (b) $y = -2(x-3)^2 + 8$
(c) $y = \frac{1}{2}(x-4)^2 - 3$ (d) $y = -\frac{1}{2}(x+2)^2 + 10$

**Exercise 5C. Page 105.**

For questions 1 to 10 the sketches, not shown here, should be consistent with the information obtained in earlier parts of the question.

**1.** (a) $x = -1$ (b) min at $(-1, -4)$ (c) $(0, -3)$ **2.** (a) $x = 3$ (b) min at $(3, 5)$ (c) $(0, 14)$

**3.** (a) $x = 1$ (b) max at $(1, 3)$ (c) $(0, 1)$

**4.** (a) $(0, 21)$ (b) $(3, 0)$ and $(7, 0)$ (c) $x = 5$ (d) min at $(5, -4)$

**5.** (a) $(0, -12)$ (b) $(-4, 0)$ and $(3, 0)$ (c) $x = -0{\cdot}5$ (d) min at $(-0{\cdot}5, -12{\cdot}25)$

**6.** (a) $(0, 8)$ (b) $(-2, 0)$ and $(-4, 0)$ (c) $x = -3$ (d) min at $(-3, -1)$

**7.** (a) $x = -2$ (b) min at $(-2, -16)$ (c) $(0, -12)$ **8.** (a) $x = 3$ (b) min at $(3, -8)$ (c) $(0, 1)$

**9.** (a) $x = 1$ (b) max at $(1, 3)$ (c) $(0, 1)$

**10.** (a) $x = 2$ (b) max at $(2, 5)$ (c) $(0, -3)$

**11.** (a) and (b) Check your answers with those of others in your class and with your teacher.
(c) Check your sketch with a graphic calculator display of the function.
(d) The greatest rectangular area is 49 $m^2$, dimensions 7 m by 7m (i.e. a square).

**12.** (a) and (b) Check your answers with those of others in your class and with your teacher.
(c) Check your sketch with a graphic calculator display of the function.
(d) The greatest rectangular area is 50 $m^2$, dimensions are 5 m by 10m ($x = 5, y = 10$).

**13.** (a) $(2{\cdot}5, 11{\cdot}25)$ (b) 10 (c) Concave down.

**14.** (a) \$590 000 (b) \$545 000 (c) $t = 10$, \$530 000

**15.** The maximum value of $h$ is 122·5 and it occurs when $t = 5$.

**16.** (a) Concave up. (b) The bridge is 15 m above water level.
(c) $x = 40$ (d) From D to C is 40 metres.
(e) From D to E is 80 metres (f) From D to A is 30 metres.

**17.** (a) Concave down (b) At the mid-point of the bridge $x = 150$
(c) The vertical strut one quarter of the way along the bridge is 10 m long.
(d) Maximum clearance is (i) 54 m at low tide and (ii) 46m at high tide.

**Exercise 5D. Page 110.**

**1.** Quadratic. $y = x^2 + 6x + 5$ **2.** Neither.

**3.** Quadratic. $y = x^2 + x + 3$ **4.** Linear. $y = 5x + 1$

**5.** Quadratic. $y = x^2 + 2$ **6.** Linear. $y = \pi x + \pi$

**7.** Neither. **8.** Quadratic. $y = x^2 + 5x + 4$

**9.** Linear. $y = 8x + 3$ **10.** Quadratic. $y = 2x^2 + 3$

**11.** Quadratic. $y = 3(x - 2)^2 + 1$ **12.** Quadratic. $y = -(x - 3)^2 + 5$

**13.** (a)

| Length of side of cube ($L$ units) | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Surface area of cube ($n$ units$^2$) | 6 | 24 | 54 | 96 | 150 | 216 |

(b) Quadratic
(c) $n = 6L^2$

**14.** (a)

| Number of rows of cans ($r$) | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Number of cans ($n$) | 1 | 3 | 6 | 10 | 15 | 21 |

(b) Quadratic
(c) $n = 0{\cdot}5r^2 + 0{\cdot}5r$

**Exercise 5E. Page 115.**

**1.** $y = (x + 2)^2 - 5$, min $(-2, -5)$ **2.** $y = (x - 3)^2 - 7$, min $(3, -7)$

**3.** $y = (x - 4)^2 - 6$, min $(4, -6)$ **4.** $y = (x + 3)^2 - 6$, min $(-3, -6)$

**5.** $y = (x - 1{\cdot}5)^2 - 0{\cdot}25$, min $(1{\cdot}5, -0{\cdot}25)$ **6.** $y = (x - 2{\cdot}5)^2 - 3{\cdot}25$, min $(2{\cdot}5, -3{\cdot}25)$

**7.** $y = -(x - 5)^2 + 24$, max $(5, 24)$ **8.** $y = 2(x - 3)^2 - 15$, min $(3, -15)$

**9.** $y = -2(x - 2)^2 + 12$, max $(2, 12)$ **10.** $y = 2(x + 1{\cdot}25)^2 + 0{\cdot}875$, min $(-1{\cdot}25, 0{\cdot}875)$

**Miscellaneous Exercise Five. Page 116.**

**1.** (a) 31 (b) 1 (c) 44

**2.** (a) Concave down (b) Concave up (c) Concave down

**3.** $a = 1$, $b = -1$, $c = -13$, $d = 0$, $e = 9$, $f = 0$.

**4.** (a) $-\frac{1}{2}$ (b) $-\frac{1}{3}$ (c) 5 (d) $y = 2x + 7$

**5.** (a) (0, 3) (b) (1, 0), (3, 0) (c) $x = 2$ (d) min at (2, −1)

**6.**

| Equation | Cuts $y$-axis | Line of symmetry | Turning point. Coordinates | Max or min? |
|---|---|---|---|---|
| $y = x^2 + 4x + 1$ | (0, 1) | $x = -2$ | (−2, −3) | min |
| $y = x^2 - 2x - 1$ | (0, −1) | $x = 1$ | (1, −2) | min |
| $y = 2x^2 + 4x - 3$ | (0, −3) | $x = -1$ | (−1, −5) | min |
| $y = 2x^2 + 6x - 1$ | (0, −1) | $x = -1{\cdot}5$ | (−1·5, −5·5) | min |

**7.** (a) $x = -3$ (b) (−3, −4) (c) $x = -1$ (d) (−1, −1)

**8.** A: $x = 4$ B: $y = -3$ C: $y = x$ D: $y = x + 2$ E: $y = 2x + 4$
F: $y = -x$ G: $y = 0{\cdot}25x + 4$ H: $y = 0{\cdot}5x + 1$ I: $y = -0{\cdot}5x - 1$

**9.** I: $y = (x - 1)(x - 3)$ II: $y = (x + 2)(2 - x)$ III: $y = -(x + 1)(x + 3)$ IV: $y = (x + 1)(x + 3)$

**10.** (a) Rule: $y = 3x + 4$

| $x$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| $y$ | 7 | 10 | 13 | 16 | 19 | 22 | 25 | 28 |

(b) Rule: $y = 2x - 1$

| $x$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| $y$ | 1 | 3 | 5 | 7 | 9 | 11 | 13 | 15 |

(c) Rule: $y = -2x + 17$

| $x$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| $y$ | 15 | 13 | 11 | 9 | 7 | 5 | 3 | 1 |

(d) Rule: $y = 5x - 1$

| $x$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| $y$ | 4 | 9 | 14 | 19 | 24 | 29 | 34 | 39 |

(e) Rule: $y = 3x - 2$

| $x$ | 3 | 8 | 1 | 6 | 7 | 4 | 5 | 2 |
|---|---|---|---|---|---|---|---|---|
| $y$ | 7 | 22 | 1 | 16 | 19 | 10 | 13 | 4 |

**11.** $y = 3(x - 2)^2 + 3$

**12.** (a) 8 m (b) 5 m (c) 3·34 m (d) 4·58 m

**13.** (a) I 300 $cm^2$, II 300 $cm^2$, III 600 $cm^2$, IV 55 $cm^2$ (b) 256 cm

**Exercise 6A. Page 123.**

**1.** $x = -5$, $x = 3$ **2.** $x = -8$, $x = -9$ **3.** $x = 5{\cdot}5$, $x = -5$
**4.** $x = \pm 5$ **5.** $x = \pm 7$ **6.** $x = \pm 10$
**7.** $x = -5$, $x = -4$ **8.** $x = -5$, $x = 4$ **9.** $x = 4$, $x = 5$
**10.** $x = -4$, $x = 5$ **11.** $x = -7$, $x = 5$ **12.** $x = -3$, $x = -1$
**13.** $x = -6$, $x = -1$ **14.** $x = -7$, $x = -3$ **15.** $x = -5$, $x = -3$
**16.** $x = -2$, $x = 6$ **17.** $x = -1$, $x = 5$ **18.** $x = 0$, $x = 4$
**19.** $x = -7$, $x = 2$ **20.** $x = \pm 6$ **21.** $x = -3$
**22.** $x = -1$, $x = 4$ **23.** $x = 4$ **24.** $x = -5$, $x = 3$
**25.** $x = 0$, $x = 3$ **26.** $x = 3$, $x = 4$ **27.** $x = -12$, $x = 2$
**28.** $x = \pm 1{\cdot}5$ **29.** $x = \pm 0{\cdot}2$ **30.** $x = -3$, $x = 5$
**31.** $x = 3$ **32.** $x = 5$ **33.** $x = 1{\cdot}5$, $x = -4$
**34.** $x = -4$ $x = \frac{2}{3}$ **35.** $x = -1$, $x = 2{\cdot}5$ **36.** $x = -7$, $x = 0{\cdot}2$
**37.** $x = -3{\cdot}5$, $x = 3$ **38.** $x = \frac{2}{3}$, $x = 2{\cdot}5$ **39.** $x = 0{\cdot}4$, $x = 0{\cdot}5$

**40.** The number is either −10 or 3. **41.** The number is −5.

**42.** When the object hits the ground again $h = 0$ and $t = 8$. **43.** $t = 2$ **44.** $p = -3$ or $p = 11$

**Exercise 6B. Page 129.**

**1.** $x = -0{\cdot}77,\ x = 0{\cdot}43$ **2.** $x = -2{\cdot}30,\ x = 1{\cdot}30$ **3.** No real solutions
**4.** $x = -2{\cdot}82,\ x = -0{\cdot}18$ **5.** $x = -1{\cdot}74,\ x = 0{\cdot}34$ **6.** $x = -1{\cdot}47,\ x = 0{\cdot}27$
**7.** $t = 13{\cdot}8$ **8.** $p = 0{\cdot}22$ or $2{\cdot}78$ **9.** No real solutions
**10.** Two real solutions **11.** No real solution **12.** One real solution
**13.** One real solution **14.** Two real solutions **15.** Two real solutions
**16.** No real solution **17.** One real solution **18.** $x \approx -2{\cdot}7,\ x \approx 0{\cdot}7$
**19.** $x \approx -5{\cdot}3,\ x \approx 1{\cdot}3$ **20.** $x \approx 0{\cdot}4,\ x \approx 3{\cdot}6$ **21.** No real solutions
**22.** $x \approx -5{\cdot}7,\ x \approx -0{\cdot}3$ **23.** $x \approx -0{\cdot}2,\ x \approx 4{\cdot}2$ **24.** $x \approx 2{\cdot}13,\ x = 9{\cdot}87$
**25.** No real solutions **26.** $x = 7{\cdot}87,\ x = 0{\cdot}13$ **27.** $x = -7{\cdot}65,\ x = 0{\cdot}65$
**28.** $x = -4{\cdot}19,\ x = 1{\cdot}19$ **29.** $x = 1,\ x = -1{\cdot}5$ **30.** $x = 1 \pm \sqrt{6}$
**31.** $x = 3 \pm 2\sqrt{2}$ **32.** $x = -5 \pm 4\sqrt{2}$ **33.** $x = -\frac{5}{2} \pm \frac{\sqrt{35}}{2}$
**34.** $x = -\frac{5}{6} \pm \frac{\sqrt{13}}{6}$ **35.** $x = -\frac{1}{10} \pm \frac{\sqrt{21}}{10}$ **36.** $x = 1{\cdot}56,\ x = -2{\cdot}56$
**37.** $x = 4{\cdot}11,\ x = -0{\cdot}61$ **38.** $x = 2{\cdot}18,\ x = 0{\cdot}15$ **39.** $x = 4{\cdot}41,\ x = 1{\cdot}59$
**40.** $x = 3{\cdot}19,\ x = -2{\cdot}19$ **41.** $x = 0{\cdot}76,\ x = -1{\cdot}09$ **42.** $x = -\frac{3}{2} \pm \frac{\sqrt{5}}{2}$
**43.** $x = \frac{7}{2} \pm \frac{3\sqrt{5}}{2}$ **44.** $x = -\frac{1}{4} \pm \frac{\sqrt{41}}{4}$ **45.** $x = \frac{5}{6} \pm \frac{\sqrt{37}}{6}$
**46.** $x = -\frac{1}{10} \pm \frac{\sqrt{101}}{10}$ **47.** $x = -1 \pm \frac{\sqrt{2}}{2}$ **48.** 2 real roots
**49.** no real roots **50.** 2 real roots **51.** 2 real roots **52.** 1 real root **53.** no real roots

**Miscellaneous Exercise Six. Page 131.**

**1.** The number could be $-5$ or it could be 3.
**2.** A: $y = -x + 60$ B: $y = 60$ C: $y = 2x - 60$ D: $x = 60$ E: $y = -2x + 30$ F: $y = 0{\cdot}5x + 30$
**3.** (a) AD is of length 6 units. DB is of length 6 units.
The straight line through A and B has a gradient of 1.
(b) DE is of length 8 units. EC is of length 4 units.
The straight line through D and C has a gradient of 0·5.
(c) The straight line through D and F has a gradient of 0·75.
**4.** $a = 1,\ b = 1,\ c = 2,\ d = 77,\ e = 77,\ f = -1$ or 3
**5.** 15 cm by 2·4 cm.
**6.** $11{\cdot}2\ \text{cm}^2$
**7.** A: $y = x^2 - 1$ B: $y = (x-7)^2$ C: $y = (x+9)^2 + 2$ D: $y = (x+5)^2 - 8$
E: $y = -(x-4)^2 + 1$ F: $y = 2(x-10)^2$ G: $y = 4(x+5)^2 - 3$ H: $y = -2(x+10)^2$
**8.** 8·3 cm
**9.** 11·49

**Exercise 7A. Page 138.**

**1.** (a) (0, 1) (b) (0, −5) (c) (0, 8) (d) (0, 6) (e) (0, 2) (f) (0, 3)
**2.** (a) (2, 0), (3, 0), (4, 0) (b) (−7, 0), (1, 0), (5, 0) (c) (2·5, 0), (−1, 0), (0·6, 0)
(d) (1, 0), (−1, 0), (7, 0) (e) (0, 0), (0·25, 0), (3·5, 0) (f) (−1, 0), (5, 0)
(g) (−3, 0), (0, 0), (3, 0) (h) (−5, 0), (0, 0), (3, 0)
**3.** (2·20, 0)
**4.** (a) k = −6 (b) (−6, 0), (−2, 0), (3, 0)
**5** (a) 0 (b) 0 (c) −12 (d) 0 $(x-6)(x+1)(x-1)$
**6.** (a) −8 (b) 0 (c) 0 $(x-2)(x-3)(x-5)$
**7.** (a) a = 1, c = −5 (b) b = −4 (c) (−1, 0), $(\frac{2}{3}, 0)$, (5, 0)

**Exercise 7B. Page 143.**

**1.** B: $y = \sqrt{x-3}$ C: $y = \sqrt{x} + 4$ D: $y = \sqrt{x+3} - 5$

**2.** (a) $y = \frac{1}{x} + 1$ (b) $y = \frac{1}{x} + 2$ (c) $y = \frac{1}{x} - 1$

**3.** (a) $y = \frac{1}{x+1}$ (b) $y = \frac{1}{x-3}$ (c) $y = \frac{1}{x-1}$

**4.** The graph of $y = x^3 + 1$ is that of $y = x^3$ translated up 1 unit.

**5.** The graph of $y = \frac{1}{x-1}$ is that of $y = \frac{1}{x}$ translated 1 unit to the right.

**6.** The graph of $y = 2\sqrt{x}$ is that of $y = \sqrt{x}$ dilated parallel to the $y$-axis, scale factor 2.

**7.** The graph of $y = (x-3)^2$ is that of $y = (x+4)^2$ translated 7 units right.

**8.** The graph of $y = \sqrt{x-2} + 1$ is that of $y = \sqrt{x}$ translated 2 units right and 1 unit up.

**9.** The graph of $y = \frac{3}{x-1}$ is that of $y = \frac{1}{x}$ translated 1 unit to the right and dilated parallel to the $y$-axis, scale factor 3.

**10.** (a) B and F (b) D (c) C, E, G and H (d) H (e) C→E, G→H
(f) A→C, E→G, H→I

**11.** A(0, 10), B(−0·51, 0), C(3·08, 0), D(6·42, 0), E(1, 17), F(5, −15), G(3, 1)

**12.** (a) When P = 40, V = 10.
(b) When P = 20, V = 20.
(c) Volume cannot be negative. With a non zero mass there must be some volume.
Thus V > 0 would be a suitable domain for V.

**13.** a = 4 b = 0·5 c = 4 d = 2 e = 3 f = 1 g = 3 h = −0·5 i = 3

A: (0, 8) B: (−2, 0) C: (0, 7) D: (0, 2) E: $(\frac{2}{3}, 0)$ F: (−3, 0) G: (0, 9) H: (0, 4) I: (4, 0)

**Exercise 7C. Page 149.**

**1.** (a) Reflect in the $x$-axis.
(b) Dilate parallel to the $x$-axis, scale factor 0·25.
(c) Dilate parallel to the $y$-axis, scale factor 4.

**2.** (a) Reflect in the $x$-axis.
(b) Translate 5 units down.
(c) Dilate parallel to the $x$-axis, scale factor 2.

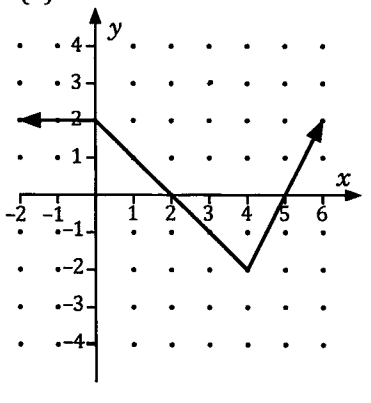
**3.** (a) Translate 3 units right.

(b) Dilate parallel to $y$-axis scale factor 3. (Or: Dilate parallel to $x$-axis scale factor $\frac{1}{\sqrt{3}}$.)

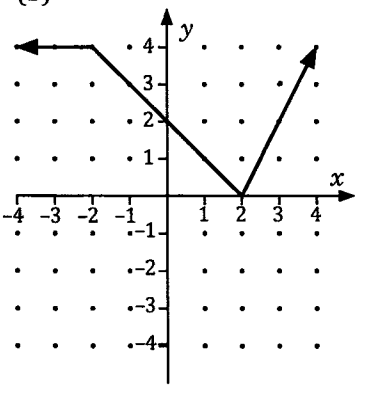
(c) Dilate parallel to $x$-axis scale factor $\frac{1}{3}$. (Or: Dilate parallel to $y$-axis scale factor 9.)

**4.**

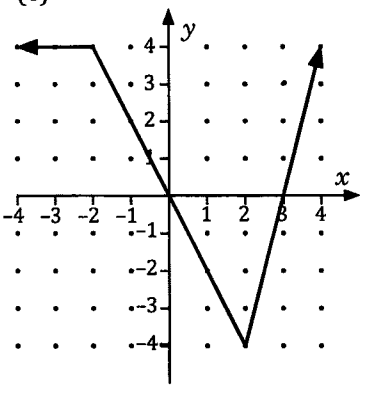
(a)



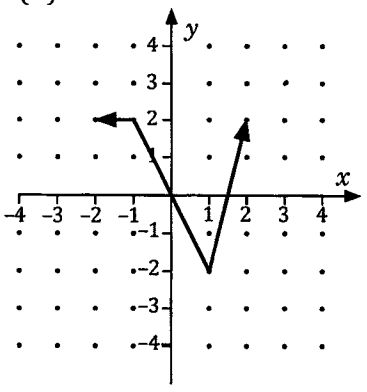

(b)



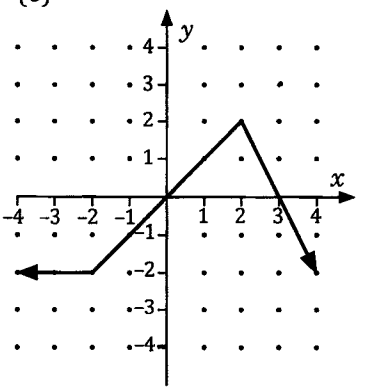

(c)



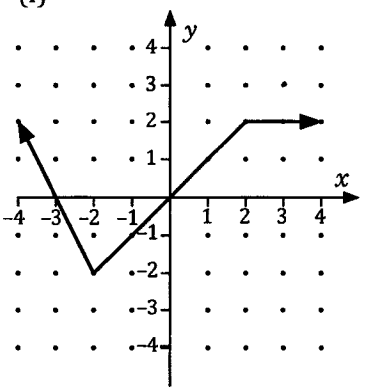
(d)



(e)

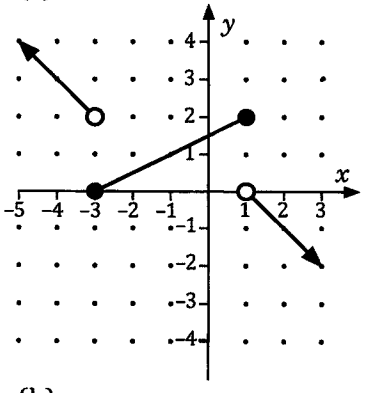


(f)

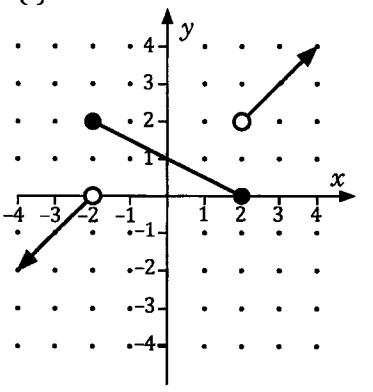


**5.** (a) 1 (b) 1·5 (c) 2 (d) 3

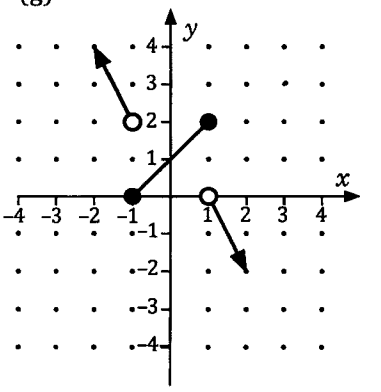
(e)



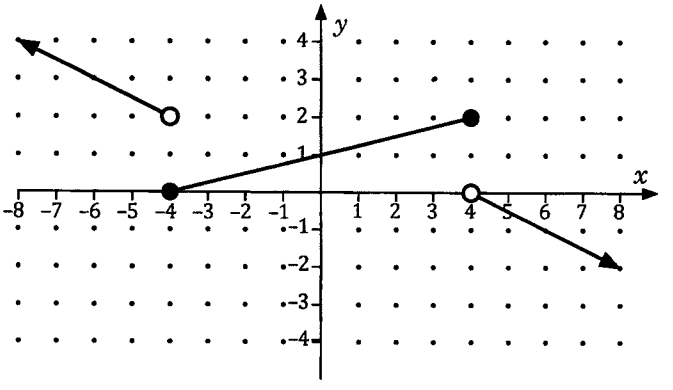
(f)



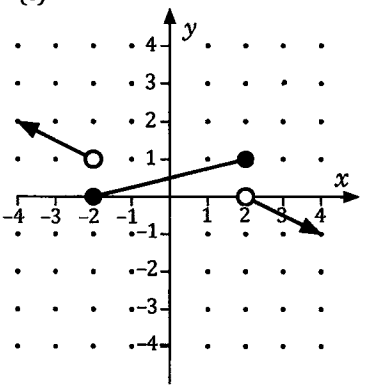
(g)



(h)



(i)



**6.** A: III, B: X, C: IX, D: VI, E: I, F: II

**7.** (a) (1, 0), (7, 0), (10, 0)
(b) (−1, 0), (2, 0), (3·5, 0)
(c) (−2, 0), (4, 0), (7, 0)
(d) (−7, 0), (−4, 0), (2, 0)
(e) (2, 8)
(f) (5, 1)

**Exercise 7D. Page 153.**

**1.** A, C, D

**2.** $x^2 + y^2 = 100$, $a = 8$, $b = \sqrt{91}$, $c = -10$, $d = -5\sqrt{3}$

**3.** (a) $(x-2)^2 + (y+3)^2 = 25$
(b) $(x-3)^2 + (y-2)^2 = 49$
(c) $(x+10)^2 + (y-2)^2 = 45$
(d) $(x+1)^2 + (y+1)^2 = 36$

**4.** (a) $x^2 + y^2 - 6x - 10y = -9$ (b) $x^2 + y^2 + 4x - 2y = 2$
(c) $x^2 + y^2 + 6x + 2y = -6$ (d) $x^2 + y^2 - 6x - 16y = -45$

**5.** (a) 5, (0, 0) (b) 0·6, (0, 0) (c) 5, (3, –4) (d) 10, (–7, 1)
(e) 3, (3, –2) (f) 5, (–1, 3) (g) 10, (–1, 7) (h) 15, (–5, 7)
(i) 12, (10, 5) (j) 2, (0·5, –2·5)

**6.** $\sqrt{5}$ **7.** $y = -11x + 29$

**8.** $(x-3)^2 + (y-4)^2 = 36$ **9.** $(x+4)^2 + (y+3)^2 = 9$

**10.** (a) $(y-2)^2 = x$ (b) $y^2 = x + 4$ (c) $(y-1)^2 = x - 2$ (d) $(y+2)^2 = x - 3$

**11.** (a) 15
(b) The circles have just one point in common because the distance between the centres equals the sum of the radii.

**12.** (a) $2\sqrt{5}$
(b) The circles have no points in common because the distance between the centres exceeds the sum of the radii.

**13.** (1, – 2) and (8, 5) **14.** (–2, 7) and (–10, 5)

**15.** (5, 10) **16.** a < 26

**Miscellaneous Exercise Seven. Page 156**

**1.** (a) $y = 0{\cdot}5(x+3)(x-2)(x-4)$ (b) $y = 2(x+2)^2(x-4)$

**2.** (a) $x = 2 \pm \sqrt{10}$ (b) $x = 2 \pm \sqrt{10}$

**3.** Centre at (–3, 5) radius 7

**4.** (a) 4 (b) 16 (c) 64 (d) 0 and 1

**5.** $f_2$ gradient 2·5, $f_4$ gradient –2

**6.** $y = 0{\cdot}4x - 7$

**7.** (a) $x = -7$, $x = 2{\cdot}25$, $x = 2{\cdot}5$. (b) $x = -5{\cdot}25$, $x = -1{\cdot}5$, $x = 7$.
(c) $x = 3$. (d) No real solutions.

**8.** (a) Statements A and C (b) Statements B and D (c) Statements B and D
(d) Statements A and C (e) Statement A (f) Statements A and C
(g) Statements B and D (h) Statement B

**9.** (a) $x = -9$, $x = 3{\cdot}5$. (b) $x = 2$, $x = 6$.
(c) $x = -1$, $x = 0{\cdot}6$. (d) $x = -11$, $x = 0{\cdot}8$, $x = 7$
(e) $x = -5$, $x = 1$, $x = 3$. (f) $x = -5$, $x = -2$, $x = 1{\cdot}5$.

**10.** (a) Cubic (b) Quadratic (c) None of the listed types.
(d) Cubic (e) Reciprocal (f) Linear

**11.** (a) c = 4 (b) b = –5 (c) $(x-3)(x-1)(x-4)$

**12.** (a) If $x$ is doubled in value $m$ must be halved in value if the system is to remain in balance.
(b) The relationship between $x$ and $m$ is one of inverse proportion.
If $x$ is multiplied by some factor k then $m$ needs to be multiplied by $\frac{1}{k}$.
(c) If $m = 20$ then $x$ must be 0·5 for the system to balance.
(d) For the system to balance $x$ cannot take negative values, it cannot be zero and, from the length of the beam, $x$ cannot exceed 3. Hence the domain consists of all real numbers greater than 0 and less than or equal to 3, i.e. $\{x \in \mathbb{R}: 0 < x \leq 3\}$.
For this domain the rule will output $m$ values such that $m \geq \frac{10}{3}$. Hence the range consists of all real numbers greater than or equal to $\frac{10}{3}$, i.e. $\{m \in \mathbb{R}: m \geq \frac{10}{3}\}$.

**13.** The triangular piece that has been removed has an area of 752 $mm^2$ and a perimeter of 128 mm, both answers given to the nearest whole number.

**Exercise 8A. Page 164.**

| | | | | | |
|---|---|---|---|---|---|
| **1.** 4 | **2.** 3 | **3.** 6 | **4.** 5 | **5.** 4 | **6.** 4 |
| **7.** 3, 6 | **8.** 3, 2 | **9.** 4, 5 | **10.** 2, 3 | **11.** 3, 2·5 | **12.** 1, 4 |

**Investigation. Page 165**

In the graph of $y = a \sin x$ the amplitude is a, or to be more correct | a | .
Changing the value of a changes the amplitude. The graph is stretched (or compressed) vertically.
(If a changes sign the graph reflects in the $x$-axis.)

The graph of $y = a \sin bx$ perform b cycles in the interval that $y = \sin x$ would perform 1 cycle.
The period of the graph is $\frac{2\pi}{b}$, if radians are used, or $\frac{360}{b}$ for degrees.
Changing the value of b changes the period. The graph is stretched or compressed horizontally.

In the graph of $y = a \sin [b(x - c)]$ changing the value of c translates the graph horizontally.
In the graph of $y = a \sin [b(x - c)] + d$ changing the value of d translates the graph vertically.

Discuss your findings for the cosine and tangent function with others in your class.

**Exercise 8B. Page 167.**

**1.** (a) 1 (b) 2 (c) 4 (d) 3 (e) 2 (f) 3 (g) 5 (h) 3

**2.** (a) 360° (b) 180° (c) 360° (d) 180° (e) 720° (f) 120° (g) 90° (h) 1080° (i) 180°

**3.** (a) $2\pi$ (b) $\pi$ (c) $2\pi$ (d) $\frac{\pi}{2}$ (e) $\frac{\pi}{3}$ (f) $\frac{2\pi}{3}$ (g) $4\pi$ (h) $\pi$ (i) 0·5

**4.** (a) Max at $(\frac{\pi}{2}, 1)$. Min at $(\frac{3\pi}{2}, -1)$.

(b) Max at $(\frac{\pi}{2}, 3)$. Min at $(\frac{3\pi}{2}, 1)$.

(c) Max at $(\frac{3\pi}{2}, 1)$. Min at $(\frac{\pi}{2}, -1)$.

(d) Max at $(\frac{\pi}{4}, 4)$ and at $(\frac{5\pi}{4}, 4)$. Min at $(\frac{3\pi}{4}, 2)$ and at $(\frac{7\pi}{4}, 2)$.

(e) Max at $(\frac{3\pi}{4}, 4)$. Min at $(\frac{7\pi}{4}, 2)$.

**5.** (a) 3, 90° (b) 2, 120° (c) 2, 60° (d) 3, 270°

**6.** (a) 3, $\frac{\pi}{4}$ (b) 5, $\frac{3\pi}{2}$ (c) 2, $\frac{11\pi}{6}$ (d) 3, $\frac{\pi}{6}$

**7.** (a) 2 (b) 3 (c) −3 (d) Approx. −1·3

**8.** (a) 3 (b) −2 **9.** (a) 2 (b) −1

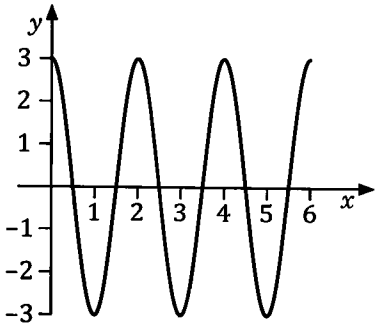
**10.** (a) 2, 3 (b) −3, 2 (c) 2, 6 (d) 3, $\frac{2\pi}{3}$

**11.** (a) 1, 2 (b) −3, 3 (c) −3, 2 (d) 2, $\frac{\pi}{2}$

**12.** (a) a = 2, b = 30, 390 (b) $y = -2 \sin (x - 210)°$

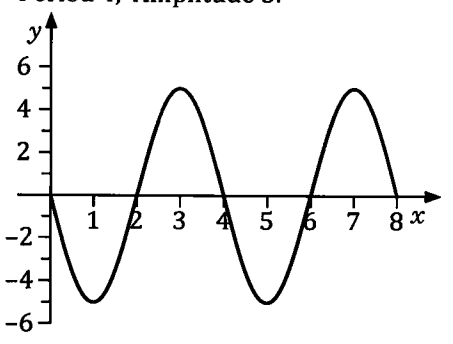
**13.** (a) Period 2, Amplitude 3.

(b)

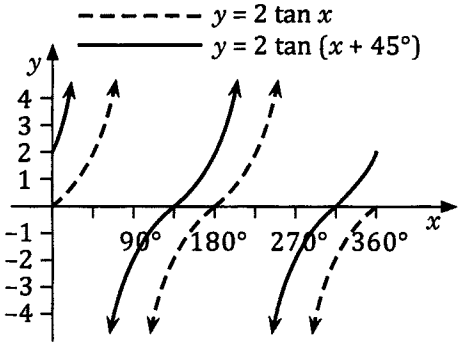



**14.** (a) Period 4, Amplitude 5.

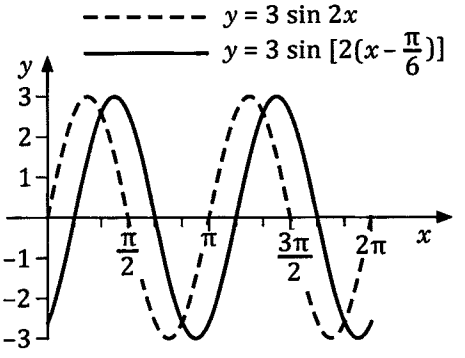
(b)



**15.**




**16.**




**Exercise 8C. Page 174.**

| | | | | | |
|---|---|---|---|---|---|
| **1.** Positive | **2.** Positive | **3.** Negative | **4.** Negative | **5.** Negative | **6.** Negative |
| **7.** Positive | **8.** Positive | **9.** Positive | **10.** Negative | **11.** Negative | **12.** Negative |
| **13.** $\sin 40^\circ$ | **14.** $-\sin 70^\circ$ | **15.** $-\sin 20^\circ$ | **16.** $\sin 80^\circ$ | **17.** $\sin\frac{\pi}{6}$ | **18.** $-\sin\frac{\pi}{6}$ |
| **19.** $\sin\frac{\pi}{5}$ | **20.** $-\sin\frac{\pi}{5}$ | **21.** $-\cos 80^\circ$ | **22.** $-\cos 20^\circ$ | **23.** $\cos 60^\circ$ | **24.** $\cos 60^\circ$ |
| **25.** $-\cos\frac{\pi}{5}$ | **26.** $-\cos\frac{\pi}{10}$ | **27.** $-\cos\frac{\pi}{10}$ | **28.** $\cos\frac{\pi}{10}$ | **29.** $-\tan 80^\circ$ | **30.** $\tan 20^\circ$ |
| **31.** $-\tan 60^\circ$ | **32.** $\tan 20^\circ$ | **33.** $\tan\frac{\pi}{5}$ | **34.** $-\tan\frac{\pi}{5}$ | **35.** $\tan\frac{\pi}{5}$ | **36.** $-\tan\frac{\pi}{5}$ |
| **37.** $-\frac{\sqrt{3}}{2}$ | **38.** $\frac{1}{\sqrt{3}}$ | **39.** $-\frac{1}{2}$ | **40.** 0 | **41.** 0 | **42.** $\frac{\sqrt{3}}{2}$ |
| **43.** $-\frac{1}{\sqrt{2}}$ | **44.** $-\frac{1}{\sqrt{2}}$ | **45.** $-\frac{1}{2}$ | **46.** $-\frac{\sqrt{3}}{2}$ | **47.** $\frac{1}{\sqrt{3}}$ | **48.** $-\frac{1}{\sqrt{2}}$ |
| **49.** $\frac{1}{\sqrt{2}}$ | **50.** 0 | **51.** 1 | **52.** $\frac{1}{2}$ | | |

**Exercise 8D. Page 179.**

| | | | | |
|---|---|---|---|---|
| **1.** $60^\circ, 300^\circ$ | **2.** $210^\circ, 330^\circ$ | **3.** $45^\circ, 225^\circ$ | **4.** $225^\circ, 315^\circ$ | **5.** $\frac{\pi}{4}, \frac{3\pi}{4}$ |
| **6.** $\frac{3\pi}{4}, \frac{5\pi}{4}$ | **7.** $\frac{3\pi}{4}, \frac{7\pi}{4}$ | **8.** $\frac{\pi}{3}, \frac{4\pi}{3}$ | **9.** $\pm 30^\circ$ | **10.** $-90^\circ$ |
| **11.** $-30^\circ, 150^\circ$ | **12.** $0^\circ, \pm 180^\circ$ | **13.** $\frac{\pi}{3}, \frac{2\pi}{3}$ | **14.** $\pm\frac{2\pi}{3}$ | **15.** $\frac{\pi}{6}, \frac{5\pi}{6}$ |
| **16.** $\pm\frac{\pi}{2}$ | **17.** $\pi + 0{\cdot}98$ | **18.** $\pm 116{\cdot}1^\circ$ | **19.** $15^\circ, 105^\circ$ | |
| **20.** $\frac{\pi}{24}, \frac{11\pi}{24}, \frac{13\pi}{24}, \frac{23\pi}{24}$ | | **21.** $-70^\circ, 10^\circ, 50^\circ$ | | |
| **22.** $\frac{\pi}{6}, \frac{\pi}{3}, \frac{7\pi}{6}, \frac{4\pi}{3}$ | | **23.** $\frac{5\pi}{18}, \frac{7\pi}{18}, \frac{17\pi}{18}, \frac{19\pi}{18}, \frac{29\pi}{18}, \frac{31\pi}{18}$ | | |
| **24.** $\frac{\pi}{6}, \frac{5\pi}{6}, \frac{3\pi}{2}$ | | **25.** $45^\circ, 135^\circ, 225^\circ, 315^\circ$ | | **26.** $\pm\frac{\pi}{6}, \pm\frac{5\pi}{6}$ |
| **27.** $0^\circ, \pm 60^\circ, \pm 180^\circ$ | | **28.** $\pm\frac{\pi}{3}, \pm\pi$ | | **29.** $\frac{5\pi}{12}, \frac{23\pi}{12}$ |

**Exercise 8E. Page 182.**

**1.** $14{\cdot}5^\circ,\ 165{\cdot}5^\circ$

**2.** $\pm\frac{5\pi}{6},\ \pm\frac{\pi}{6}$

**3.** $\frac{\pi}{2}$

**4.** $\frac{\pi}{6},\ \frac{\pi}{2},\ \frac{5\pi}{6},\ \frac{3\pi}{2}$

**5.** $0^\circ,\ 180^\circ,\ 210^\circ,\ 330^\circ,\ 360^\circ$

**6.** $11{\cdot}5^\circ,\ 120^\circ,\ 168{\cdot}5^\circ,\ 240^\circ$

**7.** $\frac{\pi}{3},\ \frac{2\pi}{3},\ \frac{4\pi}{3},\ \frac{5\pi}{3}$

**8.** $-135^\circ, -63{\cdot}4^\circ, 45^\circ, 116{\cdot}6^\circ$

**9.** $\pm 60^\circ$

**10.** $\frac{\pi}{6},\ \frac{\pi}{2},\ \frac{5\pi}{6},\ \frac{13\pi}{6},\ \frac{5\pi}{2},\ \frac{17\pi}{6}$

**Exercise 8F. Page 187.**

**1.** $\sin 3x$

**2.** $\cos 2x$

**3.** $\sin 4x$

**4.** $\cos 8x$

**5.** $\frac{\sqrt{2}(\sqrt{3}+1)}{4}$

**6.** $2-\sqrt{3}$

**7.** $\frac{\sqrt{2}(\sqrt{3}+1)}{4}$

**8.** $\frac{\sqrt{2}(\sqrt{3}-1)}{4}$

**9.** $2+\sqrt{3}$

**10.** $a=\sqrt{2},\ b=\sqrt{2}$

**11.** $c=4\sqrt{3},\ d=4$

**12.** $e=2\sqrt{3},\ f=-2$

**13.** $\sqrt{3},\ \frac{4\pi}{3}$

**14.** (a) $\frac{56}{65}$ (b) $\frac{63}{65}$

**15.** (a) $-\frac{44}{125}$ (b) $\frac{3}{5}$

**21.** (a) $-\frac{56}{65}$ (b) $\frac{63}{65}$ (c) $-\frac{56}{33}$

**22.** $\frac{\pi}{12},\ \frac{7\pi}{12}$

**23.** $80^\circ, 320^\circ$

**24.** $-40^\circ, 80^\circ$

**25.** $30^\circ, 210^\circ$

**Alternating Current. Page 188.**

Amplitude $\approx 340$ volts. Period 0·02 seconds. $V = 340\sin 100\pi t$

**Average Weekly Temperatures. Page 189.**

$T = 18 - 12\sin\frac{\pi}{26}x$

Average weekly temperature exceeded 25°C on 15 of the weeks.

**Tidal Motion. Page 189.**

Compare your answers to those of others in your class.

**Miscellaneous Exercise Eight. Page 190.**

**1.** Amplitude 5, Period $2\pi$.

**2.** Amplitude 7, Period $2\pi$.

**3.** Amplitude 3, Period $2\pi$.

**4.** Amplitude 1, Period $\frac{2\pi}{2}$, i.e. $\pi$.

**5.** Amplitude 1, Period $\frac{2\pi}{3}$.

**6.** Amplitude 1, Period $\frac{2\pi}{0{\cdot}5}$, i.e. $4\pi$.

**7.** Amplitude 3, Period $\frac{2\pi}{4}$, i.e. $\frac{\pi}{2}$.

**8.** Amplitude 4, Period $\frac{2\pi}{5}$.

**9.** Amplitude 2, Period $\frac{2\pi}{\pi}$. i.e. 2.

**10.**

| $\theta$ | $-\frac{3\pi}{4}$ | $-\frac{2\pi}{3}$ | $\frac{\pi}{6}$ | $\frac{\pi}{4}$ | $\frac{4\pi}{3}$ | $\frac{7\pi}{3}$ | $\frac{9\pi}{4}$ | $11\pi$ |
|---|---|---|---|---|---|---|---|---|
| $\sin\theta$ | $-\frac{\sqrt{2}}{2}$ | $-\frac{\sqrt{3}}{2}$ | $\frac{1}{2}$ | $\frac{\sqrt{2}}{2}$ | $-\frac{\sqrt{3}}{2}$ | $\frac{\sqrt{3}}{2}$ | $\frac{\sqrt{2}}{2}$ | 0 |
| $\cos\theta$ | $-\frac{\sqrt{2}}{2}$ | $-\frac{1}{2}$ | $\frac{\sqrt{3}}{2}$ | $\frac{\sqrt{2}}{2}$ | $-\frac{1}{2}$ | $\frac{1}{2}$ | $\frac{\sqrt{2}}{2}$ | $-1$ |
| $\tan\theta$ | 1 | $\sqrt{3}$ | $\frac{\sqrt{3}}{3}$ | 1 | $\sqrt{3}$ | $\sqrt{3}$ | 1 | 0 |

**11.** (a) Neither (b) Parallel (c) Perpendicular

**12.** (a) 13·2 (b) 13·2

**13.** The smallest angle of the triangle is 21°, to the nearest degree.

**14.** (a) (2, 0), (3, 0), (−2, 0), (−7, 0) (b) (0, 0), (2, 0), (−3, 0), (4, 0)
(c) (2, 0), (3, 0), (−3, 0) (d) (2, 0)
(e) (7, 0) (f) (−5, 0), (−1·5, 0), (3·5, 0), (6, 0)

**15.** $k_1 = 0{\cdot}5$ $k_2 = -10$ $k_3 = 4$ $k_4 = 2$ $k_5 = 2$ $k_6 = -12$
$k_7 = 13$ $k_8 = 10$ $k_9 = 1$ $k_{10} = -3$ $k_{11} = 1$ $k_{12} = 2$
$k_{13} = -3$ $k_{14} = -5$ $k_{15} = 1$ $k_{16} = -9$ $k_{17} = 27$ $k_{18} = -26$
$k_{19} = 5$ $k_{20} = 2$ $k_{21} = 5$ $k_{22} = 2$ $k_{23} = 45$ $k_{24} = 5$
$k_{25} = -4$ $k_{26} = 3$

**16.** (a) a = 2, c = −12 (b) b = 5 (c) (−4, 0), (1·5, 0), (2, 0)

**17.** (a) Maximum turning point at (−1, 26). Minimum turning point at (3, −6).
(b) Maximum turning point at (−1, 16). Minimum turning point at (3, −16).
(c) Maximum turning point at (1, 21). Minimum turning point at (−3, −11).
(d) Maximum turning point at (3, 11). Minimum turning point at (−1, −21).
(e) Maximum turning point at (−1, 63). Minimum turning point at (3, −33).
(f) Maximum turning point at (−0·5, 21). Minimum turning point at (1·5, −11).

**18.** (a) (−1, 0), (2, 0), (5, 0) (b) (0, 10) (c) a = 8 (d) b = −8 (e) c = −10
(f) (3, −4). Minimum (g) (0, 5) (h) d = 0
(i) Use a graphic calculator to check your sketch. $x \approx -0{\cdot}4$, $x \approx 2{\cdot}4$, $x = 5$

**19.** 269·4 $cm^2$

**Exercise 9A. Page 193.**

**1.** (a) $\frac{1}{2}$ (b) $\frac{1}{2}$ (c) $\frac{1}{2}$ (d) $\frac{1}{3}$ (e) $\frac{2}{3}$

**2.** (a) $\frac{1}{2}$ (b) $\frac{1}{2}$ (c) $\frac{5}{12}$ (d) $\frac{1}{18}$ (e) $\frac{5}{18}$ (f) $\frac{13}{18}$

**3.** (a) 0·3 (b) 0·7 (c) 0·5 (d) 0·8

**4.** (a) $\frac{1}{8}$ (b) $\frac{1}{8}$ (c) $\frac{3}{8}$ (d) $\frac{1}{2}$ (e) $\frac{1}{8}$ (f) $\frac{1}{4}$

**5.** (a) 0 (b) $\frac{5}{6}$ (c) $\frac{1}{3}$ (d) $\frac{1}{3}$ (e) $\frac{1}{6}$

**6.** (a) $\frac{1}{10}$ (b) $\frac{3}{20}$ (c) $\frac{47}{100}$ (d) $\frac{12}{25}$ (e) $\frac{7}{10}$ (f) $\frac{11}{50}$

**7.** (a) 0·327 (b) 0·672

**8.** (a) 7 (b) 9 (c) 10 (d) 3 (e) {8, 9, 10}
(f) {1, 3, 5, 7, 9} (g) {9} (h) {1, 3, 5, 7, 8, 9, 10}

**9.** (a) 67 (b) 3 **10.** 17

**11.** 17 **12.** 11

**13.** (a) 65 (b) 12 (c) 8

**14.** (a) 0·6 (b) 0·2 (c) 0·1 (d) 0·7 (e) 0·9 (f) 0·3

**15.** (a) $\frac{10}{19}$ (b) $\frac{12}{19}$ (c) $\frac{9}{19}$ (d) $\frac{10}{19}$ (e) $\frac{1}{19}$ (f) $\frac{3}{19}$ (g) $\frac{13}{19}$ (h) $\frac{16}{19}$ (i) $\frac{18}{19}$

**16.** (a) $\frac{17}{40}$ (b) $\frac{13}{40}$ (c) 0 (d) $\frac{3}{4}$ (e) $\frac{1}{4}$ (f) 1

**17.** 0·2 **18.** (a) 0·3 (b) 0·38 **19.** (a) $\frac{13}{20}$ (b) $\frac{13}{15}$

**Exercise 9B. Page 199.**

**1.** (a) $\frac{1}{6}$ (b) $\frac{1}{5}$ **2.** (a) $\frac{1}{4}$ (b) $\frac{1}{3}$ **3.** (a) $\frac{1}{18}$ (b) $\frac{1}{6}$

**4.** (a) $\frac{1}{52}$ (b) $\frac{1}{20}$ **5.** (a) $\frac{7}{25}$ (b) $\frac{15}{26}$

**6.** (a) $\frac{3}{5}$ (b) $\frac{47}{100}$ (c) $\frac{7}{10}$ (d) $\frac{37}{100}$ (e) $\frac{2}{5}$ (f) $\frac{53}{100}$ (g) $\frac{37}{47}$ (h) $\frac{23}{53}$

**7.** (a) $\frac{1}{2}$ (b) $\frac{1}{3}$ (c) $\frac{1}{3}$ (d) 1 (e) 1 (f) $\frac{1}{2}$

**8.** (a) 0·7 (b) 0·3 (c) 0·9 (d) 0·3 (e) 0·7 (f) $\frac{1}{3}$ (g) $\frac{1}{7}$ (h) $\frac{7}{9}$ (i) 1

**9.** (a) $\frac{1}{3}$ (b) $\frac{5}{9}$ (c) $\frac{7}{9}$ (d) $\frac{1}{9}$ (e) $\frac{2}{3}$ (f) $\frac{4}{9}$ (g) $\frac{1}{5}$ (h) $\frac{1}{3}$ (i) $\frac{5}{7}$

**10.** (a) $\frac{2}{5}$ (b) $\frac{1}{10}$ (c) $\frac{1}{4}$ (d) $\frac{3}{5}$ (e) $\frac{1}{3}$

**11.** (a) $\frac{1}{6}$ (b) $\frac{1}{3}$ (c) 0 (d) 0 (e) $\frac{1}{3}$ (f) $\frac{2}{3}$ (g) $\frac{1}{3}$ (h) $\frac{2}{3}$

**12.** (a) $\frac{1}{10}$ (b) $\frac{1}{5}$ (c) 0 (d) $\frac{1}{4}$ (e) $\frac{1}{6}$ (f) $\frac{5}{6}$ (g) $\frac{2}{5}$

**13.** (a) $\frac{1}{9}$ (b) 0 (c) $\frac{1}{6}$ (d) $\frac{1}{6}$ (e) $\frac{4}{9}$

**14.** (a) $\frac{1}{6}$ (b) $\frac{1}{3}$ (c) $\frac{1}{6}$ (d) $\frac{1}{5}$ (e) $\frac{1}{9}$ (f) $\frac{1}{2}$

**15.** (a) $\frac{1}{20}$ (b) $\frac{1}{2}$ (c) $\frac{2}{5}$ (d) $\frac{3}{10}$ (e) $\frac{3}{10}$ (f) $\frac{1}{10}$ (g) $\frac{1}{5}$ (h) $\frac{1}{11}$ (i) $\frac{1}{6}$
(j) $\frac{1}{2}$ (k) $\frac{1}{5}$ (l) $\frac{1}{3}$

**16.** (a) $\frac{1}{2}$ (b) $\frac{1}{4}$ (c) 1 (d) $\frac{1}{2}$ (e) $\frac{1}{3}$ (f) 0 **17.** (a) $\frac{1}{2}$ (b) $\frac{1}{2}$

**Exercise 9C. Page 204. (Tree diagrams not shown here.)**

**1.** (a) $\frac{1}{2}$ (b) $\frac{2}{3}$ (c) $\frac{3}{4}$ (d) $\frac{1}{2}$

**2.** (a) $\frac{1}{3}$ (b) $\frac{5}{9}$ (c) $\frac{1}{3}$ (d) $\frac{2}{3}$

**3.** (a) $\frac{1}{9}$ (b) $\frac{5}{9}$ (c) $\frac{2}{3}$ (d) $\frac{1}{2}$

**4.** (a) $\frac{1}{4}$ (b) $\frac{3}{16}$ (c) $\frac{2}{3}$ (d) $\frac{6}{13}$

**5.** (a) $\frac{1}{20}$ (b) $\frac{1}{5}$ (c) $\frac{1}{5}$ (d) $\frac{1}{20}$ (e) $\frac{1}{4}$ (f) $\frac{1}{4}$ (g) $\frac{1}{4}$

**Exercise 9D. Page 206.**

**1.** (a) $\frac{5}{6}$ (b) $\frac{1}{36}$ (c) $\frac{11}{36}$ (d) $\frac{1}{18}$ (e) $\frac{4}{9}$

**2.** (a) $\frac{1}{2}$ (b) $\frac{1}{6}$ (c) $\frac{1}{12}$ (d) $\frac{7}{12}$ (e) $\frac{1}{4}$ (f) $\frac{1}{2}$

**3.** (a) $\frac{1}{52}$ (b) $\frac{1}{13}$ (c) $\frac{1}{2}$ (d) $\frac{1}{13}$ (e) $\frac{1}{4}$ (f) $\frac{1}{13}$
(g) $\frac{12}{13}$ (h) $\frac{3}{13}$ (i) $\frac{1}{26}$ (j) $\frac{7}{13}$ (k) $\frac{1}{52}$ (l) $\frac{4}{13}$

**4.** (a) $\frac{1}{2}$ (b) $\frac{1}{4}$ (c) $\frac{3}{4}$ (d) $\frac{1}{2}$

**Exercise 9E. Page 214.**

**1.** (a) 0·6 (b) 0·12 (c) 0·6 (d) 0·3 (e) 0·2 (f) 0·7

**2.** (a) 0·4 (b) 0·2 (c) 0·26 (d) 0·8 (e) 0·1 (f) $\frac{3}{13}$

**3.** (a) $\frac{7}{30}$ (b) $\frac{7}{15}$ (c) $\frac{8}{15}$ (d) $\frac{7}{8}$

**4.** (a) $\frac{3}{4}$ (b) $\frac{4}{5}$ (c) $\frac{1}{5}$

**5.** (a) 0·6 (b) 0·56 (c) $\frac{4}{7}$ (d) $\frac{9}{11}$

**6.** (a) $\frac{1}{2}$ (b) $\frac{1}{6}$ (c) $\frac{17}{60}$ (d) $\frac{43}{60}$ (e) $\frac{1}{6}$ (f) $\frac{4}{5}$ (g) $\frac{10}{17}$ (h) $\frac{15}{43}$

**7.** (a) $\frac{25}{36}$ (b) $\frac{16}{25}$

**8.** (a) $\frac{4}{9}$ (b) $\frac{3}{4}$ (c) $\frac{55}{83}$

**9.** (a) 0·912 (b) 0·038 (c) 0·039 (d) 0·563

**10.** (a) $\frac{3}{5}$ (b) $\frac{1}{6}$ (c) $\frac{4}{15}$ (d) $\frac{1}{6}$ (e) $\frac{5}{18}$

**Exercise 9F. Page 223.**

**1.** (a) $\frac{1}{3}$ (b) $\frac{7}{15}$ (c) $\frac{1}{3}$ (d) $\frac{2}{3}$

**2.** (a) 0·8472 (b) 0·1528

**3.** (a) 0·9265 (b) 0·0735

**4.** (a) $\frac{1}{30}$ (b) $\frac{1}{20}$ (c) $\frac{1}{6}$ (d) $\frac{5}{6}$

**5.** (a) 0·064 (b) 0·118 (c) 0·216 (d) 0·784

**6.** (a) 0·1248 (b) 0·1152

**7.** $\frac{5}{12}$

**8.** 0·01097

**9.** (a) $\frac{1}{2}$ (b) $\frac{2}{3}$ (c) $\frac{1}{3}$ (d) $\frac{5}{6}$

**10.** (a) $\frac{1}{3}$ (b) $\frac{1}{2}$ (c) $\frac{1}{6}$ (d) $\frac{2}{3}$

**11.** (a) 0·8 (b) 0·2 (c) 0·2 (d) 0·25

**12.** (a) 0·4 (b) 0·5 (c) 0·8

**13.** (a) 0·00000003 (b) 0·66 (c) 0·34

**14.** (a) $\frac{1}{36}$ (b) $\frac{25}{36}$ (c) $\frac{11}{36}$

**15.** (a) 0·00005 (b) 0·98505 (c) 0·01495

**16.** (a) 0·0000001 (b) 0·983 (c) 0·017

**17.** (a) $\frac{1}{2}$ (b) $\frac{2}{5}$ (c) $\frac{3}{5}$ (d) $\frac{7}{10}$

**18.** (a) $\frac{8}{15}$ (b) $\frac{4}{5}$

**19.** (a) 0·13 (b) 0·2

**20.** 0·8

**21.** $\frac{3}{4}$

**Exercise 9G. Page 228.**

**1.** Dependent **2.** Independent **3.** Independent
**4.** Dependent **5.** Mutually exclusive **6.** Mutually exclusive
**7.** Not mutually exclusive **8.** Not mutually exclusive **9.** (a) and (d)
**10.** (a) Independent (b) Dependent
**12.** (a) 0·2 (b) 0·25 (c) 0·05 (d) 0·6 **13.** (a) 0 (b) 0 (c) 0 (d) 0·5
**15.** (a) 0·3 (b) 0·8 (c) 0·6 (d) 0·5 **16.** 0·8
**17.** 0·2 **18.** (a) 0·4 (b) 0·48
**19.** (a) 0·3 (b) 0·4 **20.** (a) 0 (b) 15
**21.** (a) 0·35 (2 dp) (b) 0·45 (2 dp) (c) 0·19 (2 dp)
(d) The disparity between the three probabilities suggests that being an Engineering student is **not** independent of gender. Whilst 35% of all students at the college are Engineering students, for males at the college this rises to 45% whilst for females it is just 19%.
**22.** (a) 0·35 (2 dp) (b) 0·34 (2 dp) (c) 0·35 (2 dp)
(d) The fact that the three probabilities are almost identical suggests that whether the student is on the honours course is independent of gender. The proportion of students on the honours course is almost exactly the same whether we are considering all the students, just the males or just the females.

**Miscellaneous Exercise Nine. Page 231.**

**1.** (a) 0·5 (b) 0·5 (c) $\frac{5}{6}$ (d) $\frac{1}{6}$ (e) 0·5

**3.** $x = -4,\ x = 4{\cdot}5$ **4.** (a) 1 (b) $\frac{1}{3}$ (c) $\frac{1}{2}$

**5.** (a) Period 180°, amplitude 4 units. (b) Period 120°, amplitude 3 units.
**6.** $x = -148,\ x = -32,\ x = 212,\ x = 328.$ **7.** C has coordinates (7, 1)
**8.** (a) $\frac{55}{93}$ (b) $\frac{7}{93}$ (c) $\frac{7}{22}$ (d) $\frac{7}{38}$
**9.** (a) (0, −28) (b) A: (−2, 0), D: (7, 0) (c) $a = 4, b = -108$ (d) $-108 < p < 0$
**10.** $\frac{\pi}{3}, \frac{14\pi}{13}, \frac{5\pi}{3}, \frac{25\pi}{13}$ **11.** (a) $\frac{1}{15}$ (b) $\frac{3}{10}$ (c) $\frac{5}{14}$ (d) $\frac{5}{7}$
**12.** (a) 0·32 (b) 0·2 (c) 0·68 (d) 0·2 (e) 0·6 (f) Yes. Justification: $P(B|A) = 0{\cdot}2 = P(B)$
[or $P(A|B) = 0{\cdot}6 = P(A)$]
[or $P(A \cap B) = 0{\cdot}12 = P(A)\,P(B)$]

**Exercise 10A. Page 236.**

**1.** 40 320 **2.** 48 **3.** 10 **4.** 90
**5.** 90 **6.** 56 **7.** 8 **8.** 970 200
**9.** 96 **10.** 120, 5! **11.** 20, $\frac{5!}{(5-2)!}$ i.e. $\frac{5!}{3!}$ **12.** 60, $\frac{5!}{2!}$
**13.** 650, $\frac{26!}{24!}$ **14.** 358 800, $\frac{26!}{22!}$ **15.** 40 320, 8! **16.** 504, $\frac{9!}{6!}$

**Exercise 10B. Page 240.**

**1.** 330 **2.** 18 564 **3.** 210 **4.** 455
**5.** 792 **6.** 133 784 560 **7.** 5 245 786 **8.** 3003, 10

**Exercise 10C. Page 241.**

**1.** $a^8 + 8a^7b + 28a^6b^2 + 56a^5b^3 + 70a^4b^4 + 56a^3b^5 + 28a^2b^6 + 8ab^7 + b^8$

**2.** $a^{10} + 10a^9b + 45a^8b^2 + 120a^7b^3 + 210a^6b^4 + 252a^5b^5 + 210a^4b^6 + 120a^3b^7 + 45a^2b^8 + 10ab^9 + b^{10}$

**3.** $x^8 - 8x^7y + 28x^6y^2 - 56x^5y^3 + 70x^4y^4 - 56x^3y^5 + 28x^2y^6 - 8xy^7 + y^8$

**4.** $x^6 + 12x^5y + 60x^4y^2 + 160x^3y^3 + 240x^2y^4 + 192xy^5 + 64y^6$

**5.** $p^6 - 12p^5q + 60p^4q^2 - 160p^3q^3 + 240p^2q^4 - 192pq^5 + 64q^6$

**6.** $243x^5 - 810x^4y + 1080x^3y^2 - 720x^2y^3 + 240xy^4 - 32y^5$

**Miscellaneous Exercise Ten. Page 244.**

**1.** (a) $x = 0{\cdot}625$ (b) $x = -4$
(c) $x = -1$ (d) $x = 1{\cdot}4$
(e) $x = 3$, $x = -2$ (f) $x = 1$, $x = -5$
(g) $x = 0{\cdot}5$, $x = -7$ (h) $x = -3$, $x = 0{\cdot}25$, $x = 1{\cdot}8$
(i) $x = 9$, $x = -3$ (j) $x = -2$, $x = 3{\cdot}5$
(k) $x = -1$, $x = 0$, $x = 6$ (l) $x = -0{\cdot}8$, $x = 1{\cdot}5$

**2.** A: $x = -6$, B: $y = 16$, C: $y = 4x$, D: $y = 2x$,
E: $y = x$, F: $y = x - 5$, G: $y = -2x$, H: $y = -4x + 20$

**3.** $0{\cdot}1$

**4.** The number could be $-3{\cdot}5$ or it could be $1{\cdot}5$.

**5.** The fire is approximately 19·7 km from lookout N$^{o}$·1 and 18·8 km from lookout N$^{o}$·2.

**6.** $\frac{1}{6}$

**7.** (a) $y = 3x + 7$ (b) $y = 3x + 11$ (c) $y = -2x + 7$ (d) $y = -2x + 16$ (e) $y = 0{\cdot}5x + 6$

**8.** $x = 1 \pm \frac{\sqrt{2}}{2}$

**9.** $y = 1{\cdot}5x + 15$

**10.** (a) $0{\cdot}15$ (b) $0{\cdot}6$ (c) $0{\cdot}75$

**11.** A and B are independent, A and C are not, B and C are not.

**12.** A and B are independent, A and C are independent, B and C are not.

**13.** (a) $\frac{1}{15}$ (b) $\frac{4}{15}$

**15.** Discuss your answer and reasoning with those of others in your class.

**16.** (a) p = $-0{\cdot}5$, p = 1 (b) $x = 0$, $x = \pm\frac{2\pi}{3}$

**17.** (a) 16 (b) 6 (c) $-4$ (d) $-4$ (e) 14 (f) 8 (g) $x^2 - x + 6$ (h) $4x^2 - 2x + 6$ (i) $-1$ or 4 (j) $-2$ or 7

**18.** a = $-0{\cdot}5$, b = 5, c = $0{\cdot}5$, d = 2, e = $-3$, f = 2, g = 3, h = $-3$,
j = 3, k = 1, m = 11, n = 3, p = $-8$, q = $-20$, r = $-10$.

**19.** a = 2, b = $\frac{\pi}{3}$

**20.** (a) 1·91 rads (b) 115 cm

**22.** $a = 3$, $b = 2$, C $(-6, 0)$, D $(0, -4)$

**23.** $y = 6\sin\frac{2\pi x}{5} + 2$

**24.** $\sqrt{162 - 30\sqrt{2}}$

**25.** $x = \frac{\pi}{18}, \frac{5\pi}{18}, \frac{13\pi}{18}, \frac{17\pi}{18}$.

**26.** $x^6 - 12x^5y + 76x^4y^2 - 192x^3y^3 + 264x^2y^4 - 200xy^5 + 65y^6$

**27.** 17%