ANSWERS

Answers are based on full calculator values and only rounded at the end, even when different parts of a question require rounding. This gives more accurate answers. Answers based on reading graphs may not be accurate.

Chapter 1

Exercise 1.01

1 **a** 14, 17, 20 **b** 23, 28, 33
c 44, 55, 66 **d** 85, 80, 75
e 1, –1, –3 **f** –15, –24, –33
g $2, 2\frac{1}{2}, 3$ **h** 3.1, 3.7, 4.3
i 32, –64, 128 **j** $\frac{27}{320}, \frac{81}{1280}, \frac{243}{5120}$

2 **a** 1456 **b** 63 **c** 78
d 126 **e** 91 **f** 441

3 $\frac{1}{16}, \frac{1}{32}, \frac{1}{64}$

4 38, 51, 66, 83

5 21, 34, 55, 89, 144

6

1
1 1
1 2 1
1 3 3 1
1 4 6 4 1
1 5 10 10 5 1
1 6 15 20 15 6 1
1 7 21 35 35 21 7 1

Exercise 1.02

1 **a** $y = 13$ **b** $x = -4$ **c** $x = 72$
d $b = 11$ **e** $x = 7$ **f** $x = 42$
g $k = 2$ **h** $x = 1$ **i** $t = -2$
j $t = 3$

2 **a** 46 **b** 78 **c** 94
d –6 **e** 67

3 **a** 590 **b** –850 **c** 414
d 1610 **e** –397

4 **a** –110 **b** 12.4 **c** –8.3
d 37 **e** $15\frac{4}{5}$

5 $T_n = 2n + 1$

6 **a** $T_n = 8n + 1$ **b** $T_n = 2n + 98$
c $T_n = 3n + 3$ **d** $T_n = 6n + 74$
e $T_n = 4n - 25$ **f** $T_n = 20 - 5n$
g $T_n = \frac{n+6}{8}$ **h** $T_n = -2n - 28$
i $T_n = 1.2n + 2$ **j** $T_n = \frac{3n-1}{4}$

7 28th term **8** 54th term
9 30th term **10** 15th term
11 Yes **12** No
13 Yes **14** $n = 13$
15 $n = 30, 31, 32, \ldots$ **16** –2
17 103 **18** 785
19 **a** $d = 8$ **b** 87
20 $d = 9$ **21** $a = 12, d = 7$
22 173 **23** $a = 5$
24 280 **25** 1133

26 **a** $T_2 - T_1 = T_3 - T_2 = d = \log_5 x$
b $80 \log_5 x$ or $\log_5 x^{80}$ **c** 8.6

27 **a** $T_2 - T_1 = T_3 - T_2 = d = \sqrt{3}$
b $50\sqrt{3}$

28 26 **29** $122b$ **30** 38th term

Exercise 1.03

1 **a** 375 **b** 555 **c** 480
2 **a** 2640 **b** 4365 **c** 240
3 **a** 2050 **b** –2575
4 **a** –4850 **b** 4225
5 **a** 28 875 **b** 3276 **c** –1419
d 6426 **e** 6604 **f** 598
g –2700 **h** 11 704 **i** –290
j 1284

6 21 **7** 8 **8** 11

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9 8 and 13 terms

10 $a = 14, d = 4$ **11** $a = -3, d = 5$

12 2025 **13** 3420 **14** 1010

15 **a** $(2x + 4) - (x + 1) = (3x + 7) - (2x + 4) = x + 3$

b $25(51x + 149)$

16 1290 **17** 16

18 $S_n = S_{n-1} + T_n$

So $S_n - S_{n-1} = T_n$

19 **a** 816 **b** 4234

Exercise 1.04

1 **a** No **b** Yes, $r = -\frac{3}{4}$ **c** Yes, $r = \frac{2}{7}$

d No **e** No **f** No

g Yes, $r = 0.3$ **h** Yes, $r = -\frac{3}{5}$ **i** No

j Yes, $r = -8$

2 **a** $x = 196$ **b** $y = -48$

c $a = \pm 12$ **d** $y = \frac{2}{3}$

e $x = 2$ **f** $p = \pm 10$

g $y = \pm 21$ **h** $m = \pm 6$

i $x = 4 \pm 3\sqrt{5}$ **j** $k = 1 \pm 3\sqrt{7}$

k $t = \pm\frac{1}{6}$ **l** $t = \pm\frac{2}{3}$

3 **a** $T_n = 5^{n-1}$ **b** $T_n = 1.02^{n-1}$

c $T_n = 9^{n-1}$ **d** $T_n = 2 \times 5^{n-1}$

e $T_n = 6 \times 3^{n-1}$ **f** $T_n = 8 \times 2^{n-1} = 2^{n+2}$

g $T_n = \frac{1}{4} \times 4^{n-1} = 4^{n-2}$ **h** $T_n = 1000(-0.1)^{n-1}$

i $T_n = -3(-3)^{n-1} = (-3)^n$ **j** $T_n = \frac{1}{3}\left(\frac{2}{5}\right)^{n-1}$

4 **a** 1944 **b** 9216 **c** –8192

d 3125 **e** $\frac{64}{729}$

5 **a** 256 **b** 26 244 **c** 1.369

d –768 **e** $\frac{3}{1024}$

6 **a** 234 375 **b** 268.8 **c** –81 920

d $\frac{2187}{156\,250}$ **e** 27

7 **a** 3×2^{19} **b** 7^{19} **c** 1.04^{20}

d $\frac{1}{4}\left(\frac{1}{2}\right)^{19} = \frac{1}{2^{21}}$ **e** $\left(\frac{3}{4}\right)^{20}$

8 11^{49} **9** 6th **10** 5th

11 No **12** 7th **13** 11th

14 9th **15** $n = 5$ **16** $r = 3$

17 **a** $r = -6$ **b** –18

18 $a = \frac{1}{10}, r = \pm 2$

19 $n = 7$ **20** $208\frac{2}{7}$

Exercise 1.05

1 **a** 2 097 150 **b** 7 324 218

2 **a** 720 600 **b** 26 240

3 **a** 131 068 **b** 0.5

4 **a** 7812 **b** $35\frac{55}{64}$ **c** 8403

d 273 **e** 255

5 **a** 1792 **b** 3577

6 148.58 **7** 133.33 **8** $n = 9$

9 10 terms **10** $a = 9$ **11** 10 terms

12 **a** 2046 **b** 100 **c** 2146

Puzzles

1 Choice 1 gives \$465.00. Choice 2 gives \$10 737 418.23 so choice 2 is better.

2 382 apples

Exercise 1.06

1 **a** Yes, $13\frac{1}{2}$ **b** No

c Yes, $12\frac{4}{5}$ **d** No

e Yes, 3 **f** Yes, $\frac{25}{32}$

g No **h** Yes, $-1\frac{5}{22}$

i No **j** Yes, $1\frac{3}{7}$

2 **a** 80 **b** $426\frac{2}{3}$ **c** $66\frac{1}{3}$ **d** 12

e $\frac{7}{10}$ **f** 54 **g** $-10\frac{2}{7}$ **h** $\frac{9}{20}$

i 48 **j** $-\frac{16}{39}$

3 **a** 0.58 **b** 0.15 **c** 0.000080

d 0.016 **e** 0.89

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4 $a = 4$ **5** $r = \frac{2}{5}$ **6** $a = 5\frac{3}{5}$

7 $r = \frac{7}{8}$ **8** $r = -\frac{1}{4}$ **9** $r = -\frac{2}{3}$

10 $a = 3, r = \frac{2}{3}$ or $a = 6, r = \frac{1}{3}$

11 $a = 192, r = -\frac{1}{4}, S = 153\frac{3}{5}$

12 $a = 1, r = \frac{2}{3}, S = 3$ or $a = -1, r = -\frac{2}{3}, S = -\frac{3}{5}$

13 $a = 150, r = \frac{3}{5}, S = 375$

14 $a = \frac{2}{5}, r = \frac{2}{3}, S = 1\frac{1}{5}$

15 $a = 3, r = \frac{2}{5}$ or $a = 2, r = \frac{3}{5}$

16 $x = \frac{21}{32}$

17 **a** $|k| < 1$ **b** $-\frac{2}{5}$ **c** $k = \frac{3}{4}$

18 See worked solutions.

Test yourself 1

1 C **2** C **3** B

4 **a** $T_n = 4n + 5$ **b** $T_n = 14 - 7n$

c $T_n = 2 \times 3^{n-1}$ **d** $T_n = 200\left(\frac{1}{4}\right)^{n-1}$

e $T_n = (-2)^n$

5 **a** 2 **b** 1185 **c** 1183

d $T_{15} = S_{15} - S_{14}, S_{15} = S_{14} + T_{15}$

e $n = 16$

6 **a** i **b** ii **c** i **d** iii

e i **f** ii **g** ii **h** i

i i **j** i

7 $n = 108$

8 $a = -33, d = 13$

9 **a** 59 **b** 80 **c** 18th

10 **a** $x = 25$ **b** $x = \pm 15$

11 $x = 3$

12 **a** 136 **b** 44 **c** 6

13 $121\frac{1}{2}$

14 **a** $S_n = n(2n + 3)$ **b** $S_n = \frac{1.07^n - 1}{0.07}$

15 **a** $|x| < 1$ **b** $2\frac{1}{2}$ **c** $x = \frac{1}{3}$

16 $d = 5$

17 $x = -\frac{2}{17}, 2$

18 1300

29 **a** 735 **b** 4315

20 $n = 20$

21 $n = 11$

Challenge exercise 1

1 **a** 8.1 **b** 19th

2 **a** $\frac{\pi}{4}$ **b** $\frac{9\pi}{4}$ **c** $\frac{33\pi}{4}$

3 **a** 2 097 170 **b** –698 775

4 6th **5** 17 823

6 $n \geq 5$

7 **a** $a = 7, r = -2$ **b** –56

8 **a** $\text{cosec}^2 x$

b $r = \cos^2 x$

$-1 < \cos x < 1$ where $\cos^2 x \neq 0, 1$

So $0 < \cos^2 x < 1$

Since $|r| < 1$, the series has a limiting sum.

Chapter 2

Exercise 2.01

1 **a** Vertical translation 3 units up

b Vertical translation 7 units down

c Vertical translation 1 unit down

d Vertical translation 5 units up

2 **a** Vertical translation 1 unit up

b Vertical translation 4 units down

c Vertical translation 8 units up

3 Vertical translation 9 units up

4 **a** $y = x^2 - 3$ **b** $f(x) = 2^x + 8$

c $y = |x| + 1$ **d** $y = x^3 - 4$

e $f(x) = \log x + 3$ **f** $y = \frac{2}{x} - 7$

5 **a** Vertical translation 1 unit down

b Vertical translation 6 units up

6 **a** **i** $y = 2x^3 - 2$ **ii** $y = 2x^3 + 6$

b **i** $y = |x| - 3$ **ii** $y = |x| - 6$

c **i** $y = e^x + 1$ **ii** $y = e^x + 5$

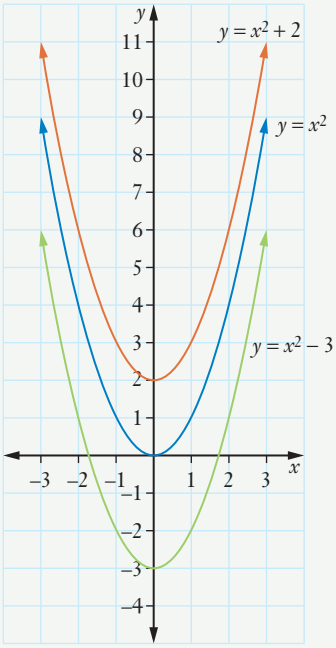
d **i** $f(x) = \log_e x + 10$ **ii** $f(x) = \log_e x - 8$

7 **a** $(1, -1)$ **b** $(1, -9)$ **c** $(1, -3 + m)$

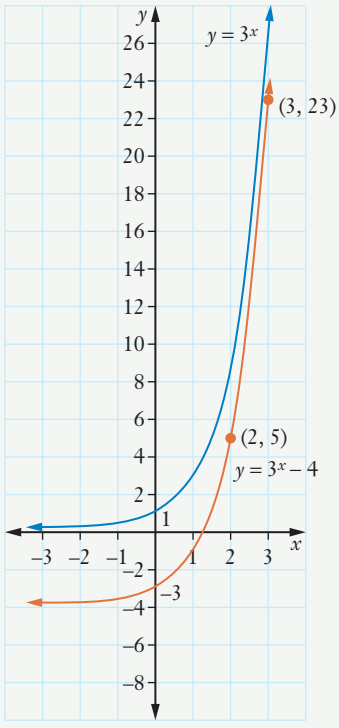
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8 **a** (–1, 1) **b** (–1, 5)

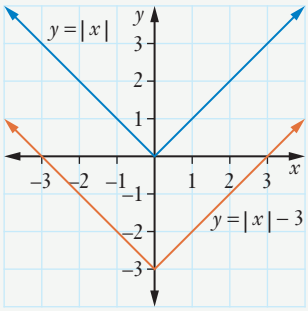
9 **a**



b

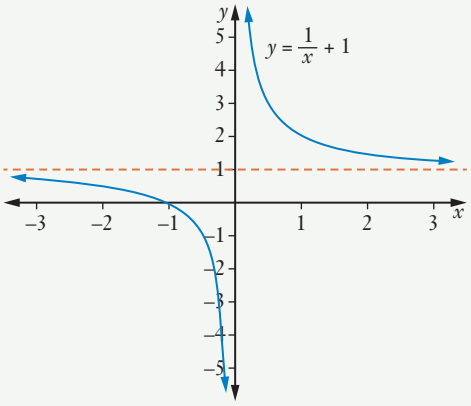


c

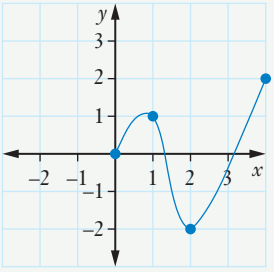


10 **a** Vertical translation 1 unit up

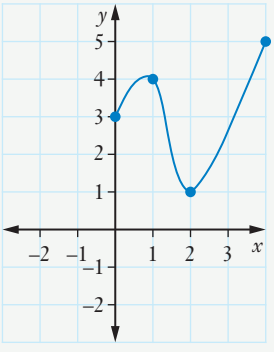
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11 **a**

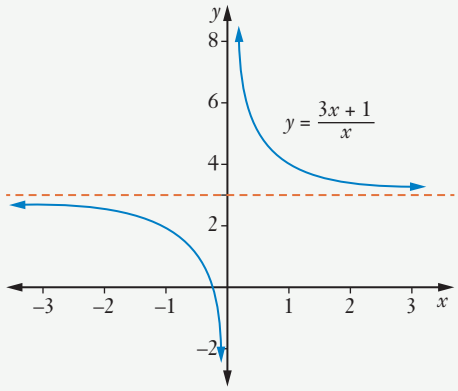


b



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12 b



Exercise 2.02

1 a Horizontal translation 4 units to the right

b Horizontal translation 2 units to the left

2 a Horizontal translation 5 units to the right

b Horizontal translation 3 units to the left

3 a $y = (x+3)^2$ **b** $f(x) = 2^{x-8}$

c $y = |x+1|$ **d** $y = (x-4)^3$

e $f(x) = \log(x+3)$

4 Horizontal translation 3 units to the right

5 a Horizontal translation 2 units to the left

b Horizontal translation 5 units to the right

6 a i $y = -(x+4)^2$ **ii** $y = -(x-8)^2$

b i $y = |x-3|$ **ii** $y = |x+4|$

c i $y = e^{x+6}$ **ii** $y = e^{x-5}$

d i $f(x) = \log_2(x-5)$ **ii** $f(x) = \log_2 x$

7 a $(5, -3)$

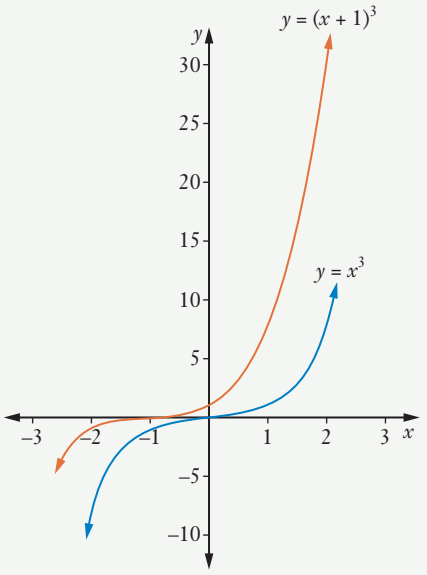
b $(-8, -3)$

c $(1+t, -3)$

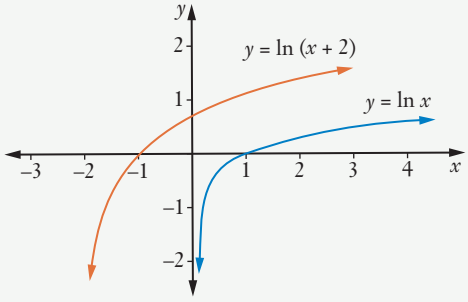
8 a $(3, 2)$

b $(-9, 2)$

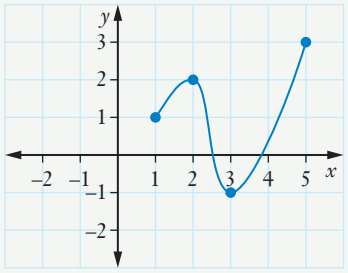
9 a



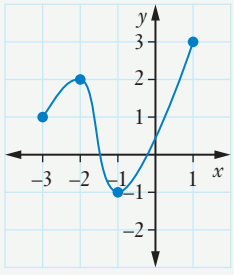
b



10 a



b



11 a $f(x) = x^5 - 5$ **b** $f(x) = (x-3)^5$

c $f(x) = x^5 + 2$ **d** $f(x) = (x+7)^5$

12 $(7, -2)$

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Exercise 2.03

1 **a** **i** Vertical dilation scale factor 6 (stretched)

ii Vertical dilation scale factor $\frac{1}{2}$ (compressed)

iii Vertical dilation scale factor -1 (reflection in x-axis)

b **i** Vertical dilation scale factor 2 (stretched)

ii Vertical dilation scale factor $\frac{1}{6}$ (compressed)

iii Vertical dilation scale factor -1 (reflection in x-axis)

c **i** Vertical dilation scale factor 4 (stretched)

ii Vertical dilation scale factor $\frac{1}{7}$ (compressed)

iii Vertical dilation scale factor $\frac{4}{3}$ (stretched)

d **i** Vertical dilation scale factor 9 (stretched)

ii Vertical dilation scale factor $\frac{1}{3}$ (compressed)

iii Vertical dilation scale factor $\frac{3}{8}$ (compressed)

e **i** Vertical dilation scale factor 5 (stretched)

ii Vertical dilation scale factor $\frac{1}{8}$ (compressed)

iii Vertical dilation scale factor -1 (reflection in x-axis)

f **i** Vertical dilation scale factor 9 (stretched)

ii Vertical dilation scale factor -1 (reflection in x-axis)

iii Vertical dilation scale factor $\frac{2}{5}$ (compressed)

2 **a** $y = 6x^2$; domain $(-\infty, \infty)$; range $[0, \infty)$

b $y = \frac{\ln x}{4}$; domain $(0, \infty)$; range $(-\infty, \infty)$

c $f(x) = -|x|$; domain $(-\infty, \infty)$; range $(-\infty, 0]$

d $f(x) = 4e^x$; domain $(-\infty, \infty)$; range $(0, \infty)$

e $y = \frac{7}{x}$; domain $(-\infty, 0) \cup (0, \infty)$; range $(-\infty, 0) \cup (0, \infty)$

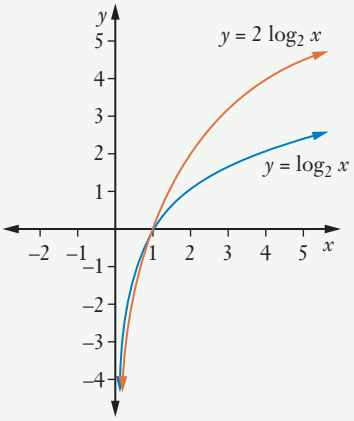
3 **a** $y = 5 \cdot 3^x$ **b** $f(x) = \frac{x^2}{3}$ **c** $y = -x^3$

d $y = \frac{1}{2x}$ **e** $y = \frac{2|x|}{3}$

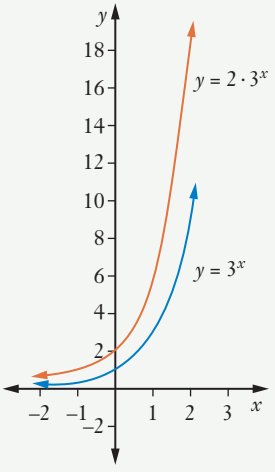
4 **a** $(3, 24)$ **b** $(3, -6)$ **c** $(3, 72)$ **d** $(3, 5)$

5 **a** $(4, 4)$ **b** $(4, 6)$ **c** $(4, 36)$ **d** $(4, 16)$ **e** $(4, -12)$

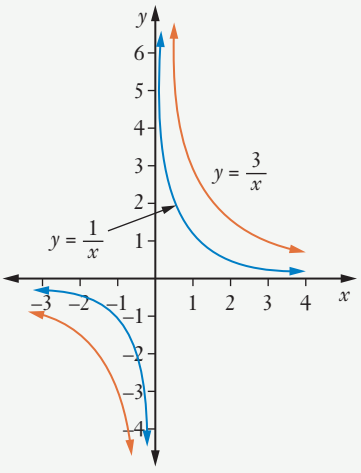
6 **a**



b

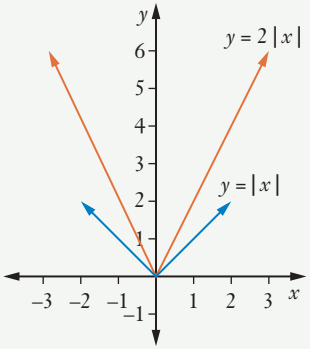


c

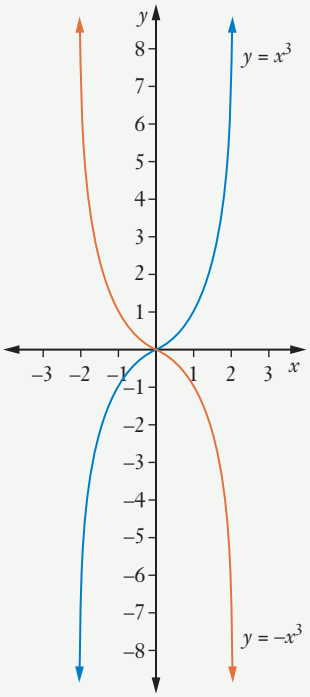


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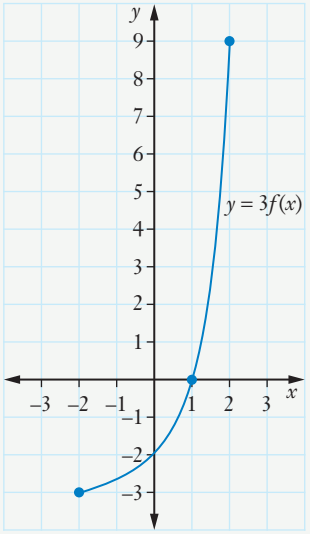
d



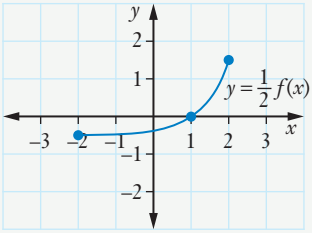
e



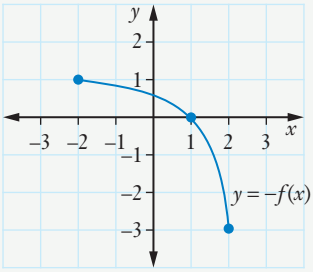
7 a



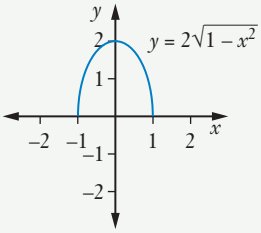
b



c



8



Exercise 2.04

1 a Horizontal dilation scale factor $\frac{1}{8}$ (compressed)

b Horizontal dilation scale factor 5 (stretched)

c Horizontal dilation scale factor $\frac{7}{3}$ (stretched)

d Horizontal dilation scale factor -1 (reflection in y-axis). Note that this is the same graph as $f(x) = x^4$.

2 a i Horizontal dilation scale factor $\frac{1}{2}$ (compressed)

ii Horizontal dilation scale factor $\frac{1}{5}$ (compressed)

iii Horizontal dilation scale factor 3 (stretched)

b i Vertical dilation scale factor 4 (stretched)

ii Horizontal dilation scale factor 2 (stretched)

iii Horizontal dilation scale factor -1 (reflection in y-axis)

c i Horizontal dilation scale factor $\frac{1}{7}$ (compressed)

ii Vertical dilation scale factor $\frac{1}{8}$ (compressed)

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iii Horizontal dilation scale factor $\frac{4}{3}$ (stretched)

d **i** Horizontal dilation scale factor $\frac{1}{5}$ (compressed) (or vertical dilation scale factor 5, stretched)

ii Horizontal dilation scale factor 2 (stretched) (or vertical dilation scale factor $\frac{1}{2}$, compressed)

iii Horizontal dilation scale factor $\frac{5}{3}$ (stretched) (or vertical dilation scale factor $\frac{3}{5}$, compressed)

e **i** Horizontal dilation scale factor $\frac{1}{3}$ (compressed)

ii Vertical dilation scale factor -1 (reflection in x-axis)

iii Horizontal dilation scale factor 2 (stretched)

f **i** Vertical dilation scale factor 8 (stretched)

ii Horizontal dilation scale factor -1 (reflection in y-axis)

iii Horizontal dilation scale factor 7 (stretched)

3 **a** $f(x) = |5x|$; domain $(-\infty, \infty)$; range $[0, \infty)$

b $y = \left(\frac{x}{3}\right)^2$; domain $(-\infty, \infty)$; range $[0, \infty)$

c $y = (-x)^3$; domain $(-\infty, \infty)$; range $(-\infty, \infty)$

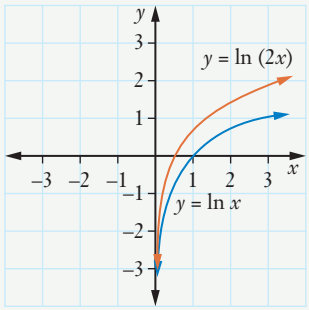
d $y = \frac{e^x}{9}$; domain $(-\infty, \infty)$; range $(0, \infty)$

e $y = -\log_4 x$; domain $(0, \infty)$; range $(-\infty, \infty)$

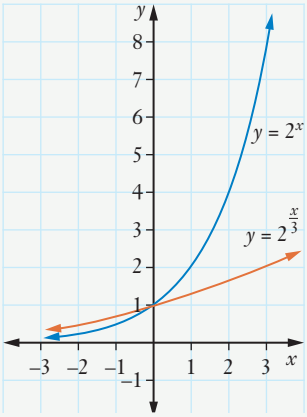
4 **a** $(-1, 7)$ **b** $(2, 7)$ **c** $(-6, 7)$

5 **a** $(-72, 1)$ **b** $(-48, 1)$ **c** $(-6, 1)$

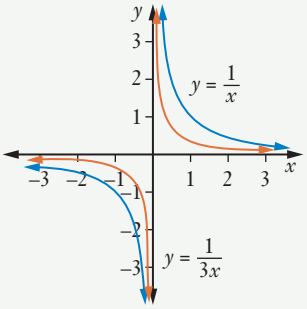
6 **a**



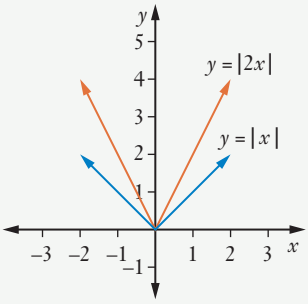
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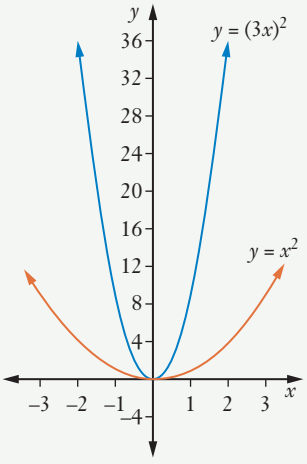
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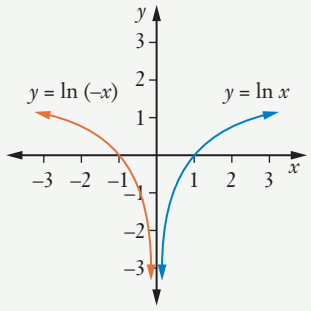


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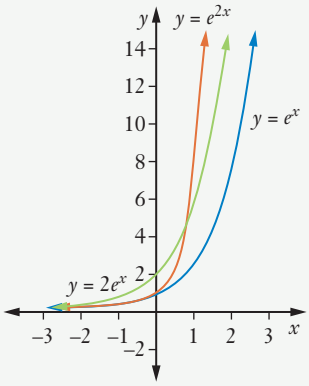


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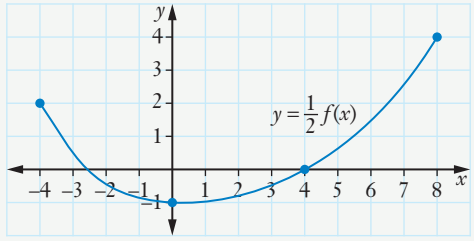


8 A reflection in y-axis transforms $y = f(x)$ into $y = f(-x)$.

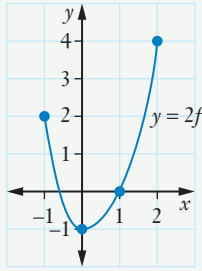
a Since $y = x^2$ is an even function, $f(x) = f(-x)$, so a reflection in the y-axis doesn't change the function.

b Since $y = |x|$ is an even function, $f(x) = f(-x)$ so a reflection in the y-axis doesn't change the function.

9 a



b



Exercise 2.05

1 a $(5, -11)$ **b** $(-1, -2)$

c $(9, 3)$ **d** $(-2, -17)$

2 a $f(x) = -4x^5$ **b** $f(x) = -\frac{1}{243}x^5$

3 a $y = (x + 4)^3 - 3$ **b** $f(x) = |x - 1| + 9$

c $f(x) = 3x - 6$ **d** $y = -e^x + 2$

e $y = (2x)^3 - 5$ **f** $f(x) = \frac{6}{x}$

g $f(x) = 3\sqrt{-2x}$ **h** $y = \ln \frac{x}{3} + 2$

i $f(x) = 3 \log_2 4x$ **j** $y = \left(\frac{x}{2}\right)^2 - 3$

4 a Horizontal translation 1 unit to the right, vertical translation 7 units up

b Vertical dilation scale factor 4, vertical translation 1 unit down

c Vertical dilation scale factor 5, reflection in x-axis, vertical translation 3 units down

d Horizontal translation 7 units to the left, vertical dilation scale factor 2

e Rewrite as $y = 6[2(x - 2)]^3 + 5$. Horizontal dilation scale factor $\frac{1}{2}$, horizontal translation 2 units to the right, vertical dilation scale factor 6, vertical translation 5 units up

f Rewrite as $y = 2[3(x + 3)]^3 - 10$. Horizontal dilation scale factor $\frac{1}{3}$, horizontal translation 3 units to the left, vertical dilation scale factor 2, vertical translation 10 units down

5 a Horizontal translation 3 units to the left, vertical dilation scale factor 2, vertical translation 1 unit down

b Horizontal dilation scale factor $\frac{1}{3}$, reflection in x-axis, vertical translation 9 units up

c Horizontal dilation scale factor $\frac{1}{5}$, vertical dilation scale factor 2, vertical translation 3 units down

d Horizontal translation 7 units to the right, vertical dilation scale factor 4, vertical translation 1 unit up

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e Reflection in y-axis, horizontal dilation scale factor $\frac{1}{2}$, horizontal translation 1 unit to the left, vertical translation 1 unit down

f Horizontal dilation scale factor $\frac{1}{2}$, reflection in x-axis, vertical translation 8 units up

6 **a** $(9, -31)$ **b** $(4, 5)$

c $(5, -25)$ **d** $(-8, -67)$

e Change to $y = -2f[2(x-2)] - 3$: $(6, 21)$

7 **a** $(x+3, y-6)$ **b** $(-x, y+6)$

c $(x-5, 2y)$ **d** $(3x, y+5)$

e $(5x-30, -8y-1)$

8 **a** $y = f(x+1) - 2$ **b** $y = f(x-5) + 3$

c $y = -f(x-4)$ **d** $y = f(-x) + 2$

e $y = -f\left(\frac{x}{4}\right)$ **f** $y = 2f(x) - 2$

9 **a** $f(x) = -\frac{9}{x} + 3$ **b** $y = 5(x+2)^2 - 6$

c $f(x) = 8\ln\left[\frac{1}{2}(x-5)\right] - 3$

d $y = 9\sqrt{-(x+4)} + 4$ **e** $f(x) = -|6x| + 7$

f $y = [4(x+4)]^3 = 64(x+4)^3$

g $y = 6(2^{x-2} + 5)$

10 **a** Domain $(-\infty, \infty)$, range $[5, \infty)$

b Domain $(-\infty, \infty)$, range $[-2, \infty)$

c Domain $(-\infty, 2) \cup (2, \infty)$, range $(-\infty, 1) \cup (1, \infty)$

d Domain $(-\infty, \infty)$, range $(2, \infty)$

e Domain $(2, \infty)$, range $(-\infty, \infty)$

11 **a** $y = (x+1)^2 - 8$

b Horizontal translation 1 unit to the left, vertical translation 8 units down

12 Horizontal translation 5 units to the right, vertical translation 28 units down

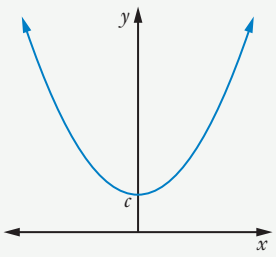
13 **a** $(2x+3, 2y+5)$ **b** $\left(\frac{x}{3} - 6, -y - 2\right)$

14 **a** Circle $(x-3)^2 + (y-4)^2 = 9$ or $x^2 - 6x + y^2 - 8x + 16 = 0$

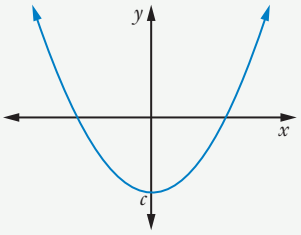
b Translated 2 units to the right, 3 units down

Exercise 2.06

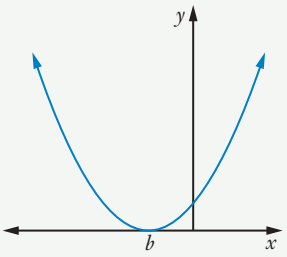
1 **a** **i**



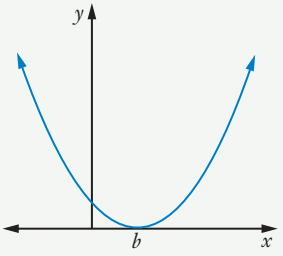
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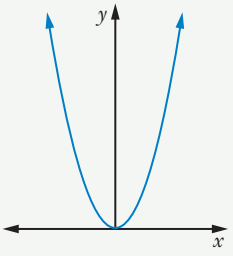
b **i**



ii

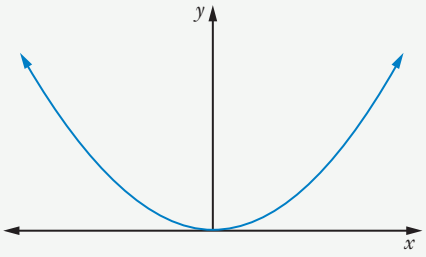


c **i**

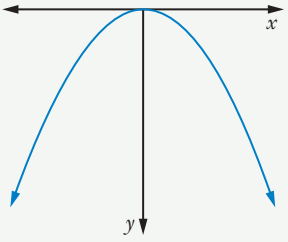


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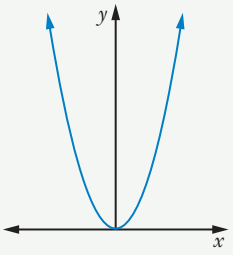
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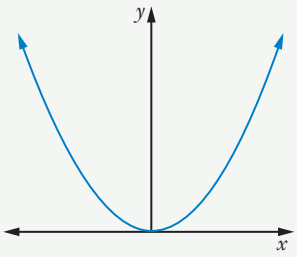
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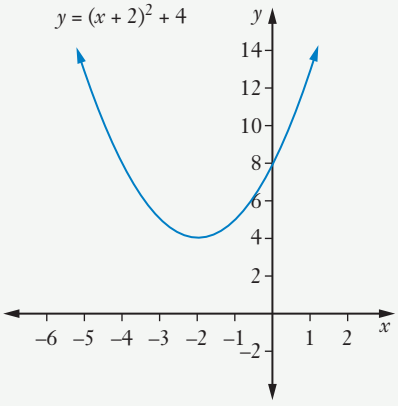
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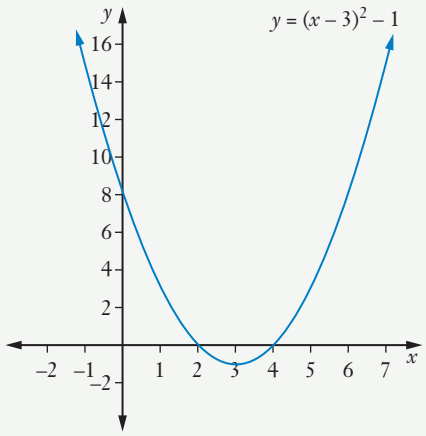
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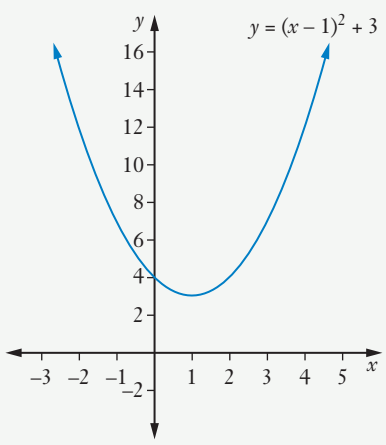
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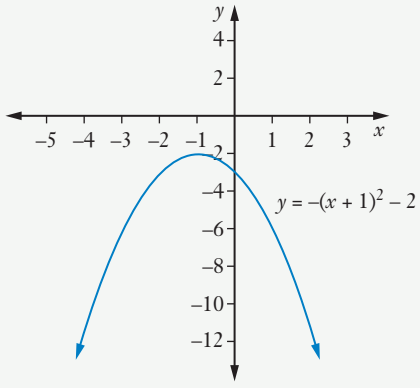
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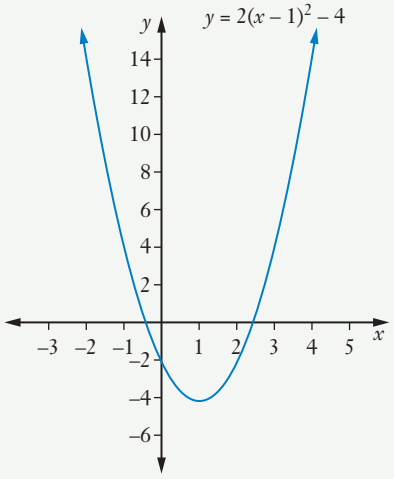


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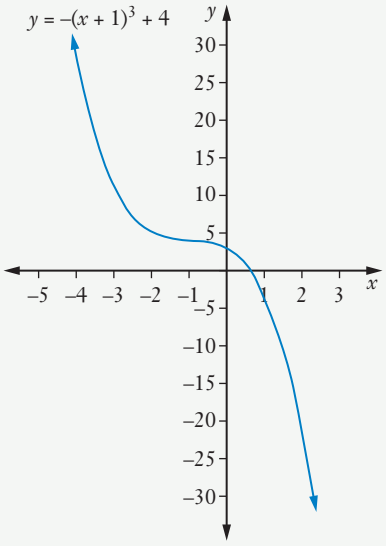


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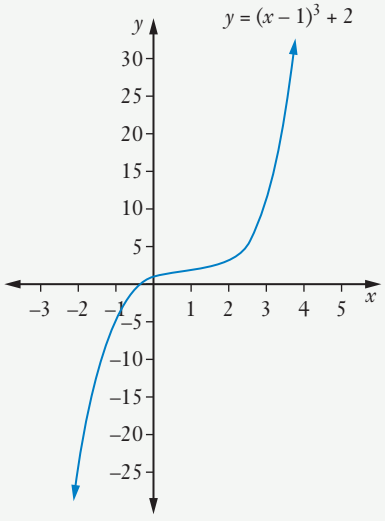
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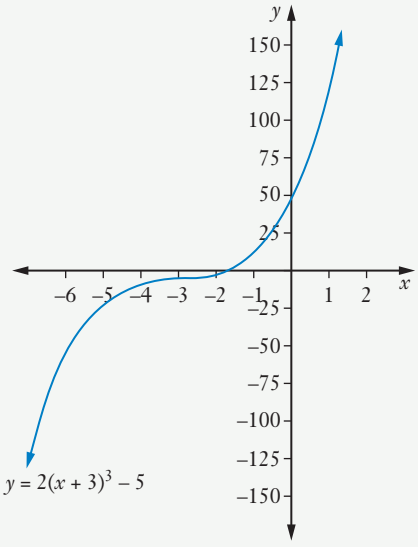
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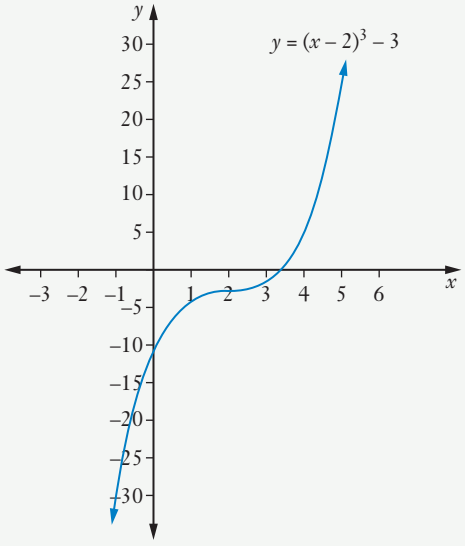
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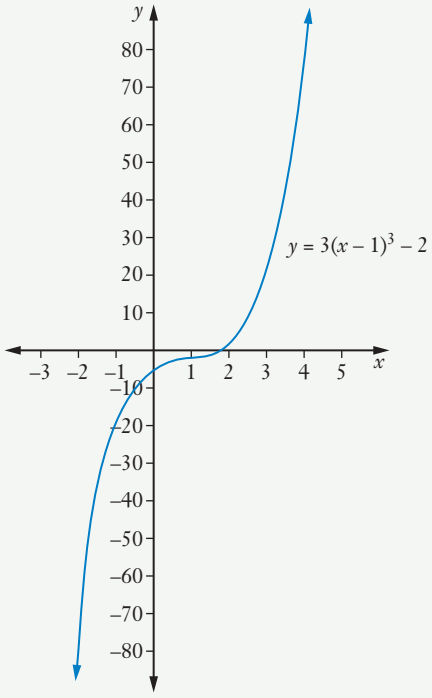


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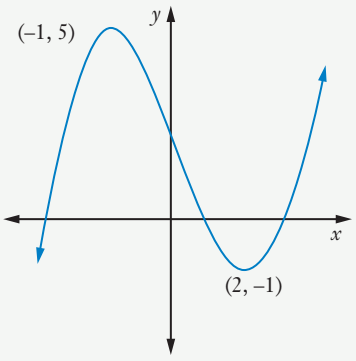
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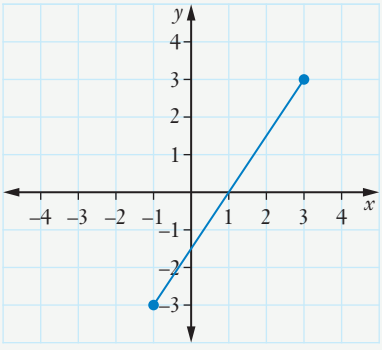


4 a (2, –1) and (–1, 5)

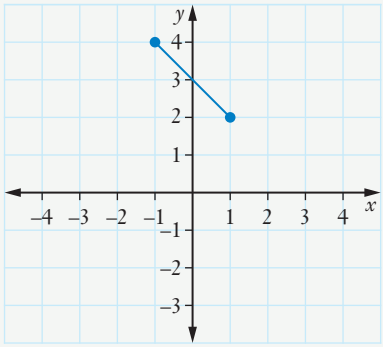
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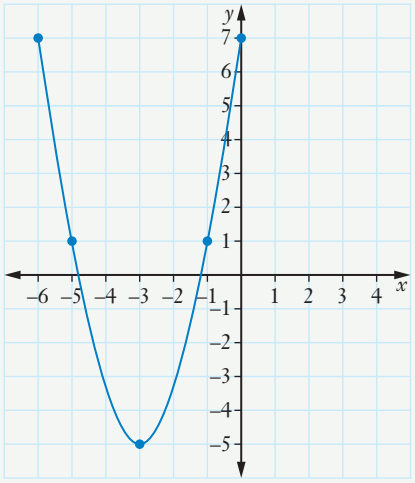
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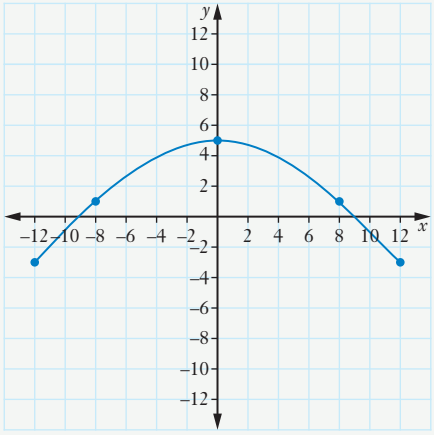
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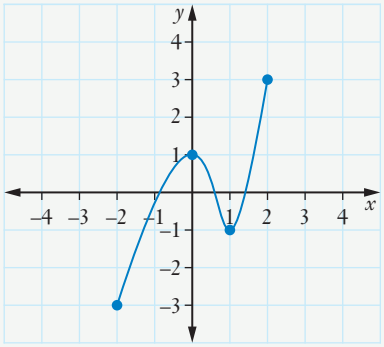


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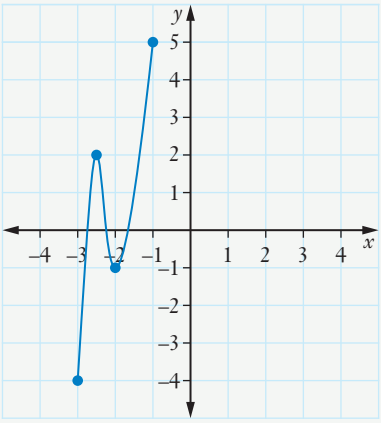


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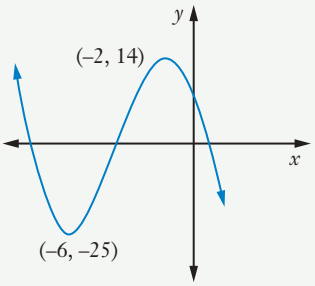
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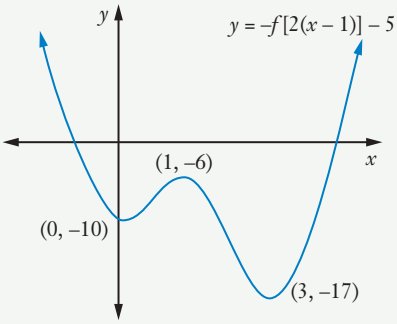
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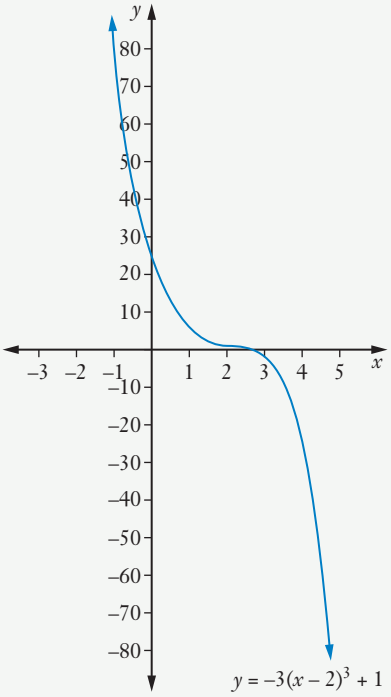
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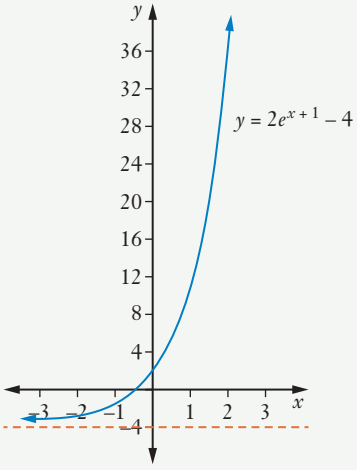
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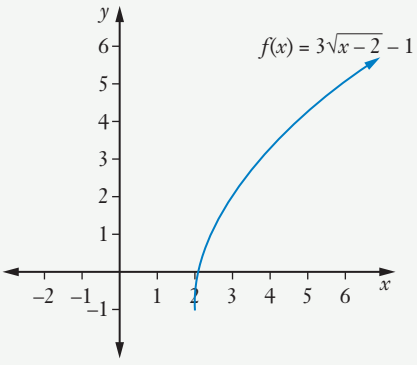
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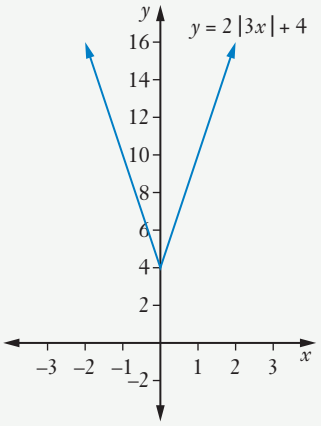


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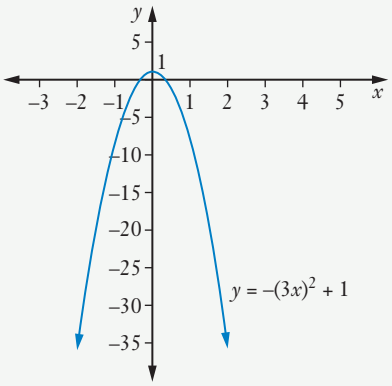


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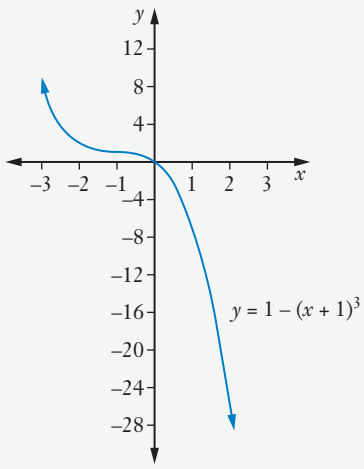
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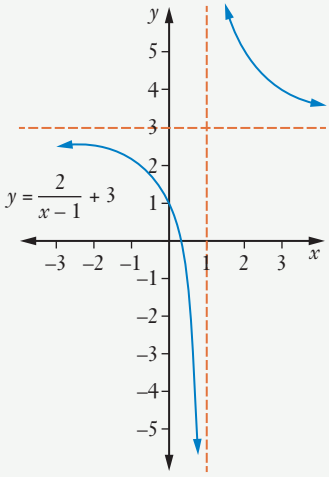
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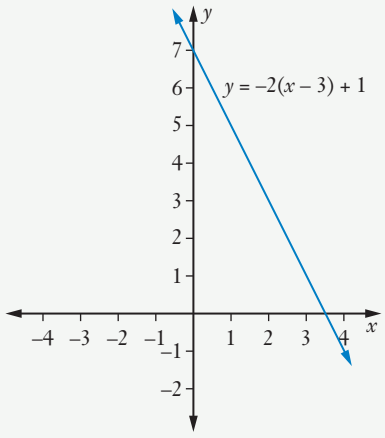
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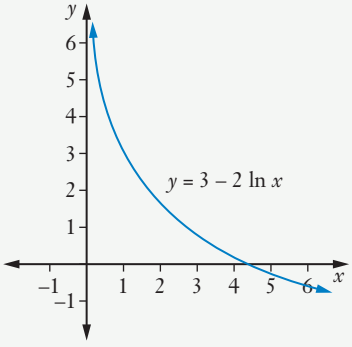
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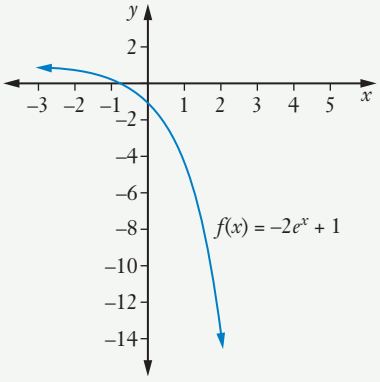
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9 a



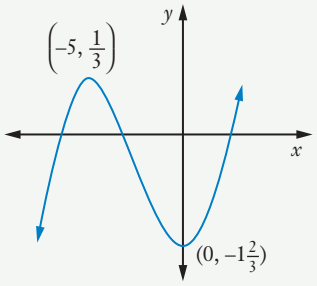
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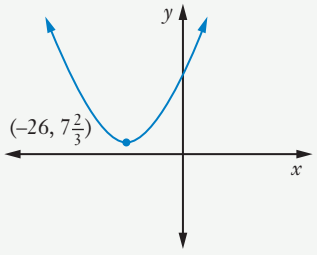
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10 **a** $(-5, \frac{1}{3})$

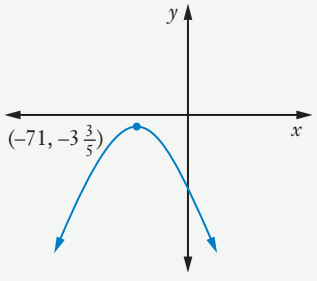
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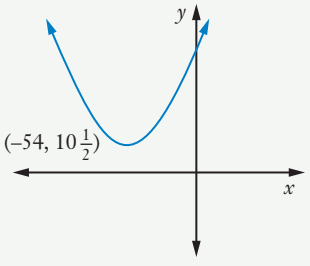
11 **a** $(-26, 7\frac{2}{3})$



b $(-71, -3.6)$



c $(-54, 10\frac{1}{2})$



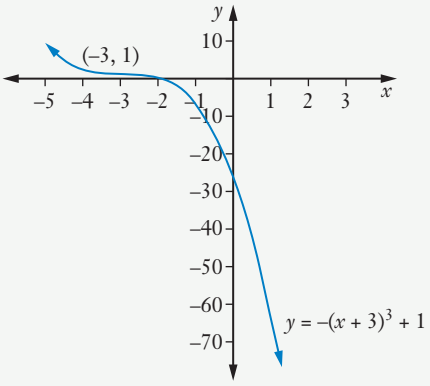
Exercise 2.07

1 **a** 2 **b** 0 **c** 1 **d** 3
e 0 **f** 1 **g** 2 **h** 0
i 1 **j** 0

2 **a** **i** $x = -2, 0$ **ii** $x = 0.6, -2.6$
iii $x = -2.2, 0.2$ **b** $x = 0.2, -2.2$

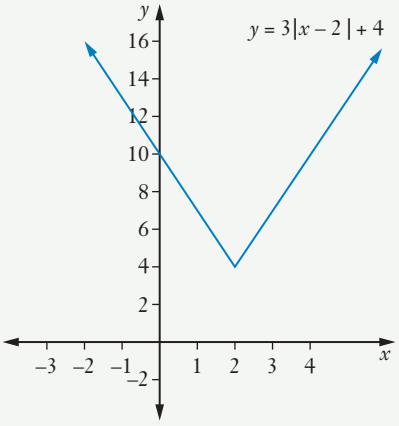
3 **a** $x = 1.4$ **b** $x = 1.9$ **c** $x = 0.2$
d $x > 2.2$ **e** $x \leq 3.1$

4 **a**



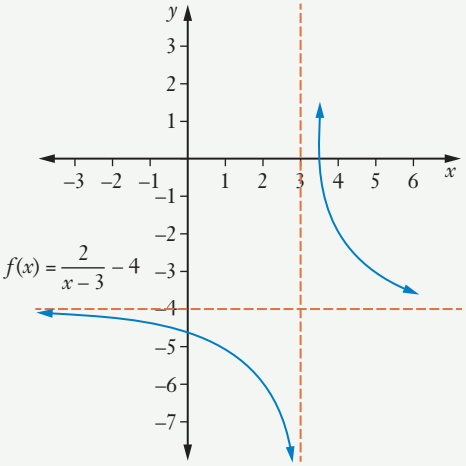
b **i** $x = -2$ **ii** $x = -0.8$ **iii** $x = -0.3$
c $x = -2$

5 **a**



b None **c** $x = 0, 4$

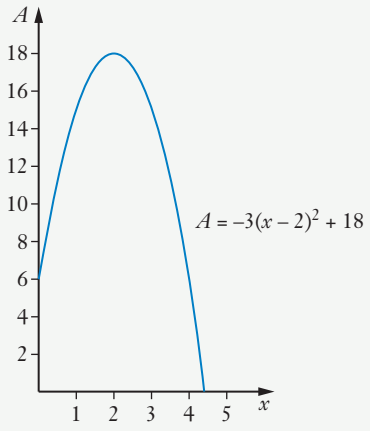
6 **a**



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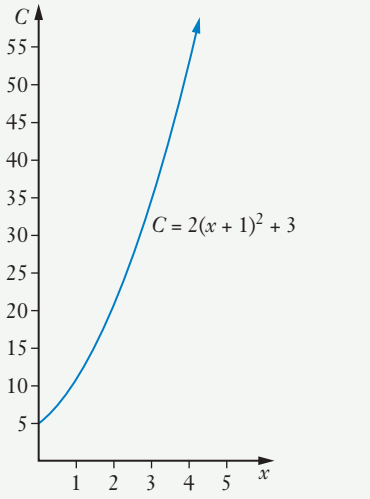
b $x = 1$ **c** $x = 4$

7 a



b $x = 0.4, 3.6$

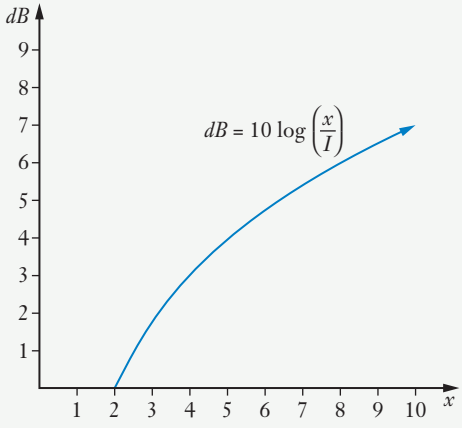
8 a



b $5000

c The costs are $20 000 when 2 products are made.

9 a



b **i** $x = 6$ **ii** $x = 3$

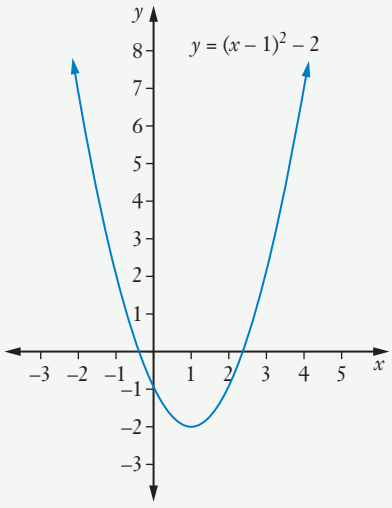
10 a **i** $t = 3.5$. After 3.5 minutes the temperature is 50°C.

ii $t = 8$. After 8 minutes the temperature is 30°C.

b **i** $t = 0.74$ **ii** $t = 11.85$

c 24°C (room temperature)

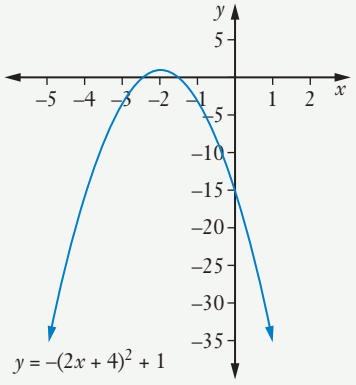
11 a



b **i** $x = 3, -1$ **ii** $x \leq -1, x \geq 3$

iii $-1 < x < 3$

12 a



b **i** $x = -3, -1$ **ii** $-3 < x < -1$

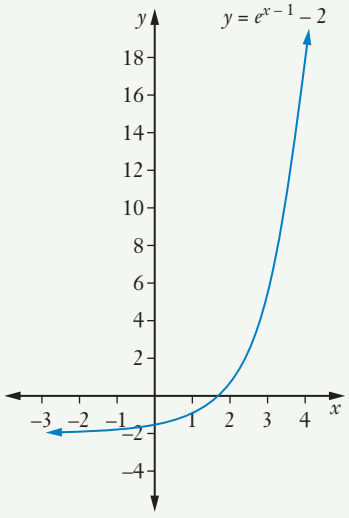
iii $x \leq -3, x \geq -1$

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Test yourself 2

1 B **2** D **3** C

4 a



b $x = 3.1$ **c** $x = 4.09$

5 a (6, 107) **b** (6, 40)

c (–24, 177) **d** (17, –75)

e (16, –31)

6 a i $y = x^3 + 3$ **ii** $y = (x + 7)^3$

b i $y = 3|x|$ **ii** $y = \left|\frac{x}{2}\right|$

c $f(x) = 5 \ln(-x)$ **d** $f(x) = -\frac{1}{x - 4}$

e $f(x) = 9 \cdot 3^{3x-2} - 6$

7 a c is a vertical translation c units up if $c > 0$ or down if $c < 0$.

b is a horizontal translation b units to the right if $b < 0$ and to the left if $b > 0$.

k is a vertical dilation with scale factor k, stretched if $k > 1$ and compressed if $0 < k < 1$.

a is a horizontal dilation with scale factor $\frac{1}{a}$, compressed if $a > 1$ and stretched if $0 < a < 1$.

b i Reflection in the x-axis

ii Reflection in the y-axis

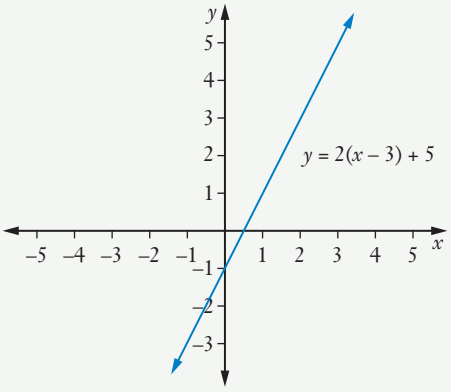
8 $f(x) = -3x^2 + 1$

$f(-x) = -3(-x)^2 + 1$

$= -3x^2 + 1$

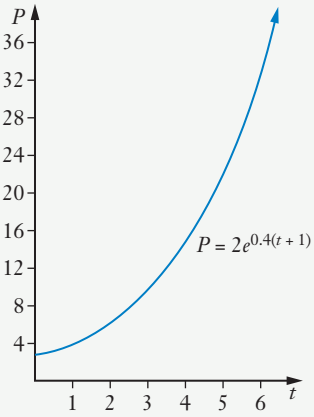
$= f(x)$ so even

9 a



b i $x \leq 4$ **ii** $x > 5$

10 a



b $t = 1.3$. It takes 1.3 years for the population to reach 50 000.

11 $f(x) = (x + 4)^4$

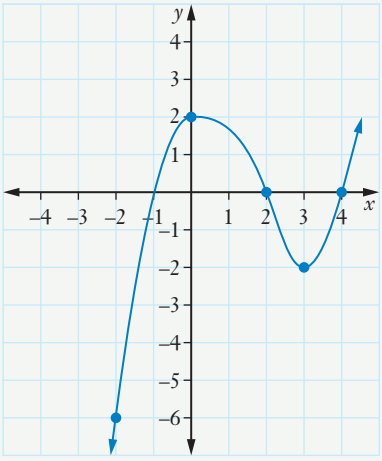
12 (3, –11)

13 a $x = 2.88, 1.12$ **b** $x < 1.12, x > 2.88$

c $1.12 \leq x \leq 2.88$

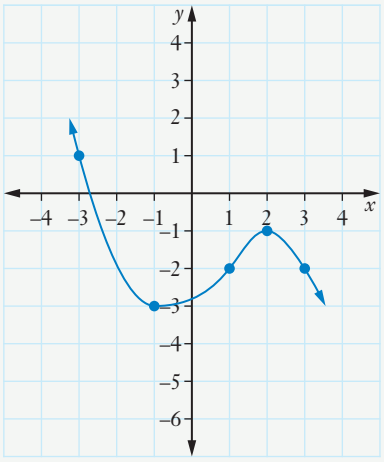
14 a $(x + 3, -7y - 4)$ **b** $x = -6, y = -1$

15 a



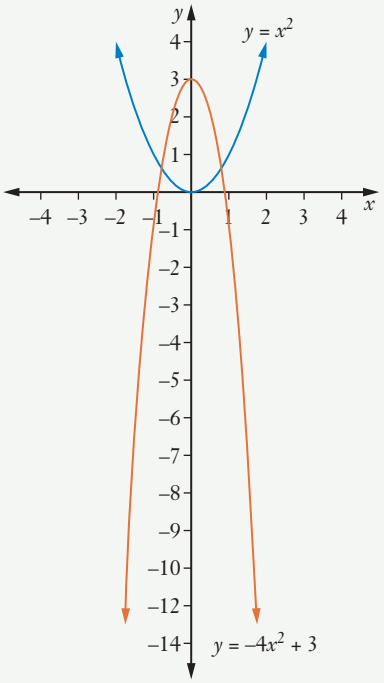
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b

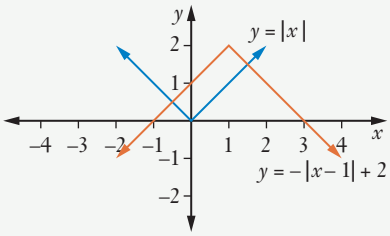


16 **a** $-3 \leq x \leq 1$ **b** $x < -3, x > 1$

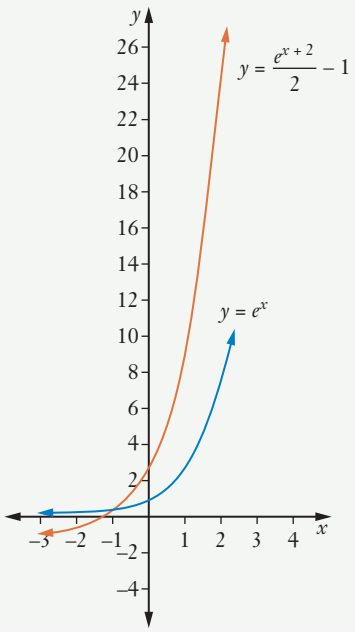
17 **a**



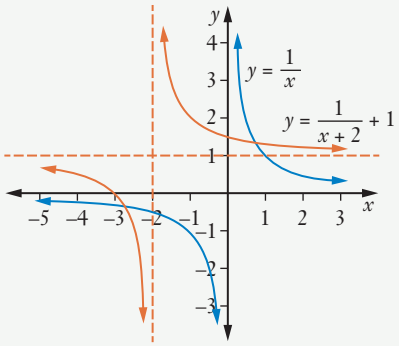
b



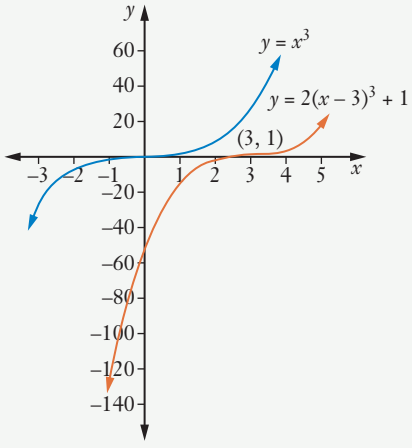
c



d

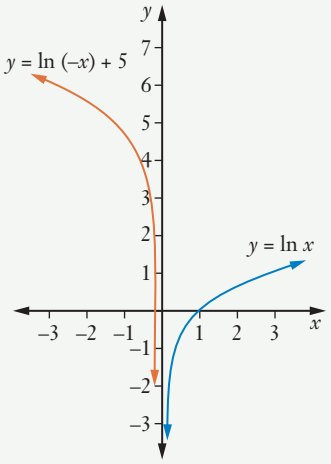


e

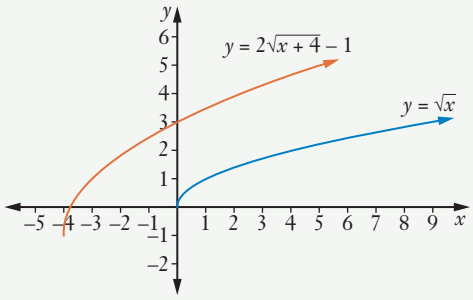


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f

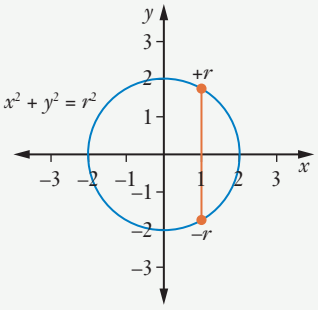


g



18 **a** 2 **b** 1 **c** 0 **d** 1
e 1 **f** 0 **g** 1 **h** 0
i 4 **j** 3

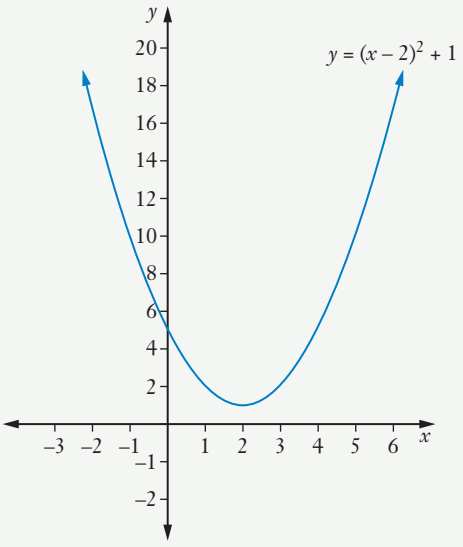
19 **a** The circle is not a function since a vertical line cuts the graph in more than one point.



b $y = \sqrt{r^2 - x^2}$ and $y = -\sqrt{r^2 - x^2}$
c An ellipse (oval)

20 (32, –1)

21 **a**



b **i** $x = -1, 5$ **ii** $x < -1, x > 5$
iii $-1 \leq x \leq 5$

22 **a** $(x - 1, 3y - 5)$ **b** $\left(\frac{1}{2}[x+6], -2y+4\right)$
c $(-x, 5y - 3)$ **d** $\left(-\frac{1}{3}[x+3], -3y-1\right)$

23 **a** Stretched **b** Compressed
c Stretched **d** Compressed
e Stretched

24 **a** Domain $(-\infty, \infty)$; range $[-10, \infty)$
b Domain $(-\infty, \infty)$; range $(-\infty, 2]$
c Domain $(-\infty, 3) \cup (3, \infty)$;
range $(-\infty, -5) \cup (-5, \infty)$

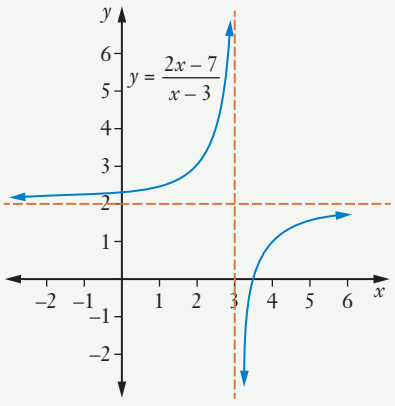
Challenge exercise 2

1 **a** $h = -2t^2 + 4t + 1$ **b** 2.2 seconds
c $h = -2(t - 1)^2 + 3$. Horizontal translation 1 unit to the right, reflection in the x-axis, vertical dilation scale factor 2, vertical translation 3 units up.

2 **a** **i** (1, –8) **ii** (2, 0) **iii** (3, –2)
b $x - 2y - 17 = 0$
c Horizontal dilation with scale factor 2 and horizontal translation 17 units to the right,
OR: vertical dilation with scale factor $\frac{1}{2}$ and vertical translation $\frac{17}{2}$ units down

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3 b



c **i** $x < 3, x \geq 3.5$ **ii** $x > 3$

4 a A horizontal dilation with scale factor $\frac{1}{a} = 2$:

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

$y = \frac{1}{(ax)} = \frac{1}{\frac{1}{2}x} = \frac{2}{x}$

A vertical dilation with scale factor $k = 2$:

$y = \left(\frac{1}{x}\right) = 2\left(\frac{1}{x}\right) = \frac{2}{x}$

So these transformations have the same effect on $y = \frac{1}{x}$.

b No. Horizontal dilation gives $y = \frac{4}{x}$, vertical dilation gives $y = \frac{2}{x}$.

5 a $x = -\frac{b}{2a}$

b Horizontal translation

c **i** $x = -1$ **ii** $x = 3$

iii $x = -b$ **iv** $x = -\frac{b}{a}$

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

b Amplitude 3, period 4π, centre -1

7 $x^2 - 6x + y^2 + 8 = 0$

8 Reflection in y-axis, horizontal dilation scale factor $\frac{1}{3}$, horizontal translation 2 units to the left, vertical dilation scale factor 3, vertical translation 5 units down

9 $y = -x^3 + 3x$

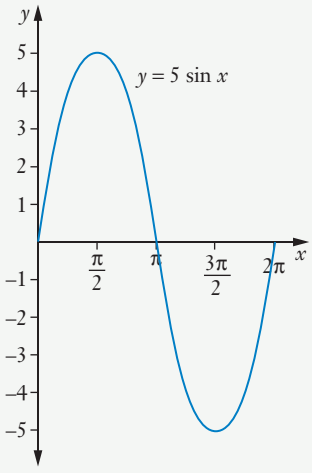
Chapter 3

Exercise 3.01

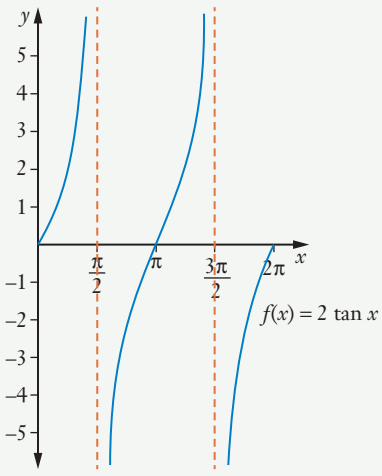
1 a Phase shift **b** Amplitude

c Period **d** Centre

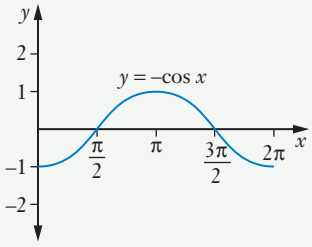
2 a



b

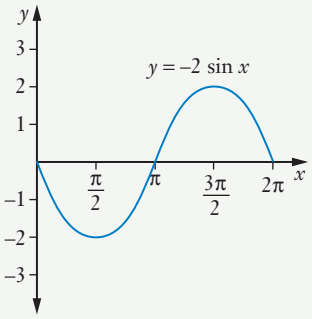


c

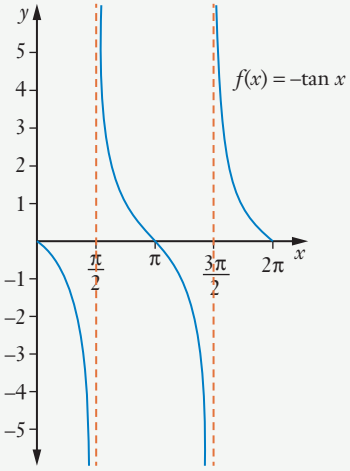


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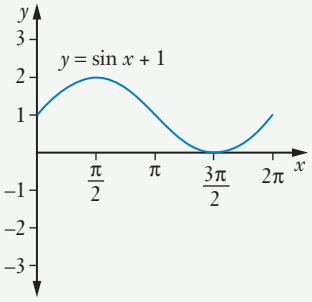
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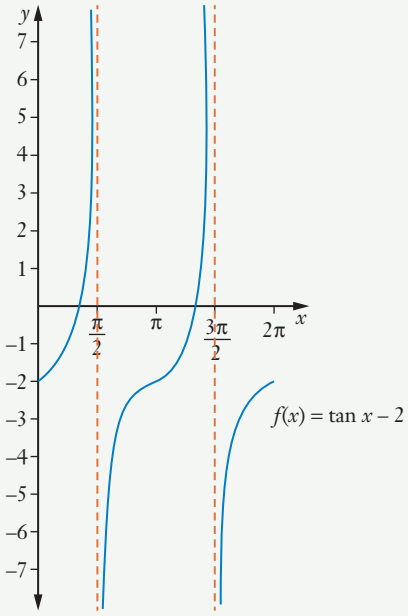
e



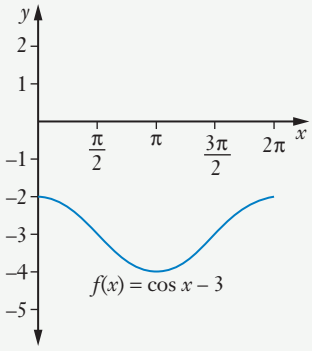
3 a



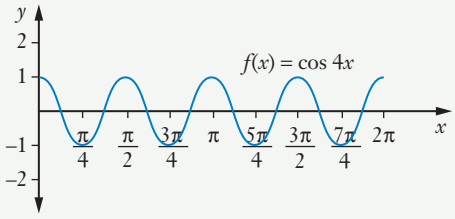
b



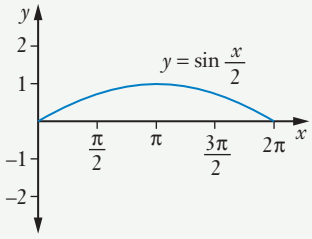
c



4 a

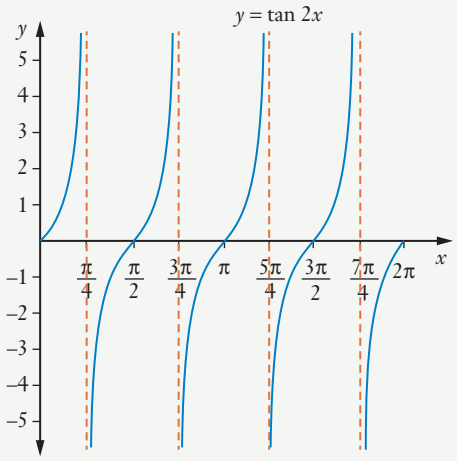


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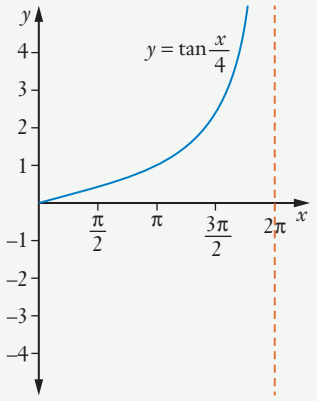


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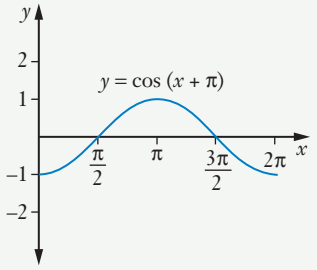
c



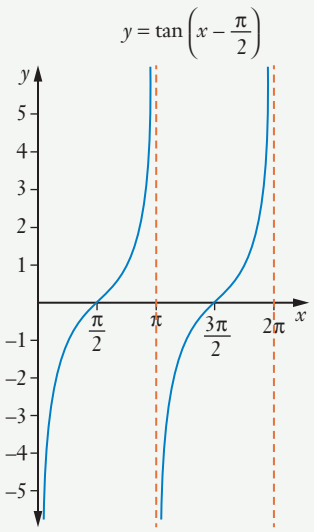
d



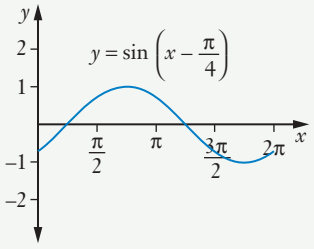
5 a



b



c



6 a $y = 9 \sin x$ **b** $y = -\sin x$

c $y = \sin x - 4$ **d** $y = \sin 2x$

e $y = \sin (x - \pi)$

7 a $y = 4 \cos x$ **b** $y = \cos\left(x + \frac{\pi}{3}\right)$

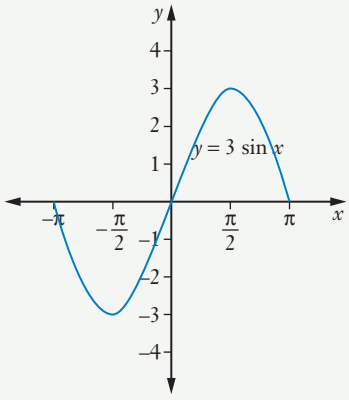
c $y = \cos x + 8$ **d** $y = \cos 4x$

e $y = 7 \cos x$

8 a $y = \tan \frac{x}{2}$ **b** $y = \tan\left(x - \frac{\pi}{6}\right)$

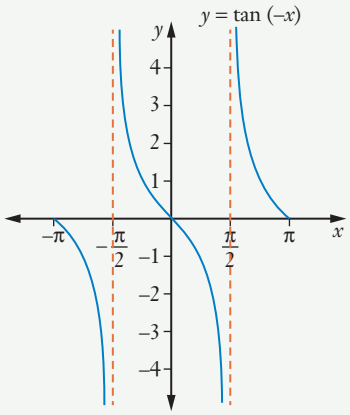
c $y = \tan (-x)$

9 a

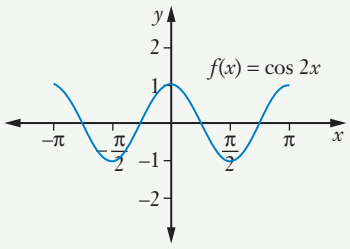


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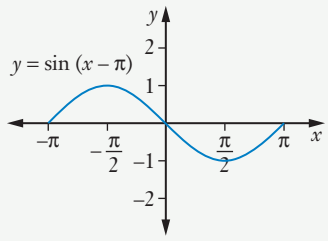
b



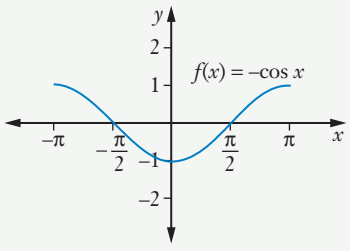
c



d

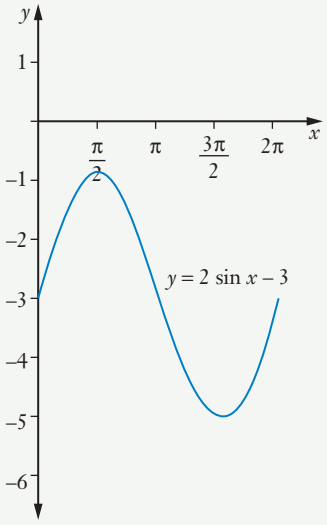


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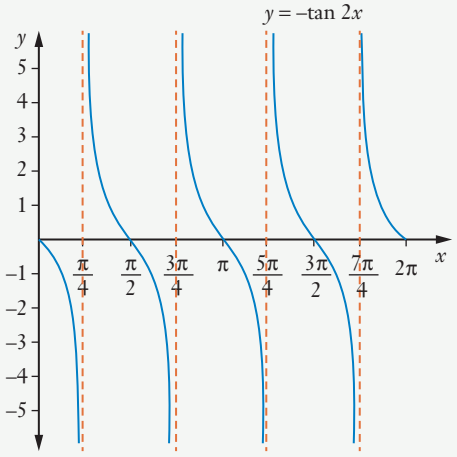


Exercise 3.02

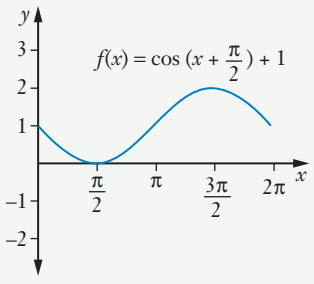
1 a



b

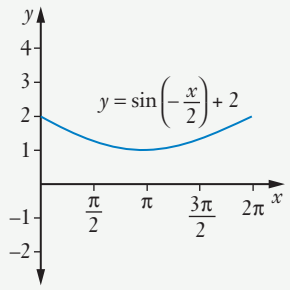


c

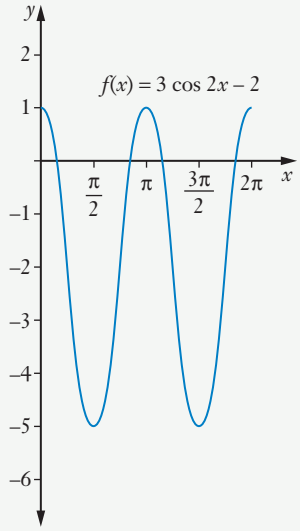


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d



e



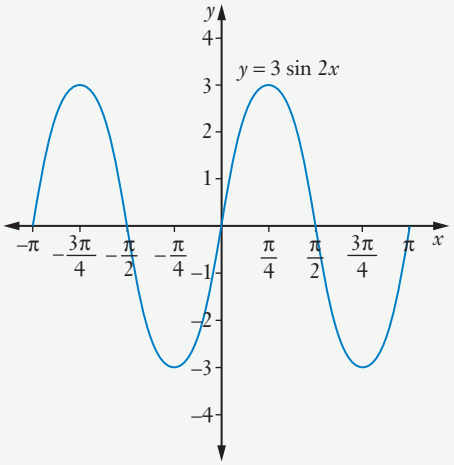
2 **a** $y = 5\sin[3(x + 5)] - 6$

b Amplitude 5, period $\frac{2\pi}{3}$, centre –6, phase shift 5 units to the left

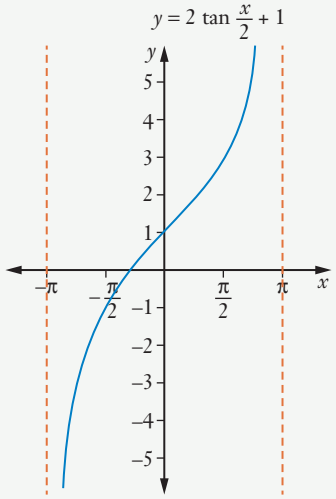
3 **a** $y = 4\cos\left[6\left(x - \frac{\pi}{3}\right)\right] + 2$

b $y = -\cos(x + \pi) - 5$

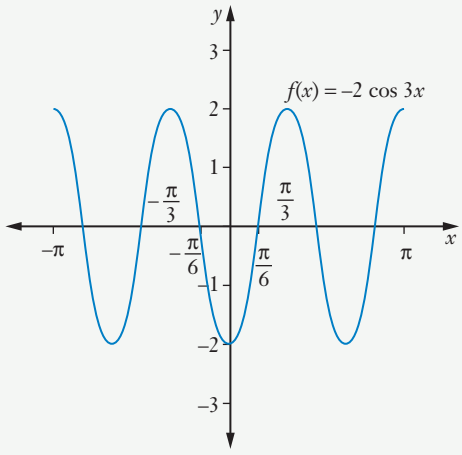
4 **a**



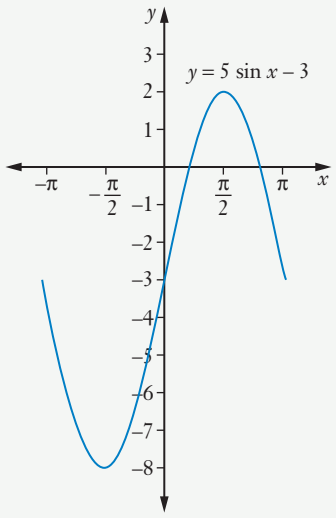
b



c

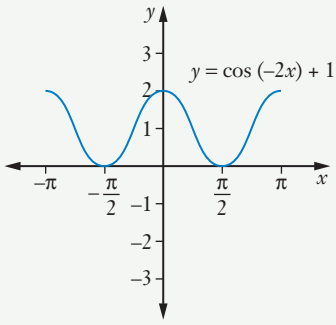


d



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e



5 **a** No amplitude, period $\frac{\pi}{4}$, centre -5

b Amplitude 8, period 2π, phase shift π units to the left, centre -3

c Amplitude 5, period π, phase shift 3 units to the right, centre 1

6 **a** $y = 7\sin[2(x-1)] - 3$

b $y = -\cos 5x + 2$

c $y = -\tan\left[\frac{1}{2}(x+2)\right]$

d $y = 4\sin\left[-\frac{1}{3}(x+5)\right] + 2$

7 No amplitude, period $\frac{2\pi}{a}$, phase shift b units to the right when $b < 0$, to the left when $b > 0$, centre c

8 $y = \tan(4x - 3)$

9 **a** 15 m

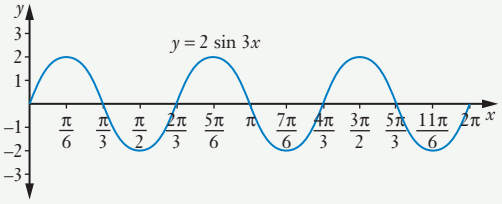
b Amplitude 10, period 12

c $D = 10\cos\frac{\pi t}{6} + 15$

10 $B = 20\sin\frac{\pi t}{30} + 100$

Exercise 3.03

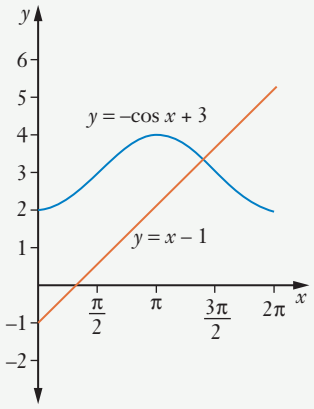
1



a 6

b $x = 0.2, 0.9, 2.3, 3, 4.3, 5.1$

2 **a**



b **i** $x = 4.4$ **ii** $x = 0, 2\pi$

3 **a** $x = 15°, 75°, 195°, 255°$

b $x = 45°, 105°, 165°, 225°, 285°, 345°$

c $x = 240°, 300°$ **d** $x = 105°, 285°$

e $x = 120°, 300°$

4 **a** $x = \frac{\pi}{6}, \frac{2\pi}{3}, \frac{7\pi}{6}, \frac{5\pi}{3}$

b $x = \frac{2\pi}{9}, \frac{4\pi}{9}, \frac{8\pi}{9}, \frac{10\pi}{9}, \frac{14\pi}{9}, \frac{16\pi}{9}$

c $x = 0, \frac{2\pi}{3}, \pi, \frac{5\pi}{3}, 2\pi$

d $x = \frac{\pi}{8}, \frac{3\pi}{8}, \frac{5\pi}{8}, \frac{7\pi}{8}, \frac{9\pi}{8}, \frac{11\pi}{8}, \frac{13\pi}{8}, \frac{15\pi}{8}$

e $x = \pi$

5 **a** $x = -\frac{11\pi}{12}, -\frac{7\pi}{12}, -\frac{\pi}{4}, \frac{\pi}{12}, \frac{5\pi}{12}, \frac{3\pi}{4}$

b $x = -\frac{\pi}{2}, 0$ **c** $x = -\frac{\pi}{4}, \frac{3\pi}{4}$

d $x = -\pi, 0, \pi$

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

6 **a** $x = \frac{\pi}{3}, \frac{2\pi}{3}, \frac{4\pi}{3}, \frac{5\pi}{3}$

b $x = \frac{2\pi}{9}, \frac{4\pi}{9}, \frac{8\pi}{9}, \frac{10\pi}{9}, \frac{14\pi}{9}, \frac{16\pi}{9}, \frac{19\pi}{9}$

7 **a** Amplitude 15, period 12, centre 20

b $t = 0, 12, 24, \ldots$ months. Average temperature of 35° occurs in January of each year.

8 **a** $y = 7\sin\frac{\pi t}{5} + 13$

b $t = 2.5, 12.5, 22.5, 32.5$ seconds

c 7.5 seconds

d 0, 5, 10, 15, 20, 25, … seconds

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9 **a** Amplitude 1, period $\frac{1}{440}$

b **i** $x = 0.0002, 0.0009, 0.0025, 0.0032, 0.0045, 0.0055, 0.007, 0.0075, 0.0093$

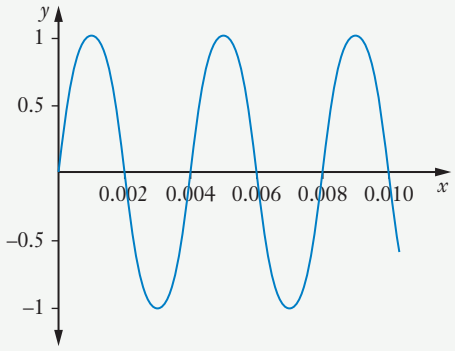
ii $x = 0, 0.001, 0.0021, 0.00035, 0.0045, 0.0056, 0.0068, 0.008, 0.009$

c **i** $x = 0.00019, 0.00095, 0.0025, 0.0032, 0.0047, 0.0055, 0.0070, 0.0078, 0.0093$

ii $x = 0, 0.0011, 0.0023, 0.0034, 0.0045, 0.0057, 0.0068, 0.0080, 0.0091$

d $y = 3 \sin (880\pi x)$

e



f 440 Hz

10 **a** Physical 23 days, emotional 28 days, intellectual 33 days

b 7 days, 21 days **c** 6 days, 19 days, 32 days

d around 7 days

11 **a** 15 is the centre of motion (equilibrium of spring)

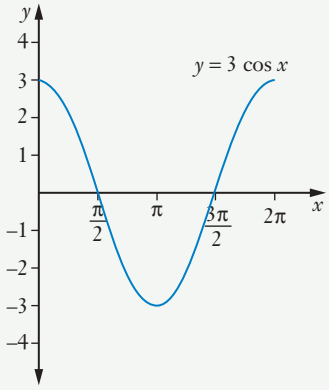
b 27 cm maximum, 3 cm minimum

c 3 cm **d** $\pi, 3\pi, 5\pi, \ldots$ seconds

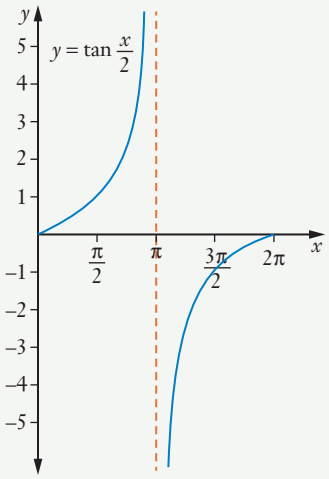
Test yourself 3

1 D **2** A **3** B

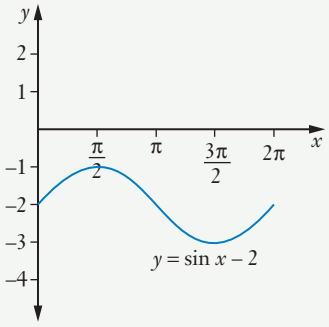
4 **a**



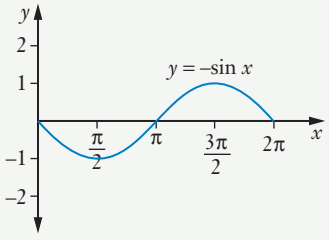
b



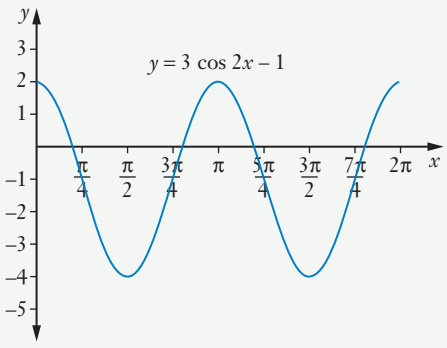
c



d



e



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5 **a** Maximum 13 m; $t = 0, 3, 6, 9, \ldots$ h; minimum 7 m; $t = 1.5, 4.5, 7.5 \ldots$h

b $t = 0.6, 2.4, 3.6, 5.4, 6.6, 8.4, \ldots$h; times when water level in the lock is 11 m

6 **a** $2\operatorname{cosec}^2 x$ **b** $\sec A$

c 1 **d** $\sin x$

7 **a** $x = \frac{\pi}{6}, \frac{5\pi}{6}, \frac{7\pi}{6}, \frac{11\pi}{6}$

b $x = \frac{\pi}{12}, \frac{5\pi}{12}, \frac{13\pi}{12}, \frac{17\pi}{12}$

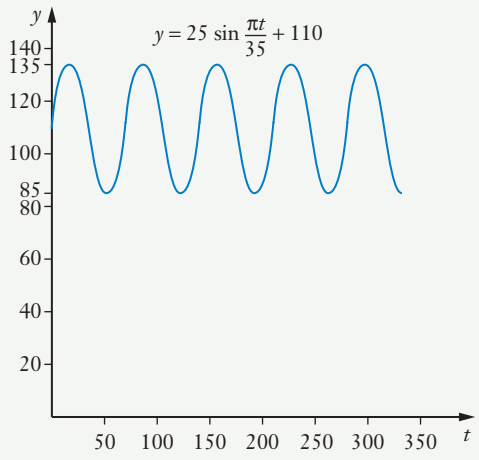
c $x = \frac{3\pi}{2}$

d $x = \frac{\pi}{6}, \frac{\pi}{2}, \frac{7\pi}{6}, \frac{3\pi}{2}$

e $x = 1.15, 1.99, 4.29, 5.13$

8 **a** $y = 25 \sin \frac{\pi t}{35} + 110$

b



9 **a** $x = \pm\frac{\pi}{6}, \pm\frac{5\pi}{6}$ **b** $x = \frac{\pi}{12}, -\frac{11\pi}{12}$

c $x = \pm\frac{\pi}{4}$

10 **a** $h = 15 \sin \frac{2\pi t}{13} + 65$

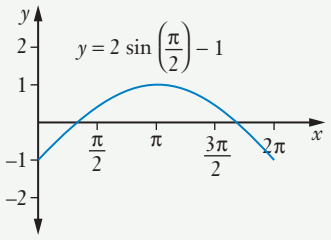
b $0, 6.5, 13, 19.5, \ldots$ hours

11 **a** $y = \cos 2x$ **b** $y = 5 \cos x$

c $y = -\cos x$ **d** $y = \cos\left(x - \frac{\pi}{6}\right)$

e $y = \cos x + 4$

12 **a**



b $x = 1, 5.2$ **c** $x = \frac{\pi}{3}, \frac{5\pi}{3}$

13 **a** Amplitude 2, period $\frac{2\pi}{3}$, centre -1

b Amplitude 1, period 4π, centre 0, phase shift 2π units to the left

c No amplitude, reflection in x-axis, period $\frac{\pi}{5}$, centre 0, phase shift $\frac{\pi}{20}$ to the right

14 **a** $x = 0°, 180°, 360°$ **b** $x = 155°, 245°$

c $x = 10°\ 54', 59°\ 6', 190°\ 54', 239°\ 6'$

15 **a** $x = -112.5°, -22.5°, 67.5°, 157.5°$

b $x = 90°, -30°, -150°$

Challenge exercise 3

1 **a** Amplitude 2, period π, phase shift $\frac{\pi}{4}$ units to the right

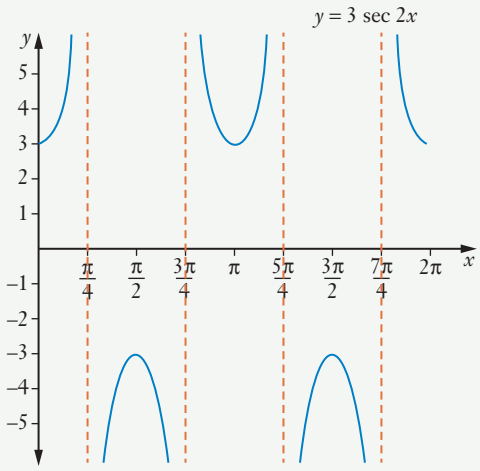
b $x = \frac{\pi}{6}, \frac{\pi}{3}, \frac{7\pi}{6}, \frac{4\pi}{3}$

2 **a** $y = 8 \cos x + 4$

b $y = 2 \sin\left[8\left(x - \frac{\pi}{3}\right)\right] + 3$

c $y = \tan\left[\frac{1}{2}\left(x + \frac{\pi}{2}\right)\right]$

3



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4 $x = \frac{\pi}{8}, \frac{3\pi}{8}, \frac{9\pi}{8}, \frac{11\pi}{8}$

5 **a** $y = 4\cos\left(\frac{1}{3}\left[x - \frac{\pi}{6}\right]\right) - 20$

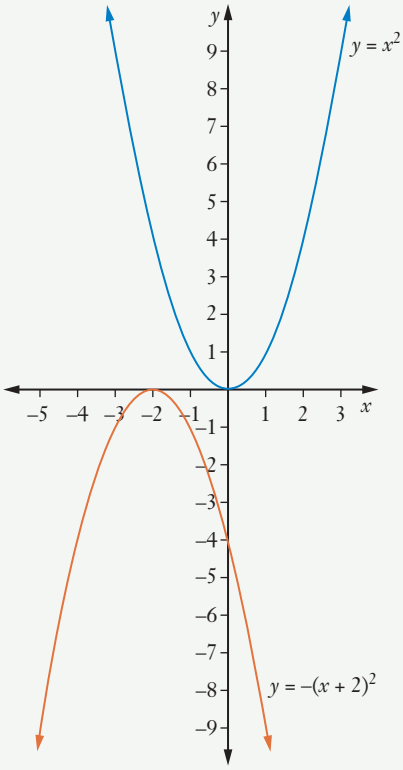
b Amplitude 4, period 6π, centre -20, phase shift $\frac{\pi}{6}$ to the right

Practice set 1

1 B **2** C **3** C **4** D

5 D **6** C **7** D

8 **a**



b Reflection in x-axis, horizontal translation 2 units to the left

9 **a** $x = 67° 30', 157° 30', 247° 30', 337° 30'$

b $x = 20°, 100°, 140°, 220°, 260°, 340°$

c $x = 150°, 210°$

d $x = 60°, 240°$

e $x = 0°, 90°, 180°, 270°, 360°$

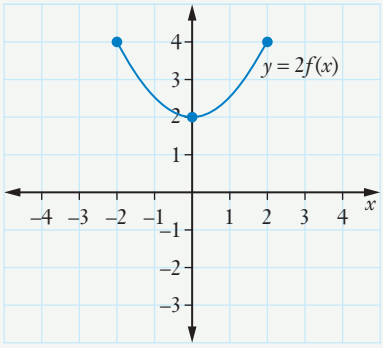
10 **a** Amplitude 4, period $\frac{2\pi}{5}$, centre 0

b Amplitude 2, reflection in x-axis, centre 1, phase shift $\frac{\pi}{6}$ units to the right

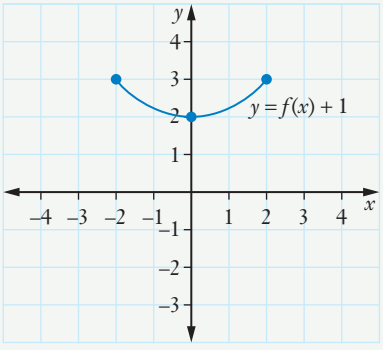
c Period 4π, phase shift 8 units to the left

11 $\frac{3}{4^{10}}$

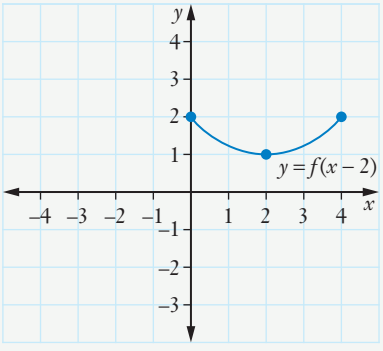
12 **a**



b

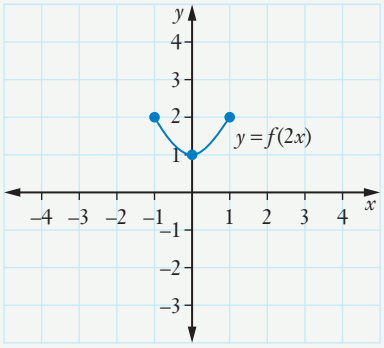


c



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d



13 ±104, 52, ±26, 13, …

14 44th term

15 Vertical dilation, scale factor 4 (stretch), horizontal translation 1 unit to the right, vertical translation 3 units down.

16 **a** $x = 30°, 41° 49', 138° 11', 150°$

b $x = 45°, 105°, 225°, 285°$

17 **a** Centre 10; max distance 16 cm, 4 cm

b 1 second

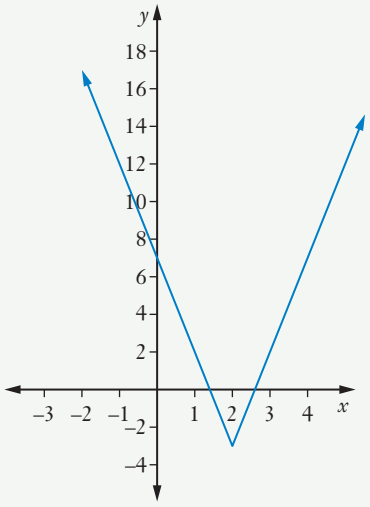
18 $y = 4\sqrt{3(x+7)} - 1$

19 **a** 199 **b** 5050

20 **a** $T_1 = 4$, $T_2 = 11$, $T_3 = 18$, $T_{12} = 81$

b 1410 **c** 29th term

21 **a**



b **i** $x = 1, 3$ **ii** $x = 0, 4$ **iii** $x = 2$

c Domain $(-\infty, \infty)$, range $[-3, \infty)$

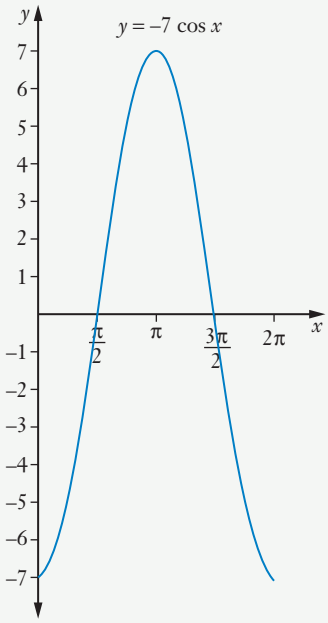
22 **a** $-\frac{1}{2}$ **b** $-\frac{\sqrt{3}}{2}$ **c** 1

d $-\frac{1}{\sqrt{2}}$ **e** $-\frac{1}{\sqrt{3}}$

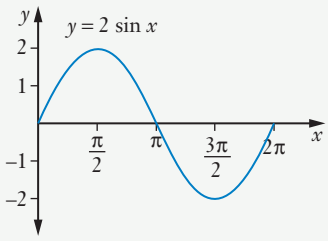
23 $T_n = 11n - 26$

24 $x = 40°$

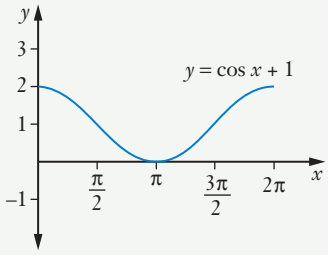
25 **a**



b

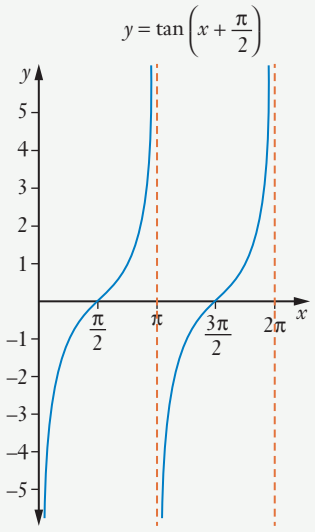


c

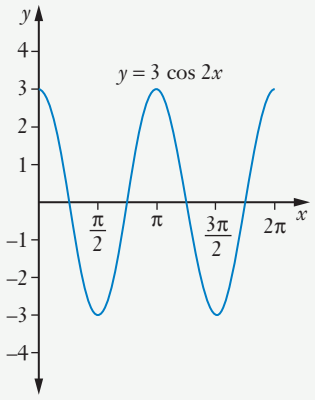


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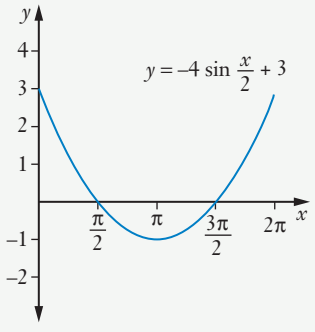
d



e



f



26 Proofs (see worked solutions)

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

c $y = \sin x - 3$ **d** $y = -5\sin x$

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

f $y = 5\sin\left[\frac{1}{3}(x - \pi)\right] + 1$

28 $x = \frac{5}{6}$

29 **a** $x = 0.9, 5.38$ **b** $x = \frac{\pi}{4}, \frac{3\pi}{4}, \frac{5\pi}{4}, \frac{7\pi}{4}$

c $x = \frac{\pi}{6}, \frac{5\pi}{6}$ **d** $x = \frac{\pi}{2}, \frac{3\pi}{2}$

e $x = \frac{\pi}{3}, \frac{2\pi}{3}, \frac{4\pi}{3}, \frac{5\pi}{3}$

f $x = \frac{\pi}{3}, \frac{2\pi}{3}, \frac{4\pi}{3}, \frac{5\pi}{3}$

30 $n = 4$ **31** $\frac{1}{10}$

32 **a** Centre 18, amplitude 20, so maximum temperature is 38°C, minimum −2°C. Period is 12, so it is an annual cycle.

b July **c** January

d 8°C **e** April and October

33 $-1 \le x \le 3$

34 $f(-x) = 3(-x)^2 - 2$

$= 3x^2 - 2$

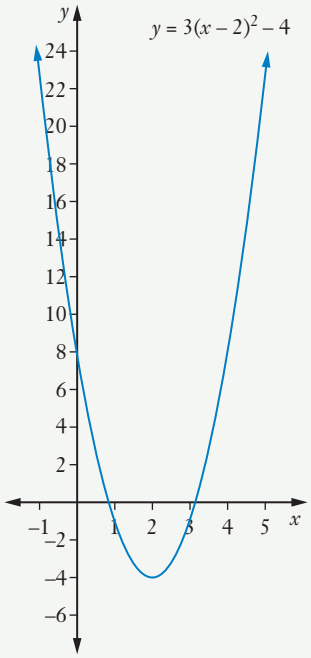
$= f(x)$ so even

35 **a** $\log 3, \log 3^2, \log 3^3, \ldots = \log 3, 2\log 3, 3\log 3, \ldots$

Arithmetic series, since $2\log 3 - \log 3 = 3\log 3 - 2\log 3 = \log 3$

b $210\log 3$

36 **a**



b **i** $x \le 0, x \ge 4$ **ii** $0 < x < 4$

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Chapter 4

Exercise 4.01

1 **a** $12x^3 - 6x^2 + 7$ **b** 2
c $12x - 3$

2 $20x^4 + 18x$ **3** $6\pi t^2 - 6t$ **4** $f'(-2) = 101$

5 **a** $-5x^{-6}$ **b** $\frac{2}{3}x^{-\frac{1}{3}}$ **c** $-\frac{2}{x^3}$
d $\frac{1}{4\sqrt[4]{x^3}}$ **e** $\frac{20}{x^5}$

6 $\frac{1}{12}$

7 **a** $21(3x-1)^6$ **b** $3(2x-1)(x^2-x+2)^2$
c $\frac{7}{2\sqrt{7x-2}}$ **d** $-\frac{3}{(3x-2)^2}$
e $\frac{2x}{3\sqrt[3]{(x^2-3)^2}}$

8 **a** $3x^2 + 8x$ **b** $24x + 4$ **c** $12x^2 + 4$
d $4(x^2-1)(5x^2+3x-1)$ **e** $\frac{x^2(7x+6)}{\sqrt{x+1}}$

9 **a** $-\frac{13}{(x-5)^2}$ **b** $\frac{x^2(8x-21)}{(4x-7)^2}$
c $\frac{2(x^2-3x-3)}{(2x-3)^2}$ **d** $\frac{-6x+23}{(2x+9)^3}$
e $\frac{3x-7}{\sqrt{(2x-1)^3}}$

10 **a** -6 **b** 3

11 **a** $\frac{1}{14}$ **b** $\frac{1}{5}$

12 **a** $7x - y - 24 = 0$ **b** $51x - y - 72 = 0$

13 **a** $x - 4y - 3 = 0$ **b** $x + 3y - 6 = 0$

14 $x = 4$ **15** $(2, 6), (-2, -10)$

16 $3x + y + 8 = 0$ **17** $(4, 2)$

18 **a** $17x - y - 3 = 0$ **b** $x + 17y + 51 = 0$

19 **a** $6t$ **b** $-\frac{2}{(t-3)^2}$ **c** $\frac{2}{3\sqrt[3]{(2x+3)^2}}$

20 **a** **i** 10 kg s^{-1} **ii** 17 kg s^{-1}
b **i** 13 kg s^{-1} **ii** 123 kg s^{-1}

21 -2.18 Pa/m^3

22 **a** **i** 2 m **ii** 1.5 m **b** 2 s
c **i** 2 m s^{-1} **ii** 0 m s^{-1} **iii** -4 m s^{-1}

Exercise 4.02

1 **a** $7e^{7x}$ **b** $-e^{-x}$ **c** $6e^{6x-2}$
d $2xe^{x^2+1}$ **e** $(3x^2+5)e^{x^3+5x+7}$
f $5e^{5x}$ **g** $-2e^{-2x}$ **h** $10e^{10x}$
i $2e^{2x} + 1$ **j** $2x + 2 - e^{1-x}$
k $5(1+4e^{4x})(x+e^{4x})^4$ **l** $e^{2x}(2x+1)$
m $\frac{e^{3x}(3x-2)}{x^3}$ **n** $x^2e^{5x}(5x+3)$
o $\frac{4e^{2x+1}(x+2)}{(2x+5)^2}$

2 $3e$

3 **a** $3^x \ln 3$ **b** $10^x \ln 10$ **c** $3(2^{3x-4}) \ln 2$

4 5 **5** $x + y - 1 = 0$

6 **a** $3e^3$ **b** $-\frac{1}{3e^3}$

7 **a** $y = 2ex - e$ **b** $x + 2ey - 2e^2 - 1 = 0$

8 $x \ln 4 - y + 4 = 0$

9 **a** **i** 29 627 **ii** 35 826
b **i** 1044 people/year **ii** 1240 people/year
c **i** 1126 people/year **ii** 1361 people/year

10 **a** 55 042 cm min^{-1}
b **i** 142.8 cm min^{-1} **ii** 1087 cm min^{-1}
iii 177 722 205.4 cm min^{-1}

11 **a** 20 g **b** 7 g
c -0.091 g/year
d **i** -0.147 g/year **ii** -0.051 g/year
iii -0.0063 g/year

12 **a** 66 079.4 cm **b** 132 158.8 cm s^{-1}

Exercise 4.03

1 **a** $1 + \frac{1}{x}$ **b** $-\frac{1}{x}$ **c** $\frac{3}{3x+1}$
d $\frac{2x}{x^2-4}$ **e** $\frac{15x^2+3}{5x^3+3x-9}$
f $\frac{10x^2+2x+5}{5x+1}$ **g** $6x + 5 + \frac{1}{x}$
h $\frac{8}{8x-9}$ **i** $\frac{6x+5}{(x+2)(3x-1)}$
j $\frac{-30}{(4x+1)(2x-7)}$ **k** $\frac{5}{x}(1+\ln x)^4$
l $9\left(\frac{1}{x}-1\right)(\ln x - x)^8$ **m** $\frac{4}{x}(\ln x)^3$

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n $6\left(2x+\frac{1}{x}\right)(x^2+\ln x)^5$

o $1+\ln x$ **p** $\frac{1-\ln x}{x^2}$

q $\frac{2x\ln x+2x+1}{x}$

r $3x^2\ln(x+1)+\frac{x^3}{x+1}$ **s** $\frac{1}{x\ln x}$

t $\frac{x-2-x\ln x}{x(x-2)^2}$ **u** $\frac{e^{2x}(2x\ln x-1)}{x(\ln x)^2}$

v $e^x\left(\frac{1}{x}+\ln x\right)$ **w** $\frac{10\ln x}{x}$

2 $f'(1)=-\frac{1}{2}$ **3** $\frac{1}{x\ln 10}$

4 $x-2y-2+2\ln 2=0$ **5** $x-y-2=0$

6 $-\frac{2}{5}$ **7** $5x+y-\ln 5-25=0$

8 $5x-19y+19\ln 19-15=0$

9 $\frac{2}{(2x+5)\ln 3}$

10 $(2\ln 2)x+y-1-4\ln 2=0$

11 **a** 20 000

b **i** 10.6 years **ii** 43.6 years

c $P=20\,000\,e^{0.021t}$ **d** 452 kangaroos/year

e **i** 447 kangaroos/year

ii 466 kangaroos/year

iii 518 kangaroos/year

Exercise 4.04

1 **a** $4\cos 4x$ **b** $-3\sin 3x$

c $5\sec^2 5x$ **d** $3\sec^2(3x+1)$

e $\sin(-x)$ **f** $3\cos x$

g $-20\sin(5x-3)$ **h** $-6x^2\sin(x^3)$

i $14x\sec^2(x^2+5)$ **j** $3\cos 3x-8\sin 8x$

k $\sec^2(\pi+x)+2x$ **l** $x\sec^2 x+\tan x$

m $3\sin 2x\sec^2 3x+2\tan 3x\cos 2x$

n $\frac{x\cos x-\sin x}{2x^2}$

o $\frac{3\sin 5x-5(3x+4)\cos 5x}{\sin^2 5x}$

p $9(2+7\sec^2 7x)(2x+\tan 7x)^8$

q $2\sin x\cos x=\sin 2x$ **r** $-45\sin 5x\cos^2 5x$

s $e^x+2\sin 2x$ **t** $-\frac{1}{x}\cos(1-\ln x)$

u $(e^x+1)\cos(e^x+x)$ **v** $\frac{\cos x}{\sin x}=\cot x$

w $e^{3x}(3\cos 2x-2\sin 2x)$

x $\frac{e^{2x}(2\tan 7x-7\sec^2 7x)}{\tan^2 7x}$

2 12 **3** $6\sqrt{3}x-12y+6-\pi\sqrt{3}=0$

4 $-\frac{\sin x}{\cos x}=-\tan x$ **5** $-\frac{2}{3\sqrt{3}}=-\frac{2\sqrt{3}}{9}$

6 $\sec^2 x\,e^{\tan x}$

7 $8x+24\sqrt{2}y-72-\pi=0$

8 Proof (see worked solutions).

9 **a** $\frac{\pi}{180}\sec^2 x°$ **b** $-\frac{\pi}{60}\sin x°$ **c** $\frac{\pi}{900}\cos x°$

10 $\sin^3 x(4\cos^2 x-\sin^2 x)$

11 **a** 750 **b** 525 **c** 975

d 2.6, 6.4, 11.6, 15.4 … days

e **i** –136 fish/day **ii** 155 fish/day

iii –101 fish/day **iv** 0 fish/day

f 0.23, 4.27, 9.23, 13.27, … days

12 **a** **i** 9 m **ii** 13 m

b 0.2, 5.8, 12.2, 17.8, … h

c **i** 0 m h^{-1} **ii** 3.6 m h^{-1} **iii** 4.2 m h^{-1}

d 1.5, 10.5, 13.5, 22.5, … h

Exercise 4.05

1 $7x^6-10x^4+4x^3-1$; $42x^5-40x^3+12x^2$; $210x^4-120x^2+24x$; $840x^3-240x+24$

2 $72x^7$

3 $f'(x)=10x^4-3x^2, f''(x)=40x^3-6x$

4 $f'(1)=11, f''(-2)=168$

5 $7x^6-12x^5+16x^3$; $42x^5-60x^4+48x^2$; $210x^4-240x^3+96x$

6 $\frac{dy}{dx}=4x-3, \frac{d^2y}{dx^2}=4$

7 $f'(-1)=-16, f''(2)=40$ **8** $-4x^{-5}$; $20x^{-6}$

9 $-\frac{1}{32}$ **10** 26

11 $x=\frac{7}{18}$ **12** $x>\frac{1}{3}$

13 $20(4x-3)^4$; $320(4x-3)^3$

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14 $f'(x) = -\dfrac{1}{2\sqrt{2-x}}; f''(x) = -\dfrac{1}{4\sqrt{(2-x)^3}}$

15 $f'(x) = -\dfrac{16}{(3x-1)^2}; f''(x) = \dfrac{96}{(3x-1)^3}$

16 $\dfrac{d^2v}{dt^2} = 24t + 16$ **17** $b = \dfrac{2}{3}$

18 196 **19** $b = -2.7$

20 $\dfrac{dy}{dx} = 4e^{4x} - 4e^{-4x}$

$\dfrac{d^2y}{dx^2} = 16e^{4x} + 16e^{-4x} = 16y$

21, 22 Proofs (see worked solutions).

23 $n = -15$

24 $y = 2\cos 5x; \dfrac{dy}{dx} = -10\sin 5x$

$\dfrac{d^2y}{dx^2} = -50\cos 5x = -25y$

25 $f(x) = -2\sin x; f'(x) = -2\cos x$

$f''(x) = 2\sin x = -f(x)$

26 $y = 2\sin 3x - 5\cos 3x; \dfrac{dy}{dx} = 6\cos 3x + 15\sin 3x$

$\dfrac{d^2y}{dx^2} = -18\sin 3x + 45\cos 3x = -9y$

27 $a = -7, b = -24$ **28** $f''(2) = \dfrac{3}{4\sqrt{2}} = \dfrac{3\sqrt{2}}{8}$

29 **a** 8 m **b** 38 m **c** 31 m s^{-1}

d 26 m s^{-2}

30 **a** 4 cm

b Maximum 20 cm, minimum 4 cm

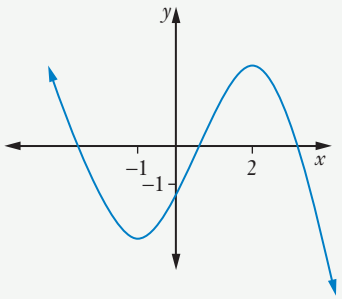
c **i** 0 cm s^{-1} **ii** 25.1 cm s^{-1}

d **i** $-8\pi^2$ or -79 cm s^{-2} **ii** $8\pi^2$ or 79 cm s^{-2}

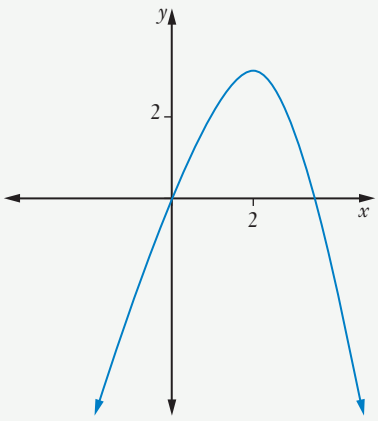
iii 0 cm s^{-2} **e** $\dfrac{d^2h}{dt^2} = -\pi^2(h - 12)$

Exercise 4.06

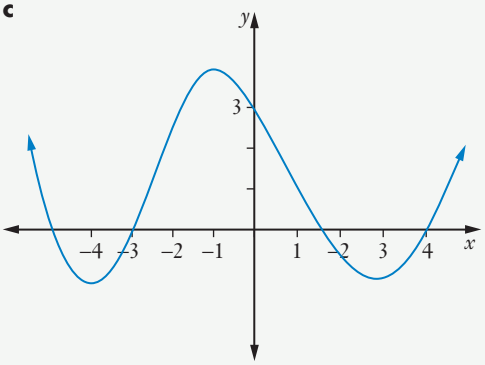
1 **a**



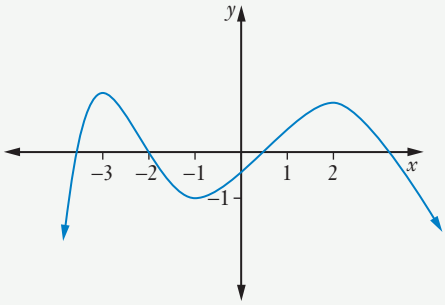
b



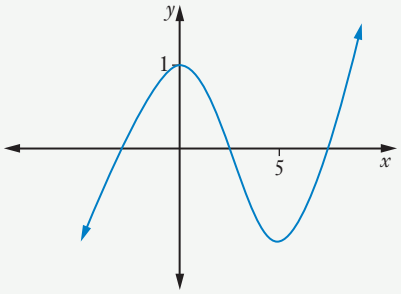
c



d

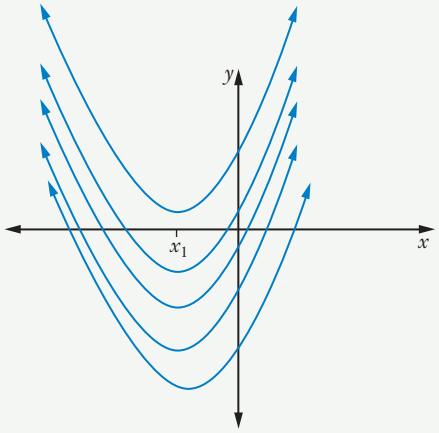


e

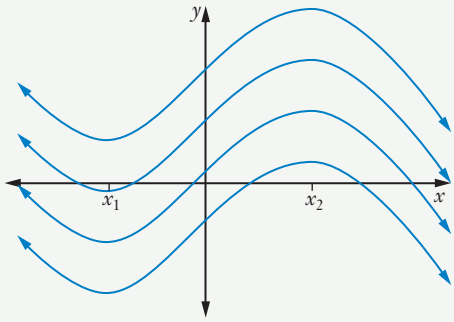


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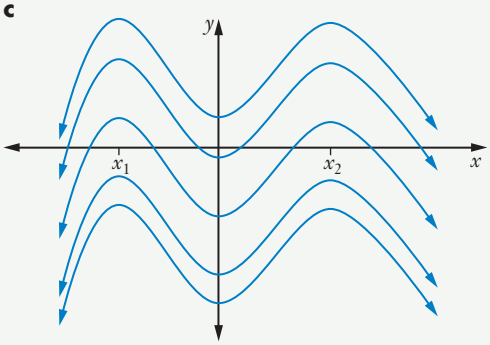
2 a



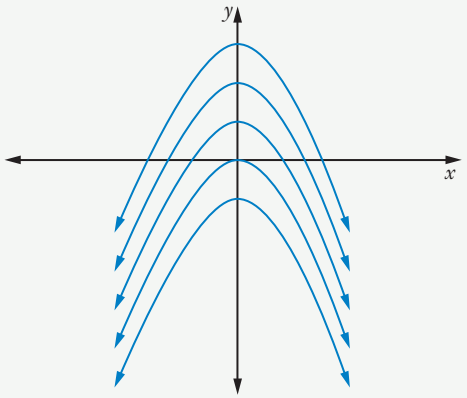
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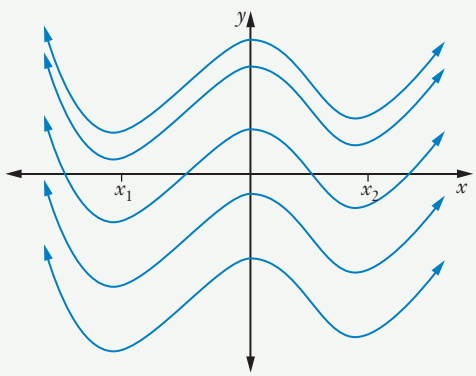
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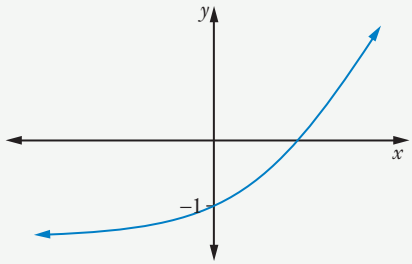
d



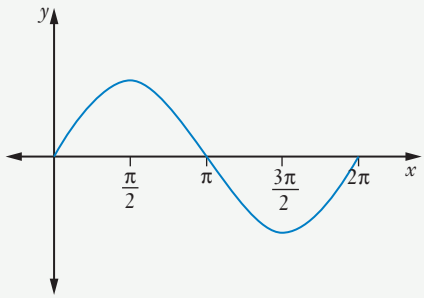
e



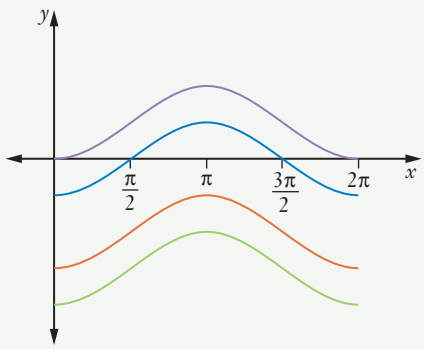
3



4



5



Exercise 4.07

1 a $x^2 - 3x + C$

b $\frac{x^3}{3} + 4x^2 + x + C$

c $\frac{x^6}{6} - x^4 + C$

d $\frac{(x-1)^3}{3} + C$

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e $6x + C$ **f** $\frac{(3x+2)^6}{18} + C$

g $\frac{4(2x-7)^5}{5} + C$

2 a $f(x) = 2x^3 - \frac{x^2}{2} + C$

b $f(x) = \frac{x^5}{5} - x^3 + 7x + C$

c $f(x) = \frac{x^2}{2} - 2x + C$

d $f(x) = \frac{x^3}{3} - x^2 - 3x + C$ **e** $f(x) = \frac{2x^{\frac{3}{2}}}{3} + C$

3 a $y = x^5 - 9x + C$ **b** $y = -\frac{x^{-3}}{3} + 2x^{-1} + C$

c $y = \frac{x^4}{20} - \frac{x^3}{3} + C$ **d** $y = -\frac{2}{x} + C$

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

4 a $\frac{2\sqrt{x^3}}{3} + C$ **b** $-\frac{x^{-2}}{2} + C$

c $-\frac{1}{7x^7} + C$ **d** $2x^{\frac{1}{2}} + 6x^{\frac{1}{3}} + C$

e $-\frac{x^{-6}}{6} + 2x^{-1} + C$

5 a $\frac{(x^2+5)^5}{5} + C$ **b** $\frac{(x^3-1)^{10}}{10} + C$

c $\frac{(2x^2+3)^4}{2} + C$ **d** $\frac{3(x^5+1)^7}{7} + C$

e $\frac{(x^2-4)^8}{16} + C$ **f** $\frac{(2x^6-7)^9}{108} + C$

g $\frac{(x^2-x+3)^5}{5} + C$ **h** $\frac{(x^3+2x^2-7x)^{11}}{11} + C$

i $\frac{(x^2-6x-1)^6}{12} + C$

6 $y = \frac{x^4}{4} - x^3 + 5x - \frac{1}{4}$

7 $f(x) = 2x^2 - 7x + 11$ **8** $f(1) = 8$

9 $y = 2x - 3x^2 + 19$ **10** $x = 16\frac{1}{3}$

11 $y = 4x^2 - 8x + 7$ **12** $y = 2x^3 + 3x^2 + x - 2$

13 $f(x) = x^3 - x^2 - x + 5$ **14** $f(2) = 20.5$

15 $y = \frac{4x^3}{3} - 15x - 14\frac{1}{3}$

16 $y = \frac{x^3}{3} - 2x^2 + 3x - 4\frac{2}{3}$

17 $f(x) = x^4 - x^3 + 2x^2 + 4x - 2$

18 $y = 3x^2 + 8x + 8$

19 $f(-2) = 77$ **20** $x = 3t^2 - 5t - 2$

21 $x = 2t^4 - 2t^3 + 3t^2 - 8t - 3$

Exercise 4.08

1 a $-\cos x + C$ **b** $\tan x + C$ **c** $\sin x + C$

d $\frac{1}{7}\tan 7x + C$ **e** $-\frac{1}{2}\cos(2x - \pi) + C$

2 a $e^x + C$ **b** $\frac{1}{6}e^{6x} + C$ **c** $\ln|x| + C$

d $\ln|3x-1| + C$ **e** $\frac{1}{2}\ln|x^2+5| + C$

3 a $e^x + 5x + C$ **b** $\sin x + 2x^2 + C$

c $\frac{x^2}{2} + \ln|x| + C$

d $2x^4 - x^3 + 3x^2 - 3x + \ln|x| + C$

e $-\frac{1}{5}\cos 5x - \frac{1}{9}\tan 9x + C$

4 $y = \sin x - 5$ **5** $f(x) = 5\ln|x| + 3$

6 $y = 2\sin 2x + \sqrt{3}$

7 $f(x) = 3e^{3x} - 8e^6x + 14e^6$

8 a $P = 25\,000e^{0.054t} + 10\,000$ **b** 52 900

9 $x = e^{3t} + 4$

10 a $\frac{dx}{dt} = 3\cos 3t$

b -0.3 cm **c** $0, \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{4\pi}{3}, \ldots$ s

Test yourself 4

1 D **2** B **3** A **4** C

5 a $5e^{5x}$ **b** $-2e^{1-x}$ **c** $\frac{1}{x}$

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

g $10e^x(e^x+1)^9$

6 a $-\sin x$ **b** $2\cos x$ **c** $\sec^2 x$

d $x\cos x + \sin x$ **e** $\frac{x\sec^2 x - \tan x}{x^2}$

f $-3\sin 3x$ **g** $5\sec^2 5x$

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7 $3x - y + 3 = 0$

8 $12x + 4\sqrt{2}y - 4 - 3\pi = 0$

9 $\dfrac{d^2x}{dt^2} = -4\cos 2t$

10 **a** $\dfrac{1}{\sqrt{1-x^2}}$ **b** $\dfrac{3}{1+9x^2}$

c $-\dfrac{10}{\sqrt{1-25x^2}}$

11 $-\dfrac{e^2}{e^2+1}$

12 **a** $2x^5 - x^4 + 3x^2 - 3x + C$

b $\dfrac{1}{5}e^{5x} + C$

c $\dfrac{1}{9}\tan 9x + C$

d $\ln|x+5| + C$

e $\dfrac{1}{2}\sin 2x + C$

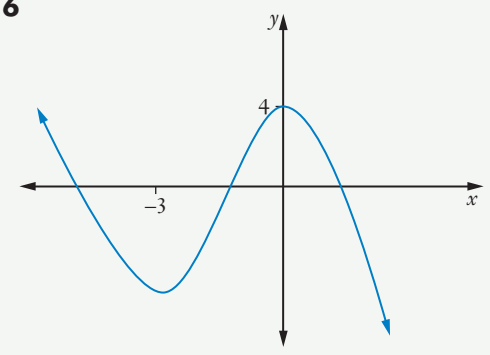
f $-4\cos\dfrac{x}{4} + C$

13 $-3\sqrt{3}$

14 $y = 2x^3 + 6x^2 - 5x - 33$

15 $\dfrac{1}{5\sqrt[5]{(x-3)^4}}$

16



17 $2x + y - \ln 2 - 4 = 0$

18 $4x + 8y - 8 - \pi = 0$

19 **a** $\dfrac{1}{\sqrt{1-x^2}}$ **b** $-\dfrac{1}{\sqrt{25-x^2}}$ **c** $\dfrac{1}{1+x^2}$

d $\dfrac{4}{\sqrt{1-16x^2}}$ **e** $\dfrac{2}{4+x^2}$

20 **a** $40x(5x^2+7)^3$

b $4(16x-3)(2x-3)^6$

c $\dfrac{23}{(3x+4)^2}$

d $2x^2e^x(x+3)$

e $\dfrac{3(x+1)\sec^2 3x - \tan 3x}{(x+1)^2}$

21 **a** 0

b $\sin^{-1}x + \cos^{-1}x = \dfrac{\pi}{2}$; $\dfrac{d}{dx}\left(\dfrac{\pi}{2}\right) = 0$

22 $f(x) = \dfrac{5x^3}{2} + 6x^2 - 49x + 59$

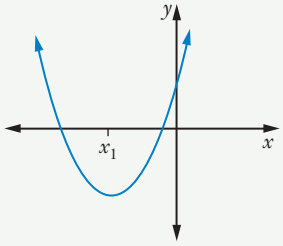
23 **a** -8 **b** 26 **c** -90

24 **a** $f^{-1}(x) = x^2 - 1$ **b** $P = (3, 8)$

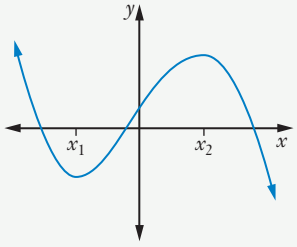
c $6x - y - 10 = 0$

25 $\dfrac{x}{1+x^2} + \tan^{-1}x$

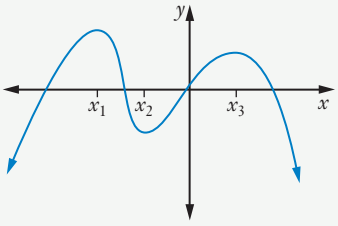
26 **a**



b



c



27 $f(x) = 2x^3 - 3x^2 - 31x + 68$

28 $4x - 6\sqrt{3}y + \sqrt{3}\pi - 6 = 0$

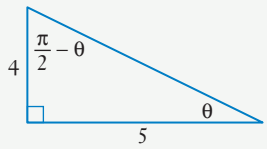
29 **a** $\dfrac{(3x^4-5)^7}{84} + C$ **b** $\dfrac{3(x^2+1)^{10}}{20} + C$

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Challenge exercise 4

1 $2e$

2 **a**



b 0

c $\theta + \frac{\pi}{2} - \theta$

3 $\frac{20x^2 - 120x - 1}{(4x^2+1)^4}; \frac{-24(20x^3 - 140x^2 - 3x + 5)}{(4x^2+1)^5}$

4 **a** $e^{x^2} + C$ **b** $-\frac{1}{3}\cos(x^3) + C$

5 $(2x\cos 2x + \sin 2x)e^{x \sin 2x}$

6 $y = \frac{x^3}{3} - x^2 - 15x - 1$

7 **a** $\frac{2x}{\sqrt{1-x^4}}$ **b** $\frac{e^x}{1+e^{2x}}$

c $\frac{\cos x - \sin x}{\sin x + \cos x}$

8 $25\frac{5}{6}$

9 $\frac{1 + \ln x - x \ln x}{e^x}$

10 **a** $\theta = \tan^{-1}(4t)$ **b** 3° 32′

11 **a** $x = y + e^y$ **b** $P = (1 + e, 1)$

c $x - (1 + e)y = 0$

12 **a** $\frac{\sec^2 x}{\tan x}$ or $\frac{1}{\sin x \cos x}$ **b** $-\ln|\cos x| + C$

13 **a** $-\frac{\cos(x^3 - \pi)}{3} + C$ **b** $\frac{e^{x^2}}{2} + C$

Chapter 5

Exercise 5.01

1 $x < 2$ **2** $x < \frac{1}{4}$

3 $(-\infty, 0)$

4 **a** $x < 1.5$ **b** $x > 1.5$ **c** $x = 1.5$

5 $f'(x) = -2 < 0$ for all x

6 $y' = 3x^2 > 0$ for all $x \neq 0$

7 $(0, 0)$

8 $x = -3, 2$

9 **a** $(1, -4)$ **b** $(0, 9)$

c $(1, 1)$ and $(2, 0)$ **d** $(0, 1), (1, 0)$ and $(-1, 0)$

10 $(2, 0)$

11 $x = 2, 5$

12 $p = -12$

13 $a = 1\frac{1}{2}, b = -6$

14 **a** $\frac{dy}{dx} = 3x^2 - 6x + 27$

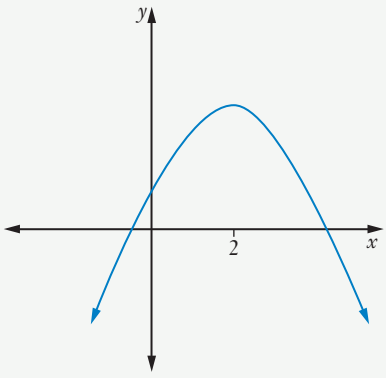
b The quadratic function has $a > 0$

$b^2 - 4ac = -288 < 0$

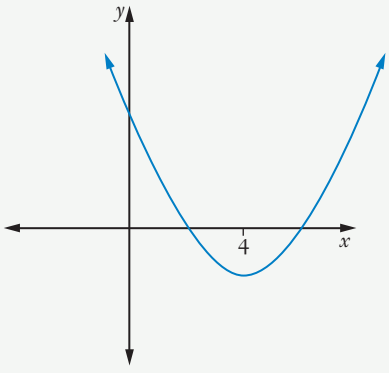
So $3x^2 - 6x + 27 > 0$ for all x.

The function is monotonic increasing for all x.

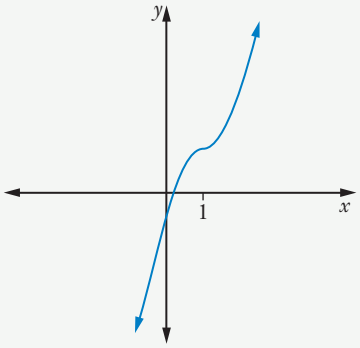
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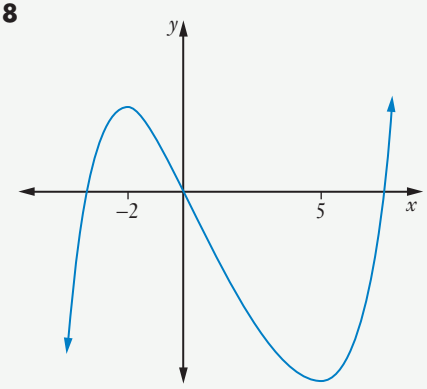


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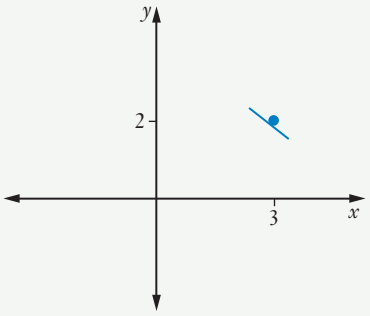


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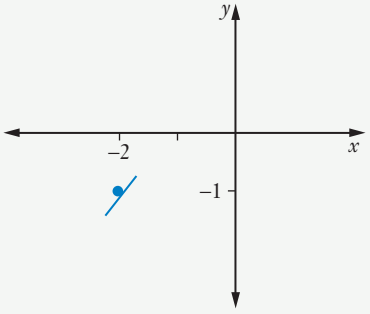
18



19



20



21 $(2, 0)$ and $\left(\frac{2}{3}, 3\frac{13}{81}\right)$

22 $\frac{3x+2}{2\sqrt{x+1}}$; $\left(-\frac{2}{3}, -\frac{2\sqrt{3}}{9}\right)$

23 $a = -1.75$

24 $y' = \frac{1}{2\sqrt{x}} \neq 0$

25 $y' = -\frac{3}{x^4} \neq 0$

Exercise 5.02

1 $(0, -1)$; show $y' < 0$ on LHS, $y' > 0$ on RHS

2 $(0, 0)$, minimum

3 $(-2, 11)$; show $f'(x) > 0$ on LHS and $f'(x) < 0$ on RHS

4 $(-1, -2)$, minimum

5 $(4, 0)$ minimum

6 $(0, 5)$ maximum, $(4, -27)$ minimum

7 $(0, 5)$ maximum, $(2, 1)$ minimum

8 $(0, -3)$ maximum, $(1, -4)$ minimum, $(-1, -4)$ minimum

9 $(1, 0)$ minimum, $(-1, 4)$ maximum

10 $m = -3$

11 $x = -3$ minimum

12 $x = 0$ minimum, $x = -1$ maximum

13 **a** $\frac{dP}{dx} = 2 - \frac{50}{x^2}$

b $(-5, -20)$ maximum, $(5, 20)$ minimum

14 $\left(1, \frac{1}{2}\right)$ minimum

15 $(2.06, 54.94)$ maximum, $(-2.06, -54.94)$ minimum

16 $(4.37, 54.92)$ minimum, $(-4.37, -54.92)$ maximum

17 **a** $\frac{3600 - 2x^2}{\sqrt{3600 - x^2}}$

b $(42.4, 1800)$ maximum, $(-42.4, -1800)$ minimum

Exercise 5.03

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

2 $x < 3$

3 $y'' = -8 < 0$

4 $y'' = 2 > 0$

5 $\left(-\infty, 2\frac{1}{3}\right)$

6 $(1, 9)$

7 $(1, -17)$ and $(-1, -41)$

8 $(0, -2)$: $y'' < 0$ on LHS, $y'' > 0$ on RHS

9 **a** No

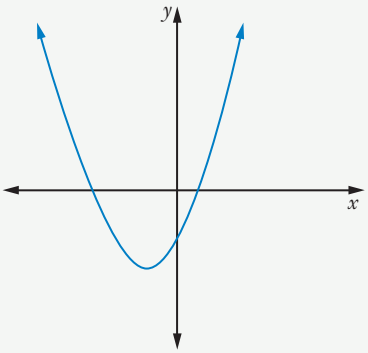
b Yes – point of inflection at $(0, 0)$

c Yes –point of inflection at $(0, 0)$

d Yes – point of inflection at $(0, 0)$

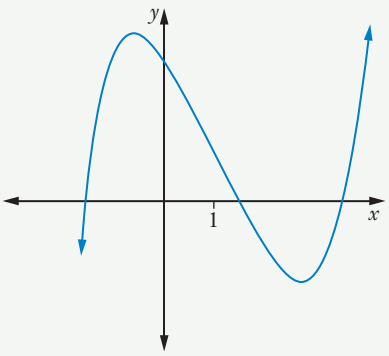
e No

10



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11



12 None: (2, 31) is not a point of inflection since concavity does not change.

13 Show that $\frac{12}{x^4} > 0$ for all $x \neq 0$.

14 **a** (0, 7), (1, 0) and (–1, 14)

b (0, 7)

15 **a** $12x^2 + 24 \neq 0$ and there are no points of inflection.

b The curve is always concave upwards.

16 $a = 2$

17 $p = 4$

18 $a = 3, b = -3$

19 **a** (0, –8), (2, 2)

b $\frac{dy}{dx} = 6x^5 - 15x^4 + 21$

At (0, –8):

$\frac{dy}{dx} \neq 0$

At (2, 2):

$\frac{dy}{dx} \neq 0$

Exercise 5.04

1 **a** $\frac{dy}{dx} > 0, \frac{d^2y}{dx^2} > 0$ **b** $\frac{dy}{dx} < 0, \frac{d^2y}{dx^2} < 0$

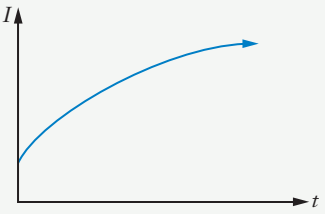
c $\frac{dy}{dx} > 0, \frac{d^2y}{dx^2} < 0$ **d** $\frac{dy}{dx} < 0, \frac{d^2y}{dx^2} > 0$

e $\frac{dy}{dx} > 0, \frac{d^2y}{dx^2} > 0$

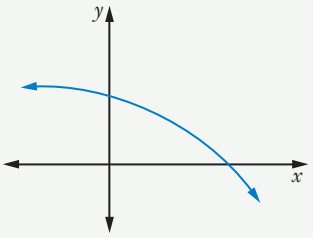
2 **a** $\frac{dP}{dt} > 0, \frac{d^2P}{dt^2} < 0$

b No, the rate is decreasing.

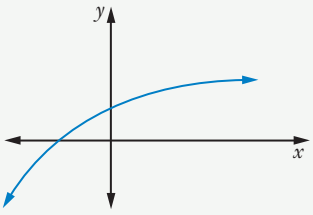
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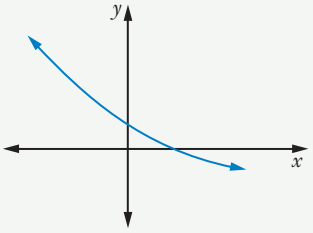
4 **a**



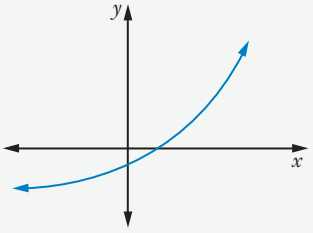
b



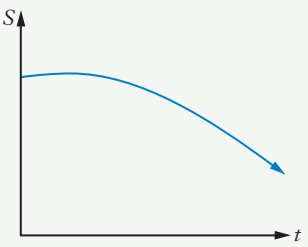
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d

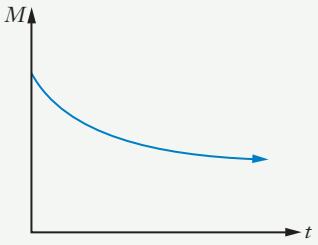


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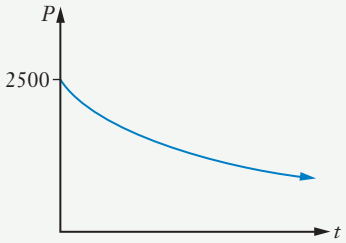


7 $\frac{dM}{dt} < 0, \frac{d^2M}{dt^2} > 0$

8 **a** The number of fish is decreasing.

b The population rate is increasing.

c



9 The level of education is increasing, but the rate of increase is slowing down.

10 The population is decreasing, and the rate of change in population is decreasing.

Exercise 5.05

1 (1, 0), minimum

2 (0, 1), minimum (flat)

3 (2, –5); $y'' = 6 > 0$ so minimum

4 (0.5, 0.25); $y'' = -2 < 0$ so maximum

5 (0, –5); $f''(x) < 0$ on LHS, $f''(x) > 0$ on RHS

6 Yes – point of inflection at (0, 3)

7 (–2, –78) minimum, (–3, –77) maximum

8 (0, 1) maximum, (–1, –4) minimum, (2, –31) minimum

9 (0, 1) maximum, (0.5, 0) minimum, (–0.5, 0) minimum

10 **a** (4, 176) maximum, (5, 175) minimum

b (4.5, 175.5)

11 (3.67, 0.38), maximum

12 (0, –1) minimum, (–2, 15) maximum, (–4, –1) minimum

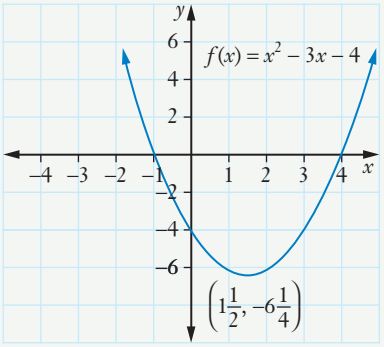
13 **a** $a = 4$ **b** $\left(\frac{1}{2}, 0\right)$, minimum

14 $m = -4$

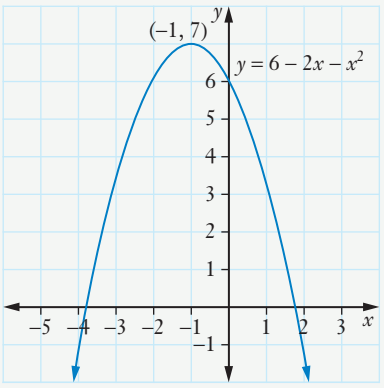
15 $a = 3, b = -9$

Exercise 5.06

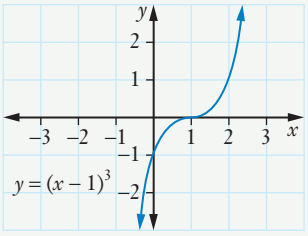
1



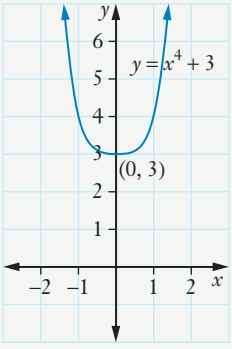
2



3 (1, 0) point of inflection

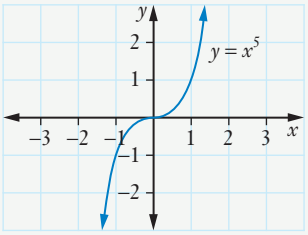


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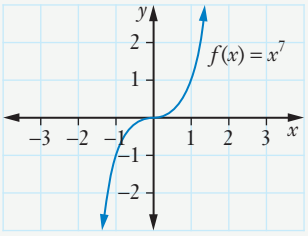


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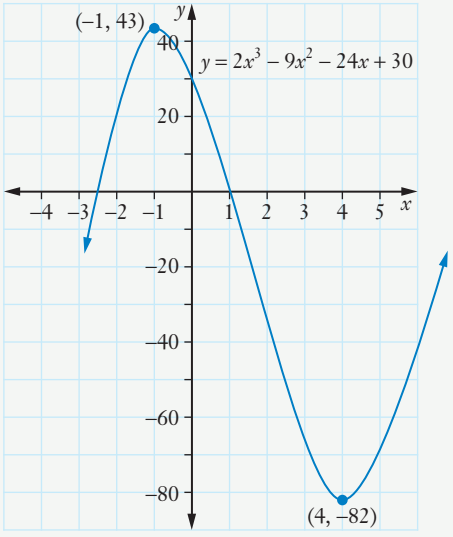
5 (0, 0)



6



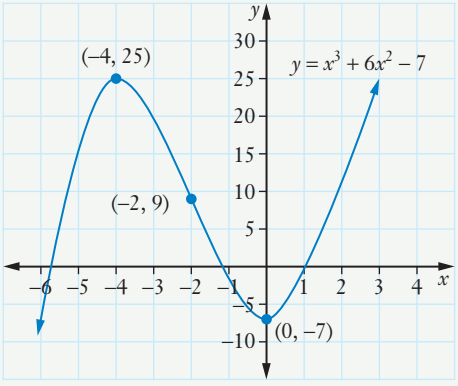
7 (–1, 43) maximum, (4, –82) minimum



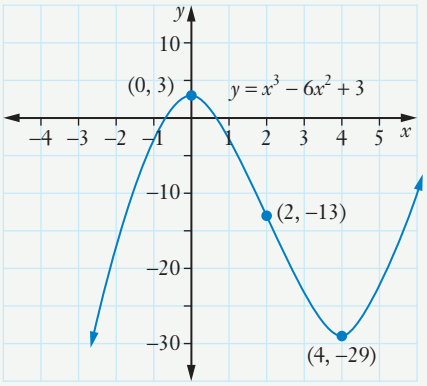
8 **a** (0, –7) minimum, (–4, 25) maximum

b (–2, 9)

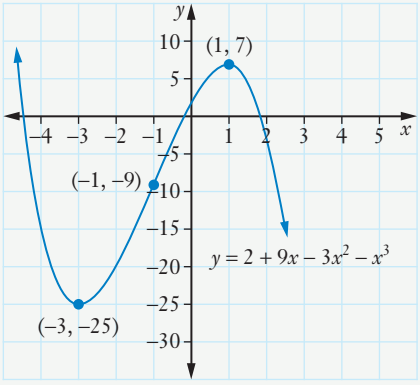
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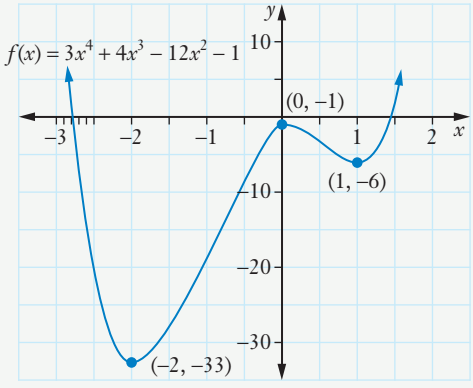
9 (0, 3) maximum, (2, –13) point of inflection, (4, –29) minimum



10 (–3, –25) minimum, (–1, –9) point of inflection, (1, 7) maximum

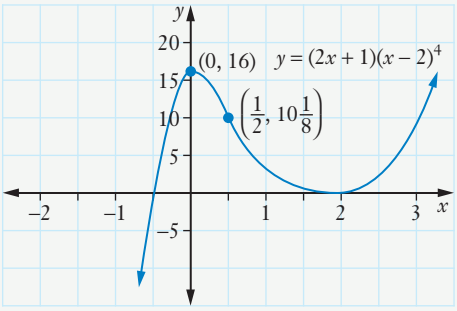


11 (–2, –33) minimum, (0, –1) maximum, (1, –6) minimum

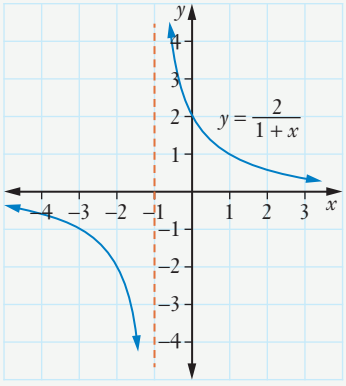


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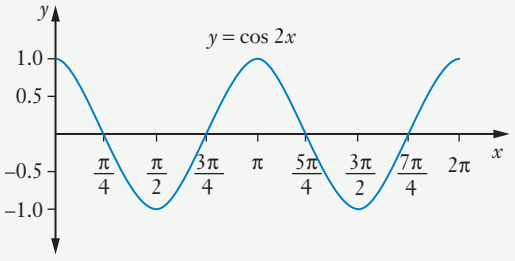
12 (0, 16) maximum, $\left(\frac{1}{2}, 10\frac{1}{8}\right)$ point of inflection, (2, 0) minimum



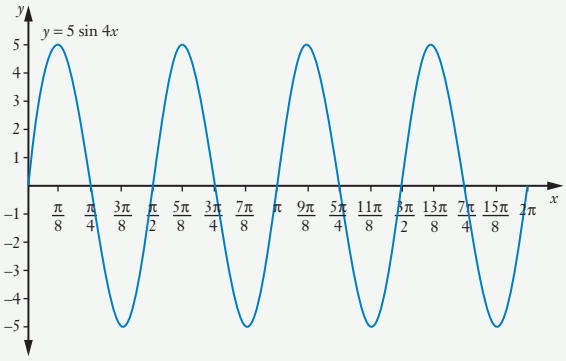
13 $\frac{dy}{dx} = -\frac{2}{(1+x)^2} \neq 0$ for any x



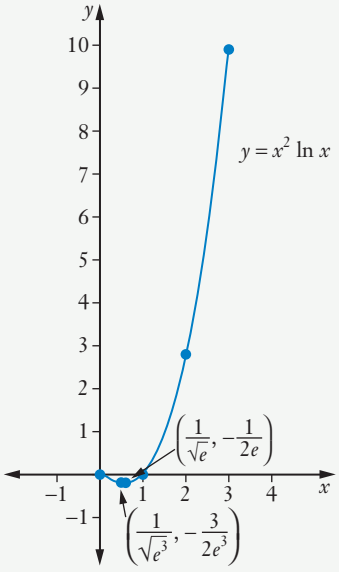
14 a



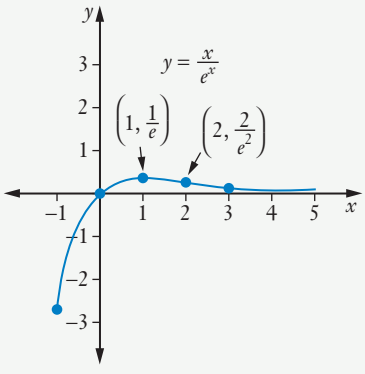
b



15 a

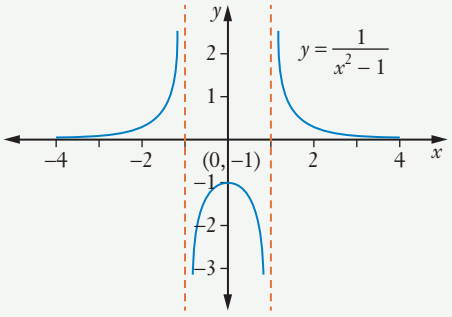


b



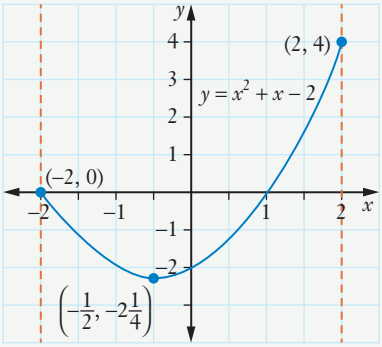
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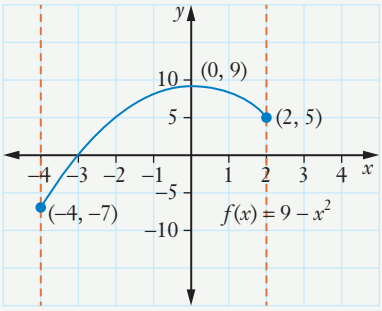


Exercise 5.07

1 Maximum value is 4.

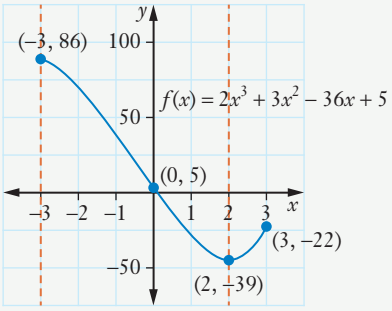


2 Maximum value is 9, minimum value is –7.



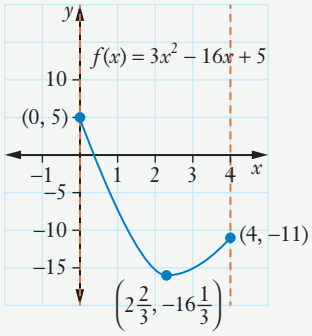
3 Maximum value is 25.

4 Maximum value is 86, minimum value is –39.



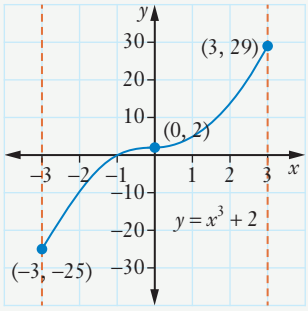
5 Maximum value is –2.

6 Maximum value is 5, minimum value is $-16\frac{1}{3}$.

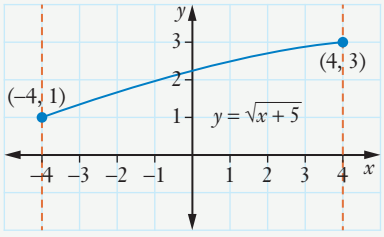


7 Global maximum 29, local maximum –3, global minimum –35, local minimum –35, –8

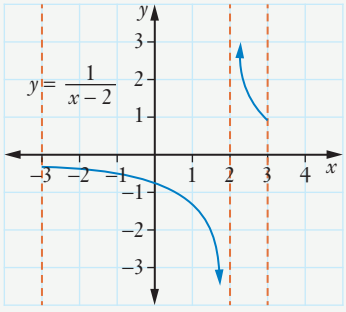
8 Minimum –25, maximum 29



9 Maximum 3, minimum 1



10 Maximum ∞, minimum –∞



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Investigation

The disc has radius $\frac{30}{7}$ cm. (This result uses Stewart's theorem – research this.)

Exercise 5.08

See worked solutions for full proofs.

1 $\frac{50}{x} = y$

$P = 2x + 2y$

2 $y = 60 - x$

$A = xy$

3 $\frac{20}{x} = y$

$S = x + y$

4 $\frac{400}{\pi r^2} = h$

$S = 2\pi r^2 + 2\pi rh$

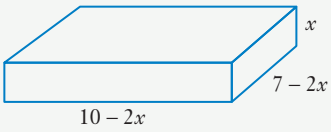
5 **a** $x + y = 30$

b $A = \left(\frac{1}{4}x\right)^2 + \left(\frac{1}{4}y\right)^2$

6 **a** $x^2 + y^2 = 280^2 = 78\,400$

b $A = xy$

7

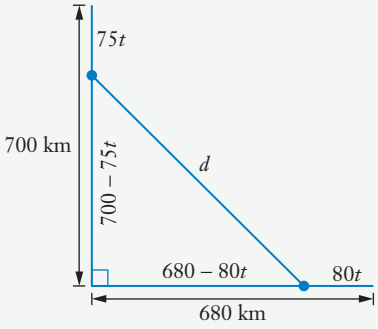


$V = x(10 - 2x)(7 - 2x)$

8 Profit per person = Cost – Expenses

$= (900 - 100x) - (200 + 400x)$

9



$d^2 = (700 - 75t)^2 + (680 - 80t)^2$

10 Distance AB: $d = \sqrt{x^2 + 0.5^2}$

$t = \frac{\sqrt{x^2 + 0.25}}{5}$

Distance BC: $d = 7 - x$

$t = \frac{7 - x}{4}$

Exercise 5.09

See worked solutions for full proofs.

1 2 s, 16 m

2 7.5 km

3 **a** $y = 30 - x$

b Maximum area is 225 m^2

4 **a** $\frac{4000}{x} = y$

$P = 2x + 2y$

b 63.2 m by 63.2 m

c \$12 322.88

5 4 m by 4 m

6 14 and 14

7 –2.5 and 2.5

8 $x = 1.25$ m, $y = 1.25$ m

9 **a** $V = x(30 - 2x)(80 - 2x)$

b $x = 6\frac{2}{3}$ cm

c 7407.4 cm^3

10 **a** $\frac{54}{r^2} = h$

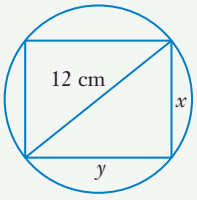
$S = 2\pi r(r + h)$

b Radius is 3 m.

11 **a** $S = 2\pi r^2 + \frac{17\,200}{r}$

b 2324 m^2

12 **a**



$x^2 + y^2 = 12^2$

$A = xy = x\sqrt{144 - x^2}$

b 72 cm^2

13 **a** $\frac{400}{x} = y$

$A = (x - 10)(y - 10)$

b 100 cm^2

14 1.12 m^2

15 **a** 7.5 m by 7.5 m

b 2.4 m

16 160.17 cm^2

17 1.68 m, 1.32 m

18 **a** $d^2 = (200 - 80t)^2 + (120 - 60t)^2$

b Minimum distance 24 km

19 **a** $d = (x^2 - 2x + 5) - (4x - x^2)$

$= 2x^2 - 6x + 5$

b 0.5

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20 **a** $s = \frac{d}{t}$

So $t = \frac{d}{s}$

$= \frac{1500}{s}$

Cost of trip taking t hours:

$C = (s^2 + 9000)t$

$= (s^2 + 9000)\frac{1500}{s}$

$= 1500\left(s + \frac{9000}{s}\right)$

b 95 km h^{-1} **c** \$2846

Test yourself 5

1 A **2** C **3** D **4** C

5 (–3, –11) maximum, (–1, –15) minimum

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

7 50 m

8 $x > -1$

9 $(\frac{1}{2}, -1)$

10 **a** $\frac{375}{\pi r^2} = h$

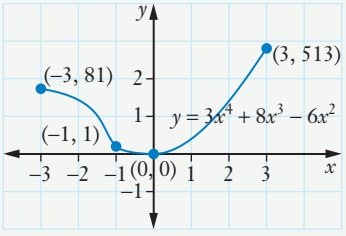
$S = 2\pi r^2 + 2\pi rh$

b 3.9 cm

11 **a** (0, 0) and (–1, 1)

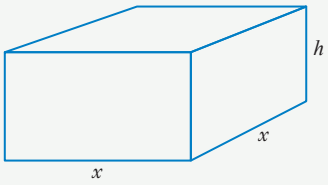
b (0, 0) minimum, (–1, 1) horizontal point of inflection

c



d Maximum value 513, minimum value 0

12 **a**



$\frac{125 - x^2}{2x} = h$

$V = x^2h$

b 6.45 cm by 6.45 cm by 6.45 cm

13 150 products

14 **a** $y = \sqrt{25 - x^2}$

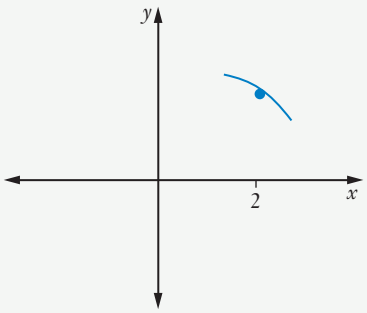
$A = \frac{1}{2}xy$

b 6.25 m^2

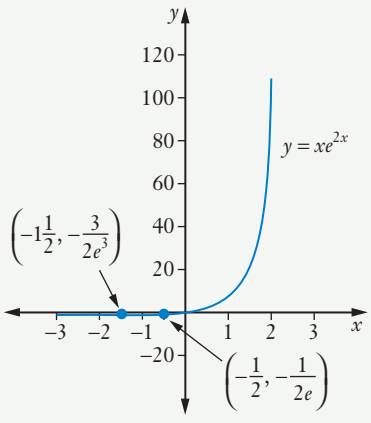
15 (0, 1) and (3, –74)

16 179

17

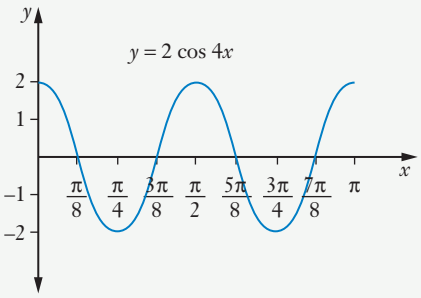


18



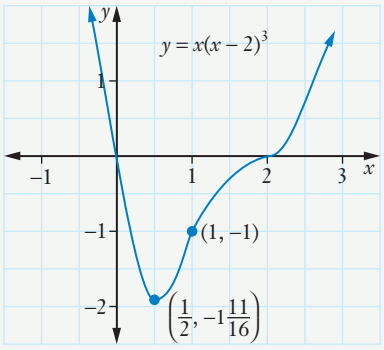
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19



Challenge exercise 5

1



2 16 m^2

3 27; –20.25

4 $f'(0.6) = f'(0.6) = 0$ and concavity changes

5 Proof. See Worked Solutions. $r = s = 12.5$

6 $y = x^2 + 2x + 3$

7 **a** $y' = 0$ at (0, 0)

b $y'' > 0$ on LHS and RHS

c $y'' < 0$ on LHS, $y'' > 0$ on RHS

8 Minimum –1, maximum $-\frac{1}{5}$

9 87 km h^{-1}

Chapter 6

Exercise 6.01

1 **a** 4.125 units^2 **b** 6.625 units^2

2 **a** 1.17 units^2 **b** 1.67 units^2

c 1.27 units^2 **d** 1.52 units^2

3 **a** 6.5 units^2 **b** 5 units^2 **c** 132 units^2

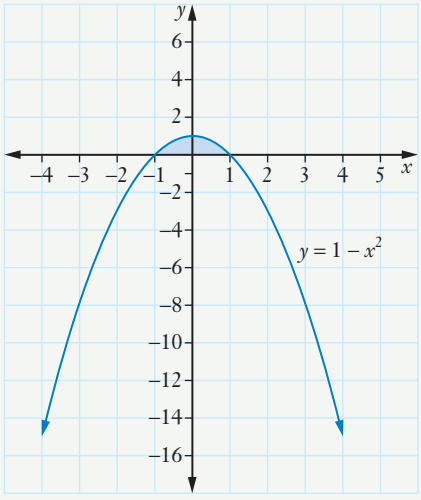
d $\frac{\pi\left(1+\sqrt{2}\right)}{8\sqrt{2}} = \frac{\pi}{16}\left(2+\sqrt{2}\right)$ units^2 **e** 6.5 units^2

4 **a** 28 units^2 **b** 156 units^2 **c** 140 units^2

5 **a** $3\frac{3}{7}$ units^2 **b** 5.5 units^2 **c** $\frac{\pi}{4}$ units^2

d $\frac{3}{2}(e + e^4)$ **e** 23 units^2

6 **a**



b 1 unit^2

7 **a** 4.41 units^2 **b** 4.91 units^2

c 4.5 units^2 **d** 4.5 units^2

8 $\frac{25\pi}{2}$ units^2

9 **a** $\frac{9\pi}{2}$ units^2

b **i** 2.5 units^2 **ii** 8.1 units^2

10 **a** 22.4 units^2 **b** 3.3 units^2 **c** 1 unit^2

11 **a** **i** 6 units^2 **ii** 14 units^2

b **i** $\frac{\pi\sqrt{2}}{4}$ units^2 **ii** $\frac{\pi\left(\sqrt{2}+2\right)}{4}$ units^2

12 **a** 60.625 units^2 **b** 73.125 units^2

Exercise 6.02

1 **a** 2.5 **b** 10

c 2.4 **d** 0.225

2 **a** 28 **b** 22

3 **a** 0.39 **b** 0.41

4 **a** 1.08 **b** 0.75 **c** 0.65

d 0.94 **e** 0.92

5 **a** 75.1 **b** 16.5 **c** 650.2

6 **a** 28.9 m^2 **b** 39.25 m^2

c 7.45 km^2 **d** 492.25 m^2

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Exercise 6.03

1 **a** 8 **b** 10 **c** 217
d –1 **e** 10 **f** 54
g $3\frac{1}{3}$ **h** 16 **i** 50

2 **a** $\frac{2}{3}$ **b** $21\frac{1}{4}$ **c** 0
d $4\frac{2}{3}$ **e** $1\frac{1}{4}$ **f** $4\frac{1}{3}$
g 0 **h** $2\frac{1}{3}$ **i** 0
j $6\frac{2}{9}$ **k** 100 **l** 54
m $15\frac{5}{6}$ **n** $22\frac{2}{3}$ **o** 0.0126

3 **a** 70 m **b** 38 km **c** 258 cm
d $72\frac{2}{3}$ m **e** 142 cm

4 **a** 750 L **b** 51 000 L **c** 810 750

Exercise 6.04

1 **a** $\frac{x^3}{3}+C$ **b** $\frac{x^6}{2}+C$ **c** $\frac{2x^5}{5}+C$
d $\frac{m^2}{2}+m+C$ **e** $\frac{t^3}{3}-7t+C$ **f** $\frac{h^8}{8}+5h+C$
g $\frac{y^2}{2}-3y+C$ **h** x^2+4x+C **i** $\frac{b^3}{3}+\frac{b^2}{2}+C$

2 **a** $\frac{x^3}{3}+x^2+5x+C$
b $x^4-x^3+4x^2-x+C$
c $x^6+\frac{x^5}{5}+\frac{x^4}{2}+C$
d $\frac{x^8}{8}-\frac{3x^7}{7}-9x+C$
e $\frac{x^4}{2}+\frac{x^3}{3}-\frac{x^2}{2}-2x+C$
f $\frac{x^6}{6}+\frac{x^4}{4}+4x+C$
g $\frac{4x^3}{3}-\frac{5x^2}{2}-8x+C$
h $\frac{3x^5}{5}-\frac{x^4}{2}+\frac{x^2}{2}+C$
i $\frac{3x^4}{2}+\frac{5x^3}{3}-4x+C$
j $-x^{-3}-\frac{x^{-2}}{2}-2x^{-1}+C$

3 **a** $-\frac{1}{7x^7}+C$ **b** $\frac{3x^{\frac{4}{3}}}{4}+C$
c $\frac{x^4}{4}-x^3+x^2+C$ **d** $x-2x^2+\frac{4x^3}{3}+C$
e $\frac{x^3}{3}+\frac{3x^2}{2}-10x+C$ **f** $-\frac{3}{x}+C$
g $-\frac{1}{2x^2}+C$
h $-\frac{4}{x}-x+\frac{3}{2x^2}-\frac{7}{4x^4}+C$
i $\frac{y^3}{3}+\frac{y^{-6}}{6}+5y+C$
j $\frac{t^4}{4}-\frac{t^3}{3}-2t^2+4t+C$
k $\frac{2\sqrt{x^3}}{3}+C$ **l** $-\frac{1}{2t^4}+C$ **m** $\frac{3\sqrt[3]{x^4}}{4}+C$
n $\frac{2\sqrt{x^5}}{5}+C$ **o** $\frac{2\sqrt{x^3}}{3}+x+C$

4 900° **5** $y=x^3-x^2+x+6$
6 –11 079.25 cm s^{-1} **7** 21 000 L

Exercise 6.05

1 **a** $\frac{(3x-4)^3}{9}+C$ **b** $\frac{(x+1)^5}{5}+C$
c $\frac{(5x-1)^{10}}{50}+C$ **d** $\frac{(3y-2)^8}{24}+C$
e $\frac{(4+3x)^5}{15}+C$ **f** $\frac{(7x+8)^{13}}{91}+C$
g $-\frac{(1-x)^7}{7}+C$ **h** $\frac{\sqrt{(2x-5)^3}}{3}+C$
i $-\frac{2(3x+1)^{-3}}{9}+C$ **j** $-3(x+7)^{-1}+C$
k $-\frac{1}{16(4x-5)^2}+C$ **l** $\frac{3\sqrt[3]{(4x+3)^4}}{16}+C$

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m $-2(2-x)^{\frac{1}{2}}+C$ **n** $\frac{2\sqrt{(t+3)^5}}{5}+C$

o $\frac{2\sqrt{(5x+2)^7}}{35}+C$

2 **a** 288.2 **b** $-1\frac{1}{4}$ **c** $-\frac{1}{8}$

d $60\frac{2}{3}$ **e** $\frac{1}{6}$ **f** $\frac{1}{7}$

g $4\frac{2}{3}$ **h** $1\frac{1}{5}$ **i** $\frac{3}{5}$

3 **a** $\frac{1}{3}(x^4+5)^3+C$ **b** $\frac{1}{6}(x^2-3)^6+C$

c $\frac{1}{4}(x^3+1)^4+C$ **d** $\frac{1}{5}(x^2+3x-2)^5+C$

e $\frac{1}{42}(3x^2-7)^7+C$ **f** $-\frac{1}{45}(4-5x^3)^3+C$

g $\frac{1}{15}(2x^6-3)^5+C$ **h** $\frac{3}{80}(5x^2+3)^8+C$

i $\frac{1}{12}(x^2+4x)^6+C$ **j** $\frac{1}{12}(3x^3-6x-2)^4+C$

4 **a** $108\frac{2}{3}$ **b** $-\frac{1}{18}$

c 66 812.75 **d** $10\,159\frac{1}{32}$

e 564 537.6 **f** $-1236\frac{2}{3}$

g $-19\,839\frac{3}{14}$ **h** $96\frac{4}{9}$

i –474 618 565.3

5 $y=\frac{1}{15}((x^3-2)^5+61)$

6 **a** $x=\frac{1}{10}[(x^2-3)^5-1]$ **b** 777.5 m

Exercise 6.06

1 **a** $\frac{1}{4}e^{4x}+C$ **b** $-e^{-x}+C$ **c** $\frac{1}{5}e^{5x}+C$

d $-\frac{1}{2}e^{-2x}+C$ **e** $\frac{1}{4}e^{4x+1}+C$ **f** $-\frac{3}{5}e^{5x}+C$

g $\frac{1}{2}e^{2t}+C$ **h** $\frac{1}{7}e^{7x}-2x+C$

i $e^{x-3}+\frac{x^2}{2}+C$

2 **a** $\frac{1}{5}(e^5-1)$ **b** $e^{-2}-1=\frac{1}{e^2}-1$

c $\frac{2e^7}{3}(e^9-1)$ **d** $19-\frac{1}{2}e^4(e^2-1)$

e $\frac{1}{2}e^4+1\frac{1}{2}$ **f** $e^2-e-1\frac{1}{2}$

g $\frac{1}{2}e^6+e^{-3}-1\frac{1}{2}$

3 **a** 0.32 **b** 268.29

c 37 855.68 **d** 346.85

e 755.19

4 **a** $\frac{1}{\ln 5}5^x+C$ **b** $\frac{1}{3\ln 7}7^{3x}+C$

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

5 **a** $x(2+x)e^x$ **b** x^2e^x+C

6 $f(x)=\frac{1}{6}(e^{2x^3}-1)$ **7** $2e^3+5$ m

Exercise 6.07

1 **a** $\ln|2x+5|+C$ **b** $\ln|2x^2+1|+C$

c $\ln|x^5-2|+C$

d $\frac{1}{2}\ln|x|+C$ or $\frac{1}{2}\ln|2x|+C$

e $2\ln|x|+C$ **f** $\frac{5}{3}\ln|x|+C$

g $\ln|x^2-3x|+C$ **h** $\frac{1}{2}\ln|x^2+2|+C$

i $\frac{3}{2}\ln|x^2+7|+C$ **j** $\frac{1}{2}\ln|x^2+2x-5|+C$

2 **a** $\ln|4x-1|+C$ **b** $\ln|x+3|+C$

c $\frac{1}{6}\ln|2x^3-7|+C$ **d** $\frac{1}{12}\ln|2x^6+5|+C$

e $\frac{1}{2}\ln|x^2+6x+2|+C$

3 **a** 0.5 **b** 0.7 **c** 1.6

d 3.1 **e** 0.5

4 **a** RHS = LHS

b $\ln|x+3|+2\ln|x-3|+C$

5 **a** RHS = LHS

b $x-5\ln|x-1|+C$

6 $f(x)=\frac{1}{9}\ln\left|\frac{3x^3-1}{2}\right|$ **7** 8.95 m

8 4

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Exercise 6.08

1 **a** $\sin x + C$ **b** $-\cos x + C$

c $\tan x + C$ **d** $-\frac{45}{\pi}\cos x^\circ + C$

e $-\frac{1}{3}\cos 3x + C$ **f** $\frac{1}{7}\cos 7x + C$

g $\frac{1}{5}\tan 5x + C$ **h** $\sin(x+1) + C$

i $-\frac{1}{2}\cos(2x-3) + C$ **j** $\frac{1}{2}\sin(2x-1) + C$

k $\cos(\pi - x) + C = -\cos x + C$

l $\sin(x+\pi) + C = -\sin x + C$

m $\frac{2}{7}\tan 7x + C$ **n** $-8\cos\frac{x}{2} + C$

o $9\tan\frac{x}{3} + C$

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

c $\frac{2}{\sqrt{2}} = \sqrt{2}$ **d** $-\frac{1}{3}$

e $\frac{1}{\pi}$ **f** $\frac{1}{2}$

g $\frac{3}{4}$ **h** $-\frac{1}{5}$

3 **a** $\sin\left(x + \frac{\pi}{3}\right) + C$ or $\frac{\sin x + \sqrt{3}\cos x}{2} + C$

b $\cos(\pi - x) + C = -\cos x + C$

4 $y = \frac{1}{4}\sin 4x + \frac{\pi}{4}$

5 **a** $x = 18\sin\frac{2\pi t}{3} + 2$ cm

b **i** $9\sqrt{3} + 2$ cm **ii** $-9\sqrt{3} + 2$ cm

6 **a** $d = -24\cos\frac{\pi t}{6} + 26$ **b** 14 m

c 50 m; 2 m; 26 m **d** 12 h

Exercise 6.09

1 $1\frac{1}{3}$ units^2 **2** 36 units^2 **3** 4.5 units^2

4 $10\frac{2}{3}$ units^2 **5** $\frac{1}{6}$ units^2 **6** 14.3 units^2

7 4 units^2 **8** 0.4 units^2 **9** 8 units^2

10 24.25 units^2 **11** $e^2(e^2 - 1)$ units^2

12 $\frac{1}{4}(e - e^{-3})$ units^2 **13** 2.86 units^2

14 29.5 units^2 **15** 4 units^2

16 $\frac{1}{3\sqrt{2}} = \frac{\sqrt{2}}{6}$ units^2 **17** 0.86 units^2

18 2 units^2 **19** $9\frac{1}{3}$ units^2

20 $11\frac{2}{3}$ units^2 **21** $\frac{1}{6}$ units^2

22 $\frac{2}{3}$ units^2 **23** $\frac{1}{3}$ units^2

24 $\ln 3 - \ln 2 = \ln 1.5$ units^2

25 $\ln 2$ units^2

26 0.61 units^2 **27** $5\frac{1}{3}$ units^2

28 18 units^2 **29** 3.98 units^2

30 $\frac{a^4}{2}$ units^2

Exercise 6.10

1 $21\frac{1}{3}$ units^2 **2** 20 units^2

3 $4\frac{2}{3}$ units^2 **4** 1.5 units^2

5 $1\frac{1}{4}$ units^2 **6** $2\frac{1}{3}$ units^2

7 $10\frac{2}{3}$ units^2 **8** $\frac{1}{6}$ units^2

9 $3\frac{7}{9}$ units^2 **10** 2 units^2

11 $11\frac{1}{4}$ units^2 **12** 60 units^2

13 4.5 units^2 **14** $1\frac{1}{3}$ units^2

15 1.9 units^2 **16** 47.2 units^2

Exercise 6.11

1 $1\frac{1}{3}$ units^2 **2** $1\frac{1}{3}$ units^2

3 $\frac{1}{6}$ units^2 **4** $10\frac{2}{3}$ units^2

5 $20\frac{5}{6}$ units^2 **6** 8 units^2

7 $\frac{2}{3}$ units^2 **8** $166\frac{2}{3}$ units^2

9 $\frac{5}{12}$ units^2 **10** $\frac{2}{3}$ units^2

11 $\frac{1}{12}$ units^2 **12** $\frac{1}{3}$ units^2

13 36 units^2 **14** $2\frac{2}{3}$ units^2

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15 $(\pi - 2)$ units^2 **16** $\frac{1}{2} + \ln 2$ units^2

17 $2\sqrt{2}$ units^2 **18** $\frac{1}{2}(e^4 - 5)$ units^2

19 $\sqrt{3} - \frac{\pi}{3} = \frac{3\sqrt{3} - \pi}{3}$ units^2

Test yourself 6

1 D **2** B **3** A **4** D

5 **a** 0.535 **b** 0.5

6 **a** $\frac{3x^2}{2} + x + C$ **b** $\frac{5x^2}{2} - x + C$

c $\frac{2\sqrt{x^3}}{3} + C$ **d** $\frac{(2x+5)^8}{16} + C$

e $\frac{(3x^4 - 2)^5}{60} + C$

7 $\frac{3^x}{\ln 3} + C$

8 **a** 14 units^2 **b** 27 units^2 **c** 28 units^2

9 **a** 2 **b** 0 **c** $2\frac{1}{5}$

d $6\frac{7}{9}$ **e** $228\frac{3}{8}$

10 $e(e^2 - 1)$ units^2 **11** 3 units^2

12 $-\frac{180}{\pi}\cos x° + C$ **13** $2\frac{2}{3}$ units^2

14 **a** $\frac{1}{4}e^{4x} + C$ **b** $\frac{1}{2}\ln|x^2 - 9| + C$

c $-e^{-x} + C$ **d** $\ln|x + 4| + C$

e $\frac{(x^2 - 6x + 1)^9}{18} + C$

15 $4\frac{1}{2}$ **16** $\frac{9\pi}{4}$ units^2

17 $\frac{3}{4}$ units^2 **18** $\frac{(7x+3)^{12}}{84} + C$

19 3 units^2 **20** $\frac{1}{2}e^4(e^6 - 1)$ units^2

21 5.36 units^2 **22** 36

23 **a** $-\frac{1}{2}\cos 2x + C$ **b** $3\sin x + C$

c $\frac{1}{5}\tan 5x + C$ **d** $x - \cos x + C$

24 $85\frac{1}{3}$ units^2

25 **a** $T = 40e^{-0.4t} + 175$

b **i** 180° **ii** 175°

26 **a** $\frac{1}{\sqrt{2}}$ **b** $\sqrt{3} - \frac{1}{\sqrt{3}} = \frac{2\sqrt{3}}{3}$

27 **a** $\frac{(2x-1)^5}{2} + C$ **b** $\frac{x^6}{8} + C$

28 $\frac{1}{\sqrt{2}}$ units^2

29 **a** $\frac{1}{18}(x^3 - 2)^6 + C$ **b** $\frac{1}{50}(5x^2 + 2)^5 + C$

c $\frac{5}{24}(2x^4 - 1)^3 + C$ **d** $\frac{1}{8}(x^2 + 4x - 3)^4 + C$

30 2 units^2

31 **a** $\sqrt{2}$ units^2

b 1 unit^2

c $1 + \sqrt{2}$ units^2

32 **a** $f(x) = \frac{1}{20}[3(2x^2 - 1)^5 + 57]$

b $f(x) = \frac{1}{2}\tan 2x$

c $f(x) = \frac{1}{5}e^{5x}$

d $f(x) = \frac{1}{16}[(x^4 - 15)^4 - 1]$

e $f(x) = \frac{3}{4}\ln(x^4 + 1) + 2$

33 **a** $x = \frac{2\sqrt{t^3 + 9}}{3} - 4$

b 3.7 m

c 7.6 s

Challenge exercise 6

1 **a** Show $f(-x) = -f(x)$

b 0

c 12 units^2

2 **a** RHS = LHS **b** $\ln\sqrt{3} = \frac{\ln 3}{2}$

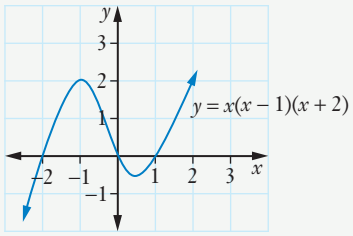
3 9 units^2 **4** $\frac{3-\sqrt{3}}{6}$

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5 $\frac{1}{8}$

6 7.3 units^2

7 **a**



b $3\frac{1}{12}$ units^2

8 11.68 units^2

9 **a** $\frac{3(x+2)}{2\sqrt{x+3}}$

b $\frac{2x\sqrt{x+3}}{3} + C$

10 **a** $x(1 + 2 \ln x)$

b $18 \ln 3$

11 $\frac{5}{12}$ units^2

12 **a** 6879.7

b 1375.93

c 1527.62

13 **a** 6879.7

b 1375.9 units^2

c 1527.6 units^2

Practice set 2

1 C **2** D **3** B

4 B **5** A **6** C

7 $x < \frac{1}{2}$

8 $x^3 - x^2 + x + C$

9 24

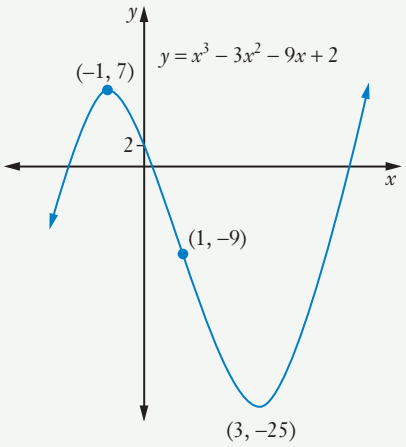
10 **a** 8 **b** $\frac{2\pi}{3}$ **c** 5

11 8 m

12 $\frac{d^2y}{dx^2} = 7(-7 \sin 7x)$

13 $\frac{x^9}{3} + 2x^2 + C$

14



15 $1\frac{1}{3}$ units^2

16 $\frac{3}{4} \ln |2x^2 - 5| + C$

17 $f'(3) = 20; f''(-2) = -16$

18 68

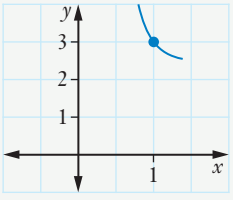
19 $-\frac{7}{9}, \infty$

20 3

21 $\frac{1}{4}(\tan x + 1)^4 + C$

22 **a** $f(1) = 3, f'(1) = -2, f''(1) = 18$

b Curve is decreasing and concave upwards at (1, 3).



23 **a** $P = 8x + 4y = 4$

$4y = 4 - 8x$

$y = 1 - 2x$

$A = 3x^2 + y^2$

b Rectangle $\frac{2}{7}$ m $\times \frac{6}{7}$ m, square with sides $\frac{3}{7}$ m

24 $y = 3\left[\frac{1}{2}(x+4)\right]^2 + 5$

25 $f(-1) = 0$

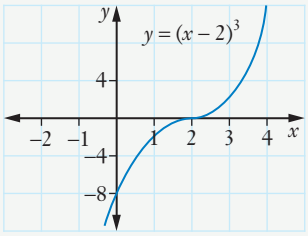
26 12

27 0.944

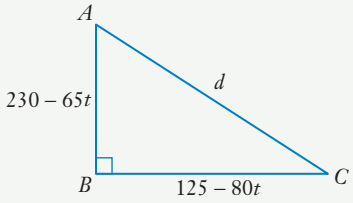
ISBN 9780170413220

28 **a** (2, 0); point of inflection

b



29 **a**



$d^2 = (230 - 65t)^2 + (125 - 80t)^2$

b 2.3 h **c** 99.8 km

30 **a** $-\frac{25}{128}$ **b** $66\frac{77}{128}$ **c** $66\frac{2}{3}$

31 450 cm^2 **32** $\frac{(3x+5)^8}{24} + C$

33 1.099

34 (0, 3) maximum, (1, 2) minimum, (–1, 2) minimum

35 $2\frac{8}{15}$ **36** $10\frac{2}{3}$ units^2

37 $f(2) = -16$ **38** 9 units^2 **39** $3x^2 + 2e^{2x}$

40 **a** 7900 L **b** 400 min (6 h 40 min)

41 $\frac{3e}{2}(e^9 - 1)$ **42** 953 m

43 $f(x) = x^3 - 4x^2 - 3x + 20$

44 $\frac{12}{4x+3}$

45 $\frac{1}{3}\ln(3x^2 + 3x - 2) + C$

46 **a** $\frac{1-2x}{e^{2x}}$ **b** $\frac{1}{x \ln 3}$

47 $x - y + 2 = 0$

48 $\left(-\frac{1}{2}, -\frac{1}{2e}\right)$; minimum

49 $y = 2\cos 3x + 3$

50 1

51 **a** $\cot x$ **b** $5e^{5x}\sec^2(e^5 + 1)$

52 0.393

53 **a** 6 units^2 **b** 14 units^2

54 **a** $e^x(\sin x + \cos x)$ **b** $3\tan^2 x \sec^2 x$

c $-6\sin(3x - \frac{\pi}{2})$

55 $12x - 2y - 2 - 3\pi = 0$

56 **a** $3e^x \sin^2(e^x)\cos(e^x)$ **b** $\frac{\sec^2(\ln x + 1)}{x}$

57 $(5 - e)$ units^2

58 **a** $\frac{1}{3}e^{3x} + C$ **b** $\frac{1}{\pi}\tan \pi x + C$

c $\frac{1}{2}\ln x + C$ **d** $5\sin\left(\frac{x}{5}\right) + C$

e $-\frac{1}{8}\cos 8x + C$

59 $3x - 2\ln x - \frac{5}{x} + C$

60 $\frac{1}{5}e^{5x} + \frac{1}{\pi}\cos \pi x + C$ **61** $(e^2 - 1)$ units^2

62 –1

Chapter 7

Note: Answers obtained from reading graphs are approximate.

Exercise 7.01

1 **a** N **b** N **c** N
d C **e** N **f** N
g N **h** C **i** N
j C **k** N **l** C
m N **n** N **o** N
p N **q** N **r** N
s C **t** N

2 **a** O **b** C **c** N
d N **e** C **f** D
g D **h** N **i** C
j N **k** D **l** N
m N

3 **a** e.g. types of sport, hair colour
b e.g. heights, test scores, prices
c e.g. rankings, test scores, clothing sizes
d e.g. karate belt colour, size of take-away coffee cups, Olympic medals
e e.g. race times, length, rainfall
f e.g. types of trees, housing, cars

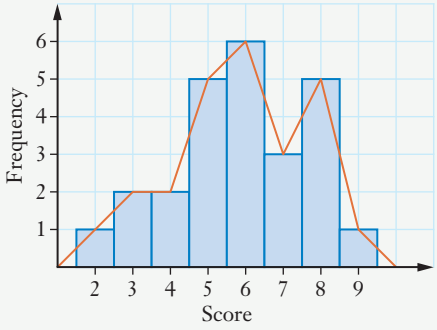
ISBN 9780170413220

Exercise 7.02

1 a i

Score	Frequency
2	1
3	2
4	2
5	5
6	6
7	3
8	5
9	1

ii



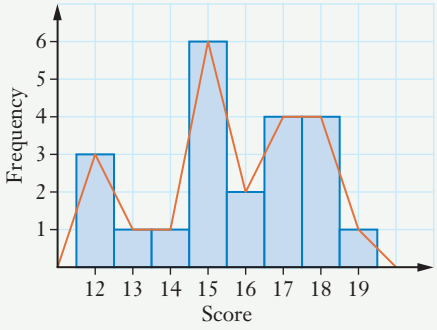
iii Highest 9, lowest 2

iv 6

b i

Pizzas	Frequency
12	3
13	1
14	1
15	6
16	2
17	4
18	4
19	1

ii

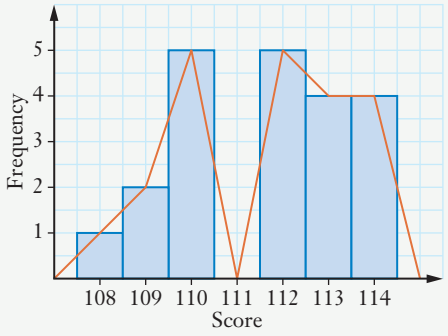


iii Highest 19, lowest 12 **iv** 15

c i

Gym attendance	Frequency
108	1
109	2
110	5
111	0
112	5
113	4
114	4

ii



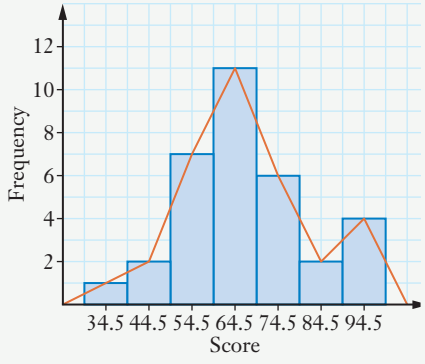
iii Highest 114, lowest 108

iv 110 and 112

d i

Results	Class centre	Frequency
30–39	34.5	1
40–49	44.5	2
50–59	54.5	7
60–69	64.5	11
70–79	74.5	6
80–89	84.5	2
90–99	94.5	4

ii



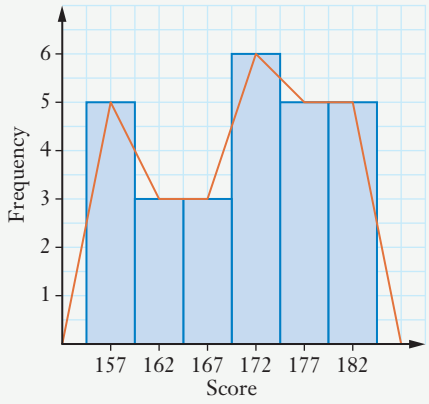
iii Highest 94.5, lowest 34.5 **iv** 64.5

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e i

Height (cm)	Class centre	Frequency
155–159	157	5
160–164	162	3
165–169	167	3
170–174	172	6
175–179	177	5
180–184	182	5

ii

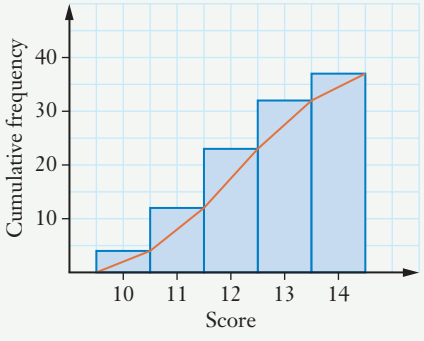


iii Highest 182, lowest 157 **iv** 172

2 a i

Number of cars	Frequency	Cumulative frequency
10	4	4
11	8	12
12	11	23
13	9	32
14	5	37

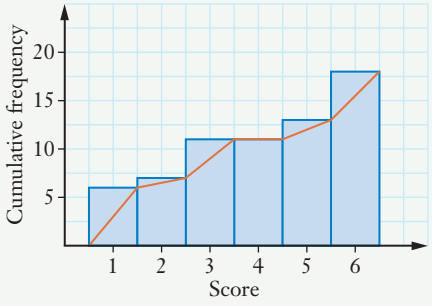
ii



b i

Score	Frequency	Cumulative frequency
1	7	7
2	1	8
3	3	11
4	0	11
5	2	13
6	5	18

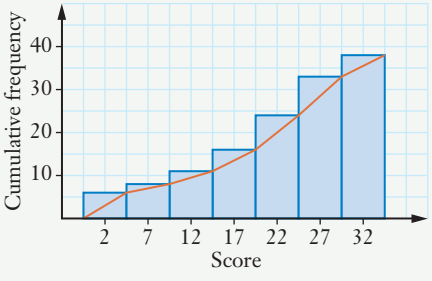
ii



c i

Sales	Class centre	Frequency	Cumulative frequency
0–4	2	6	6
5–9	7	2	8
10–14	12	3	11
15–19	17	5	16
20–24	22	8	24
25–29	27	9	33
30–34	32	5	38

ii

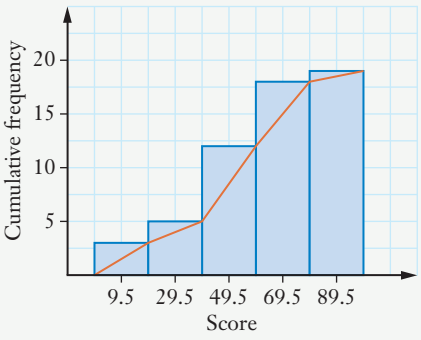


d i

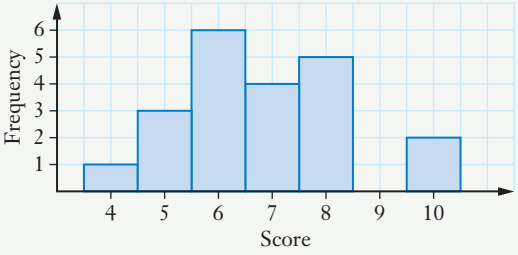
Scores	Class centre	Frequency	Cumulative frequency
0–19	9.5	3	3
20–39	29.5	2	5
40–59	49.5	7	12
60–79	69.5	6	18
80–99	89.5	1	19

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ii



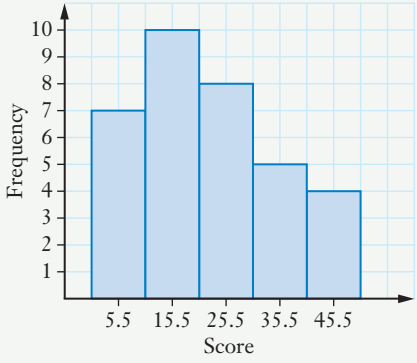
3 a



b 11 times

c 6 rescues

4 a



b 38.2%

5 a

	Play soccer	Do not play soccer
Play tennis	12	35
Do not play tennis	27	28

b i 11.8% **ii** 27.5%

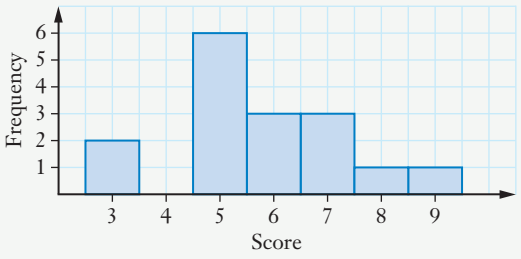
c 36.5%

d $\frac{4}{13}$

e 74.5%

6 a 16 **b** 5

c

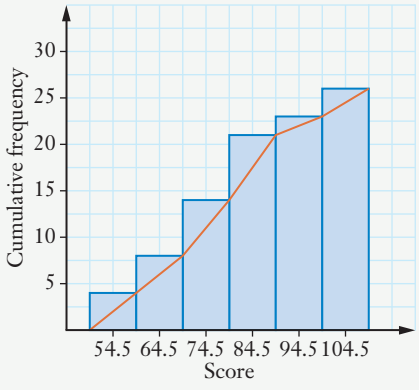


d 87.5% **e** $\frac{1}{8}$

7 a

Weight (kg)	Class centre	Frequency	Cumulative frequency
50–59	54.5	4	4
60–69	64.5	4	8
70–79	74.5	6	14
80–89	84.5	7	21
90–99	94.5	2	23
100–109	104.5	3	26

b



c i 12 **ii** 4

d 50% **e** $\frac{7}{13}$

8 a 25%

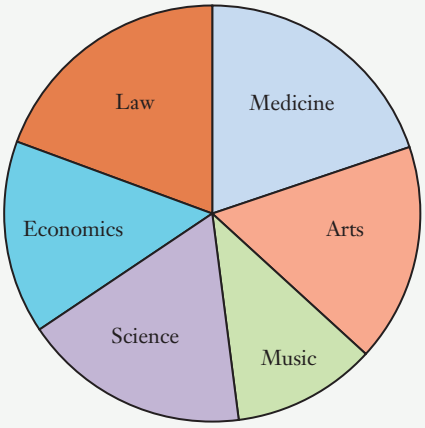
b

Sport	Frequency
Tennis	90
Soccer	120
Athletics	60
Cricket	180
Basketball	150
Volleyball	120

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9 **a** 19.3% **b** 31%

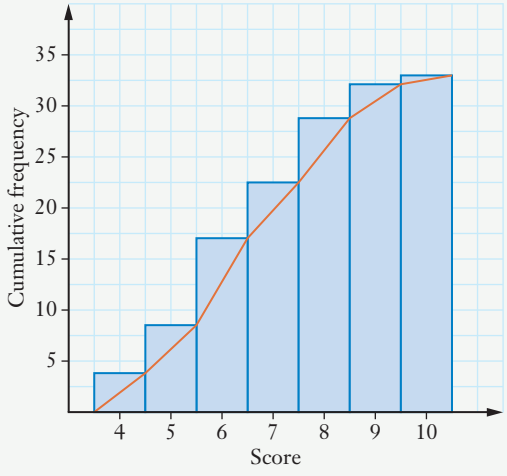
c



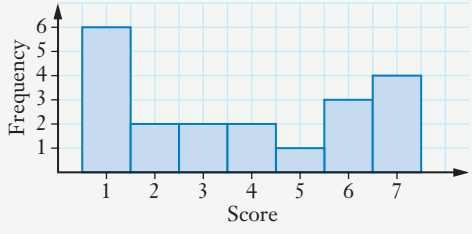
10 **a** 87 **b** 55.9%
c 6.5% **d** 76

11 **a** 430 **b** 48.6% **c** 50.2%
d 221 **e** $\frac{112}{221}$

12



13 **a**

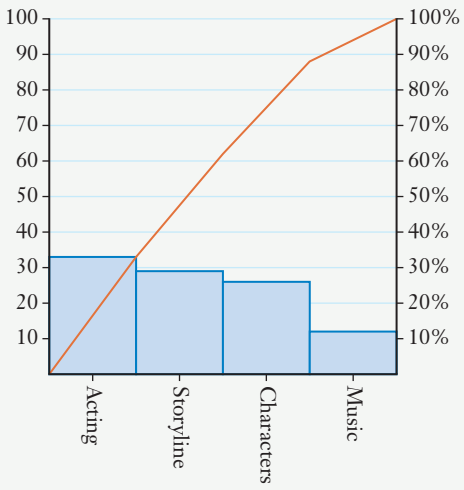


b

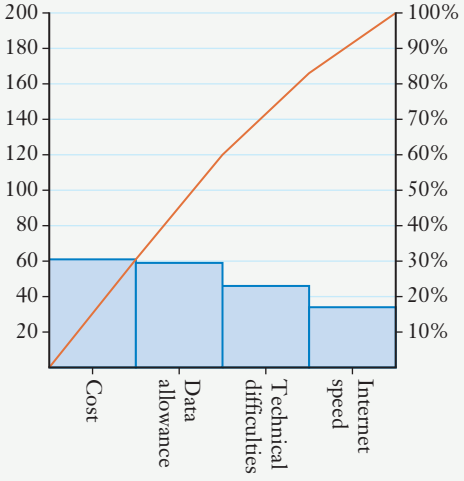
Junk mail items	Frequency
1	6
2	2
3	2
4	2
5	1
6	3
7	4

14 Stem-and-leaf plots list individual scores so retain all details. Not easy to draw, and can be long. A grouped frequency distribution table groups scores so individual data is lost. Easy to draw and compact.

15 **a**

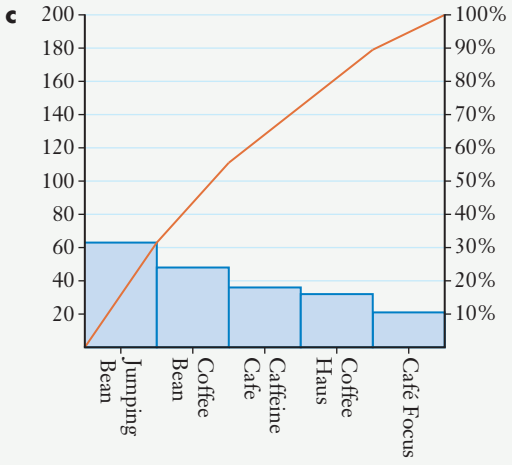


b



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c



Exercise 7.03

1 **a** **i** 5 **ii** 5 **iii** 5
b **i** 5 **ii** 4 **iii** 5
c **i** 16 **ii** 18 **iii** 17
d **i** 5.7 **ii** 4 **iii** 5.5
e **i** 1.51 **ii** 1.49 **iii** 1.49

2 **a** Brown **b** Tabby

3 **a** **i** 6 **ii** 6 **iii** 6
b **i** 52.4 **ii** 52 **iii** 51
c **i** 17.56 **ii** 18 **iii** 20
d **i** 103.3 **ii** 104 **iii** 104

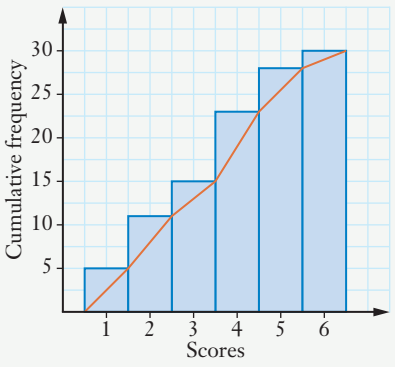
4 **a** 3 **b** 1.5
c 3.5 **d** 3

5 **a** **i** 9.24 **ii** 8–10
b **i** 17 **ii** 20–24
c **i** 68.7 **ii** 70–84
d **i** 39 **ii** 20–24, 50–54 (bimodal)

6 **a** **i**

Athletes	Frequency	Cumulative frequency
1	5	5
2	6	11
3	4	15
4	8	23
5	5	28
6	2	30

ii

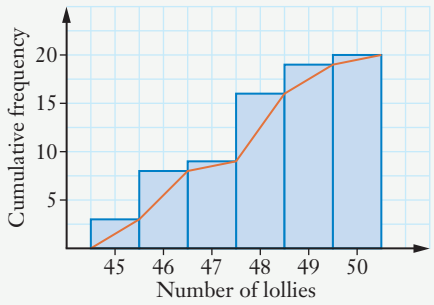


iii 3.5

b **i**

Lollies	Frequency	Cumulative frequency
45	3	3
46	5	8
47	1	9
48	7	16
49	3	19
50	1	20

ii



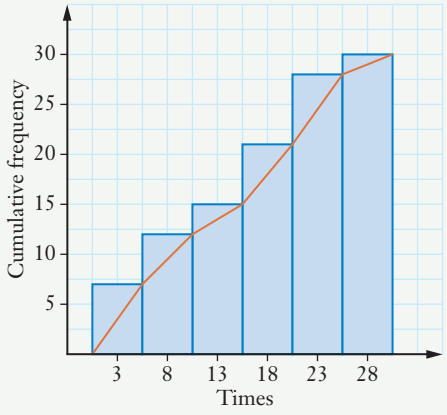
iii 48

c **i**

Time (h)	Class centre	Frequency	Cumulative frequency
1–5	3	7	7
6–10	8	5	12
11–15	13	3	15
16–20	18	6	21
21–25	23	7	28
26–30	28	2	30

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ii

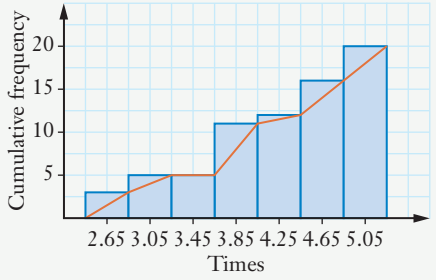


iii 15.5

d i

Time (min)	Class centre	Frequency	Cumulative frequency
2.5–2.8	2.65	3	3
2.9–3.2	3.05	2	5
3.3–3.6	3.45	0	5
3.7–4.0	3.85	6	11
4.1–4.4	4.25	1	12
4.5–4.8	4.65	4	16
4.9–5.2	5.05	4	20

ii



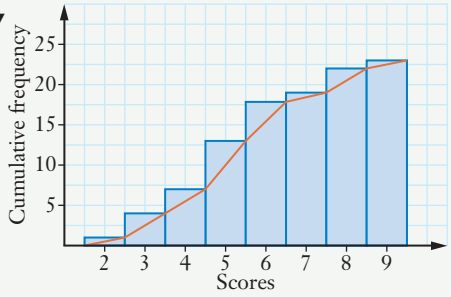
iii 4.0

7 a i

Score	Frequency	Cumulative frequency
2	1	1
3	3	4
4	3	7
5	6	13
6	5	18
7	1	19
8	3	22
9	1	23

ii 5.35 **iii** 5

iv



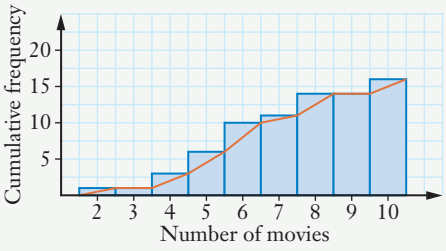
v 5.5

b i

Number of movies	Frequency	Cumulative frequency
2	1	1
3	0	1
4	2	3
5	3	6
6	4	10
7	1	11
8	3	14
9	0	14
10	2	16

ii 6.25 **iii** 6

iv



v 6.5

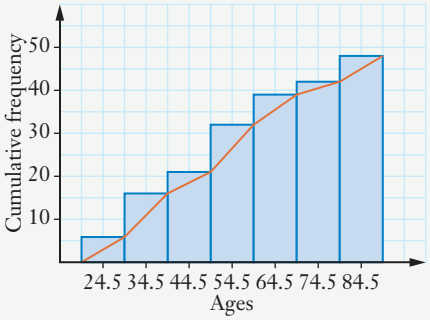
c i

Ages	Class interval	Frequency	Cumulative frequency
20–29	24.5	6	6
30–39	34.5	10	16
40–49	44.5	5	21
50–59	54.5	11	32
60–69	64.5	7	39
70–79	74.5	3	42
80–89	84.5	6	48

ii 54.5 **iii** 50–59

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iv



v 54.5

8 a i 32

ii Mean = 62.4, no mode, median = 64

iii Mean = 66.25, no mode, median = 66

b i 1

ii Mean = 6.6, mode = 6, median = 7

iii Mean = 6.8, mode = 6, median = 7

c i 97

ii Mean = 47.1, mode = 50, median = 46.5

iii Mean = 43.2, mode = 50, median = 43

d i 3

ii Mean = 6.1, mode = 5, median = 6

iii Mean = 6.3, mode = 5, median = 6

9 Outlier 1. It changes the mean.

10 a 17. One student had a very low score on the test.

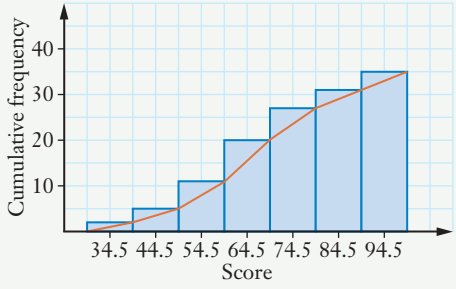
b

Class	Class centre	Frequency	Cumulative frequency
10–19	14.5	1	1
20–29	24.5	0	1
30–39	34.5	2	3
40–49	44.5	3	6
50–59	54.5	6	12
60–69	64.5	9	21
70–79	74.5	7	28
80–89	84.5	4	32
90–99	94.5	4	36

c i Mean = 65.6, modal class = 60–69

ii Mean = 67.1, modal class = 60–69

d



Median = 66

Exercise 7.04

1 a i 2 **ii** 3 **iii** 4.5

b i 11 **ii** 12 **iii** 13

c i 7 **ii** 8 **iii** 9

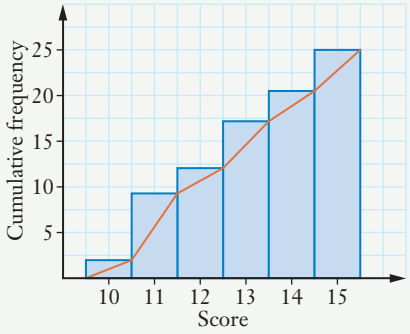
d i 2 **ii** 3 **iii** 5

2 $Q_1 = 2$, $Q_3 = 4.5$

3 a 23rd percentile = 24, 55th percentile = 25.5, 91st percentile = 28

b 2nd decile = 24, 8th decile = 27

4 a



b i 11 **ii** 14 **iii** 12

iv 13.5 **v** 10.5

5 a 42 **b** 37 **c** 38

d 43 **e** 37–47

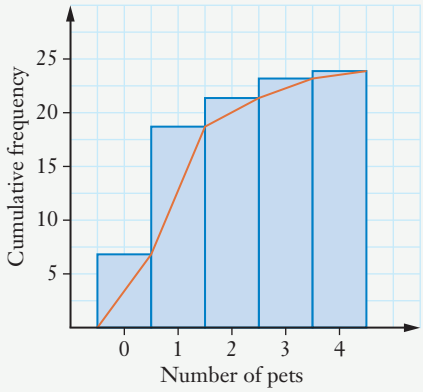
6 a 100 **b** 20% **c** 12

d 14 **e** 69th

7 a 12.5%

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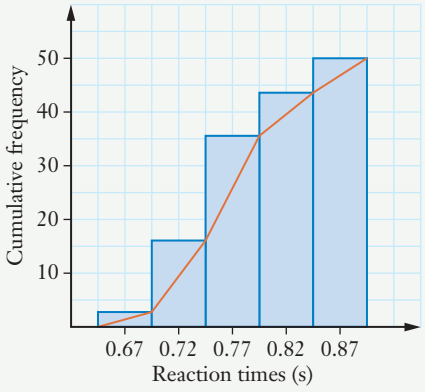
b



c **i** 1 **ii** 0 **iii** 1.5

8 **a** 0.774 **b** 38%

c



d **i** 0.74 **ii** 0.77 **iii** 0.72–0.82

9 **a** **i** 51 **ii** 38 **iii** 79

b **i** 11 **ii** 6 **iii** 14.5

c **i** 132.9 **ii** 115.3 **iii** 154.6

d **i** 15.5 **ii** 14.5 **iii** 17.5

Exercise 7.05

1 **a** 16 **b** 71

c 39 **d** 5

2 **a** **i** 6.5 **ii** 5 **iii** 4

b **i** 2 **ii** 5 **iii** 1

c **i** 40 **ii** 100 **iii** 55

d **i** 2 **ii** 6 **iii** 1

3 **a** **i** 7 **ii** 5 **iii** 2

b **i** 5 **ii** 5 **iii** 2

c **i** 17 **ii** 9 **iii** 4

d **i** 14 **ii** 19 **iii** 5

e **i** 6 **ii** 7 **iii** 2

4 **a** 6.76 **b** 7 **c** 7

d 4 **e** 1.5

5 **a** No outlier **b** 19 **c** 1

Exercise 7.06

1 **a** **i** 5.4 **ii** 2.1

b **i** 52.5 **ii** 14.6

c **i** 123.3 **ii** 16.1

d **i** 6.3 **ii** 1.8

e **i** 17.6 **ii** 1.96

2 **a** **i** 7.2 **ii** 52.1

b **i** 1.96 **ii** 3.8

c **i** 13.5 **ii** 183.2

d **i** 14 **ii** 196.6

e **i** 2.3 **ii** 5.2

3 **a** **i** 8.4 **ii** 2.4 **iii** 5.8

b **i** 4.4 **ii** 1.7 **iii** 2.9

c **i** 34.1 **ii** 1.5 **iii** 2.39

d **i** 51.2 **ii** 14.9 **iii** 222

4 **a** 4 **b** 1.5 **c** 1.14

5 **a** **i** 73.4 **ii** 16.3

b Yes, 20–29 **i** 74.8 **ii** 14.4

6 **a** Yes, 53.

$Q_3 + 1.5 \times \text{IQR} = 30.5 + 15.75 = 46.25$

$Q_1 - 1.5\ \text{IQR} = 20 - 15.75 = 4.25$

So 53 is outside 4.25–46.25.

b **i** 8.4 **ii** 5.3

7 **a** 9.2 **b** 3.5 **c** 12.6

Exercise 7.07

1 **a** Positively skewed, unimodal

b Negatively skewed, unimodal

c Positively skewed, multimodal

d Symmetrical, unimodal

e Positively skewed, unimodal

f Bimodal

g Negatively skewed, unimodal

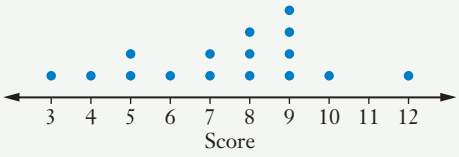
h Bimodal

i Positively skewed, unimodal

j Multimodal

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2 a



b Positively skewed

3 a Positively skewed, unimodal

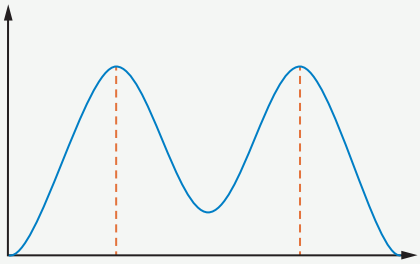
b Symmetrical, unimodal

c Bimodal

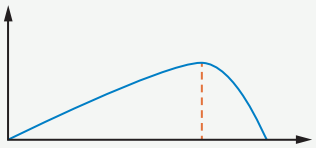
d Negatively skewed, unimodal

e Symmetrical, unimodal

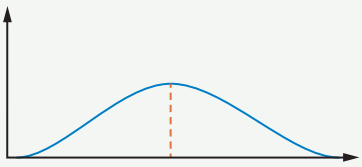
4 a



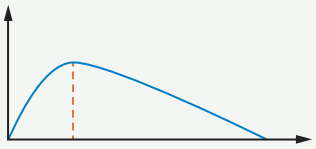
b



c



d



5 Set 1: bimodal, Set 2: positively skewed, unimodal

6 a Plot 1: positively skewed, Plot 2: negatively skewed

b 5 **c** 1

7 a

Score	Class centre	Frequency
145–149	147	3
150–154	152	3
155–159	157	3
160–164	162	6
165–169	167	3
170–174	172	1
175–179	177	6
180–184	182	4
185–189	187	1

b Bimodal

8



9 a **i** 7 **ii** 7 **iii** 7

b Symmetrical

10 Class discussion

Exercise 7.08

1 a **i** 7 **ii** 4

b **i** 2 **ii** 2

c **i** 3 **ii** 2

d Class discussion

2 a

Sample 1							Sample 2					
			9	8	7	14						
9	8	7	5	3	0	15	1	7	7	9		
9	7	6	4	2	0	16	2	4	5	6	8	
	7	6	2	1	0	17	2	3	3	6	8	9
						18	0	1	1	1	2	

b Sample 1: 161, Sample 2: 172.5

c Sample 1: 30, Sample 2: 31

d Class discussion

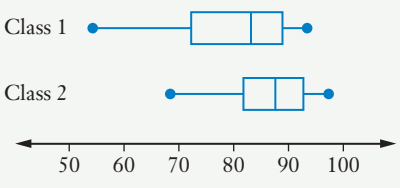
3 a **i** Bank 1: 5.08, Bank 2: 2.77, Bank 3: 11.95

ii Bank 1: 4, Bank 2: 1, Bank 3: 13

b Bank 1: 4.1, Bank 2: 2.4, Bank 3: 4.4

c Class discussion

4 a



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b **i** Class 1: 82.5, Class 2: 88

ii Class 1: 17, Class 2: 10.5

iii Class 1: 79.4, Class 2: 85.8

iv Class 1: 38, Class 2: 28

5 **a**

Camera 1								Camera 2						
			9	9	9	6	5	6						
7	6	5	4	4	3	3	2	7						
			9	5	4	3	0	8						
							0	9						
							3	10						
								11	3	6	8	9	9	
								12	0	0	2	2	3	4	5
								13	0	0	1	5	5	8	
								14	0	2					

b Camera 1: 77.3 kmh^{-1}; Camera 2: 126.1 kmh^{-1}

c Camera 1: 60 kmh^{-1}; Camera 2: 110 kmh^{-1}

6 **a** 17.5 **b** 17 **c** 10

d 2.67

7 **a** **i** 5.57 **ii** 5.86

b **i** 3.16 **ii** 1.25

c The average test score is similar in both tests, but test 1 has a wider spread of scores.

8 **a** Parents: 2, Children: 4

b **i** Parents: 4, Children: 3

ii Parents: 5, Children: 6 **c** 6

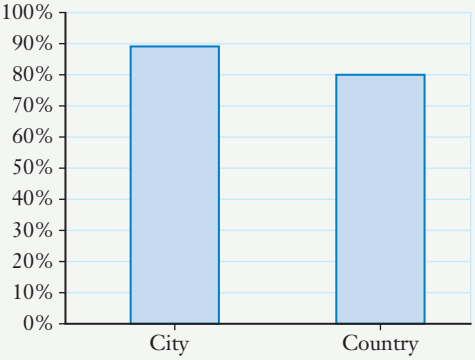
9 **a** Science: 70, English: 63.5

b Science: 69.8, English: 68.8

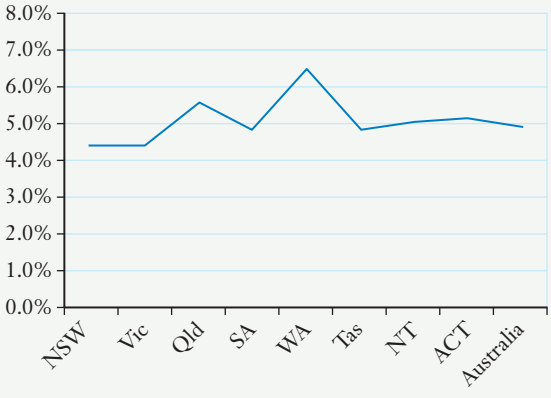
c Science: 12.8, English: 13.4 **d** 10

10 **a** The graph makes it look as if city access is about 3 times as high as country access.

b



11



Test yourself 7

1 B **2** C **3** D

4 D **5** D **6** A

7 Mode 8, median 7, range 5

8 **a** 5–9 **b** 10.75 **c** 9.5

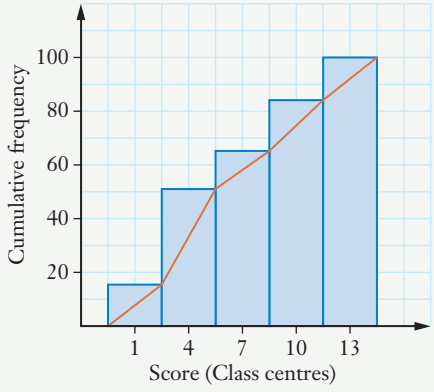
d **i** 6.6 **ii** 43.97

9 Mean 55.7, standard deviation 23.5

10 **a** 10 **b** 11

c 14 **d** 6

11 **a**



b 5.5

c **i** 3 **ii** 10 **iii** 13

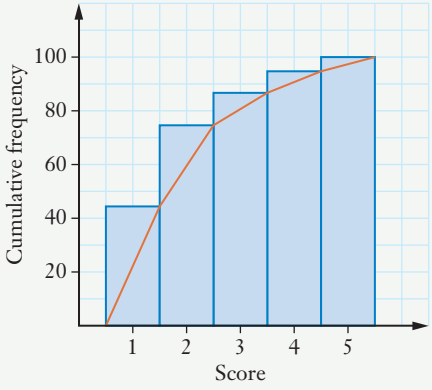
iv 4 **v** 12

12 **a** 1.5 **b** 1 **c** 5 **d** 2

13 Mode

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14 **a**



b **i** 2 **ii** 1.5

15 **a** 7.6 **b** 1.35 **c** 6

16 Mean 44.8, mode 49, median 45

17 **a** 3 **b** 3.5

18 **a** **i** 17 **ii** 14.42 **iii** 14, 18
iv 15

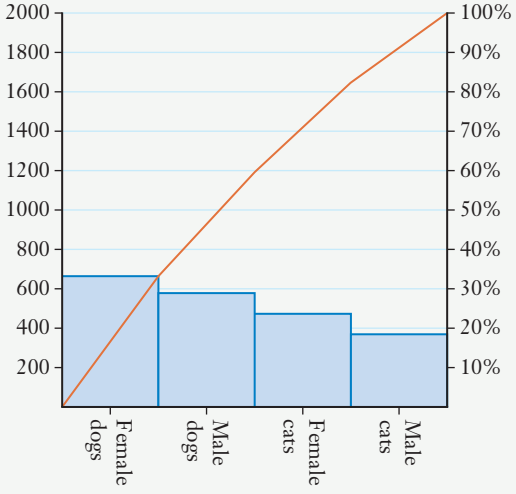
b *2*

c **i** 8 **ii** 15.1 **iii** 14, 18
iv 15

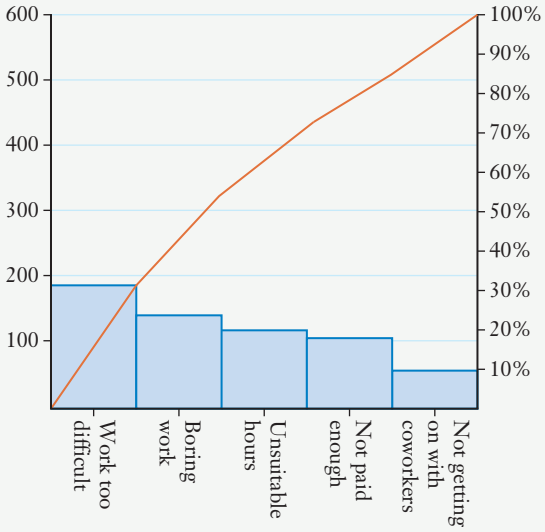
d Affects range and mean.

19 **a** **i** 54.6% **ii** 22.7% **iii** 27.7%
iv 59.6%

b



20



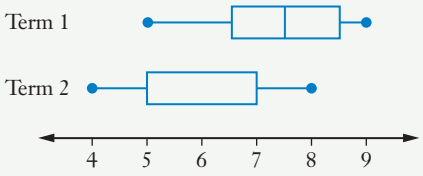
21 **a** North = 47.5, West = 43

b Mean 46.5, standard deviation 7.8

c Mean 43.4, standard deviation 10.7

d Slightly more mushrooms found in the North region on average, spread higher in West region so results more variable.

22 **a**



b Term 1: 7.5; Term 2: 5

c Term 1: 2; Term 2: 2

d Term 1: mean 7.3, standard deviation 1.4; Term 2: mean 5.6, standard deviation 1.2

e Students did better on average in Term 1. The 2 assessments had a similar spread.

Challenge exercise 7

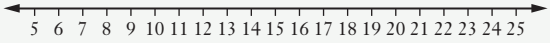
1 **a** Bimodal. Female heights may have their own mode and male heights have their own (higher) mode.

b Mean 168.3, variance 92.2

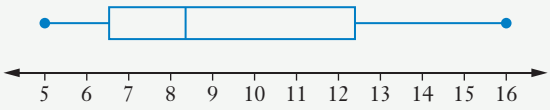
2 4

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3 a



b Positively skewed. There is an outlier at 25.



Without the outlier it is still slightly positively skewed, but it is more symmetrical.

4 a i 15 **ii** 5.66

b

Score x	$x - \bar{x}$	$(x - \bar{x})^2$
7	–8	64
11	–4	16
15	0	0
19	4	16
23	8	64
	$\Sigma(x - \bar{x}) = 0$	$\Sigma(x - \bar{x})^2 = 160$

c 5.66

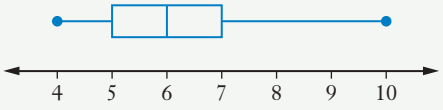
5 25.375

6 a Set B has a higher average or centre, and more consistent results (less spread out than set A).

b Set B has a higher average and is less consistent (more spread out).

7 a Mean 6.04, standard deviation 1.41

b



c Positively skewed

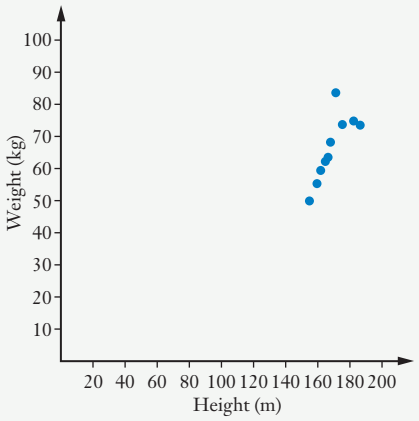
8 a Positively skewed

b Negatively skewed

Chapter 8

Exercise 8.01

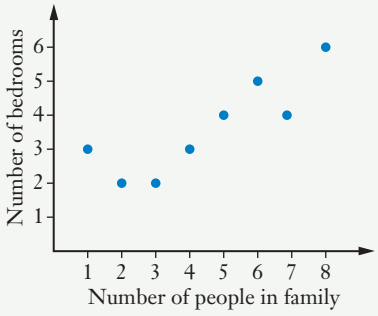
1 a



b The shape seems to be linear in a positive direction.

c As height increases, weight increases.

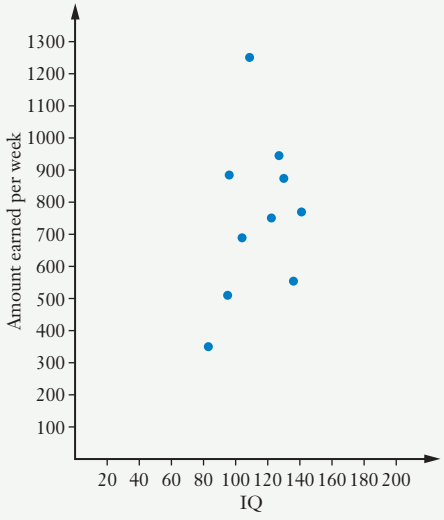
2 a



b The scatterplot is non-linear, or linear (positive) with outliers.

c With some exceptions, the more family members, the more bedrooms in the home.

3 a

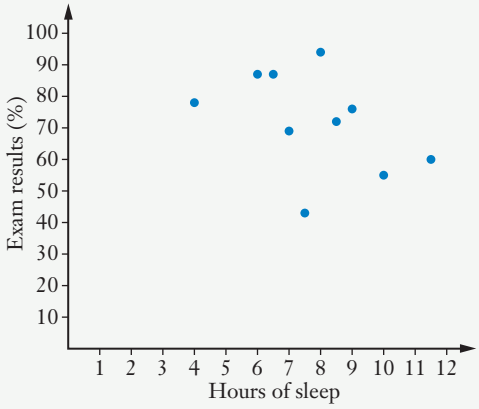


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b The scatterplot has no pattern, or is linear (positive) with outliers.

c With some exceptions, the higher the IQ, the more the person earns.

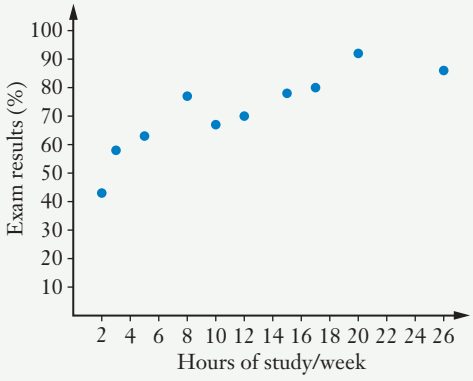
4 a



b The scatterplot has no pattern.

c There is little or no correlation found between amount of sleep and exam results.

5 a



b The shape is linear in a positive direction.

c As the number of hours of study increases, exam results increase.

6 a Non-linear

b Linear in negative direction

c No pattern

d Linear in positive direction

e Linear in negative direction with outliers

f Non-linear

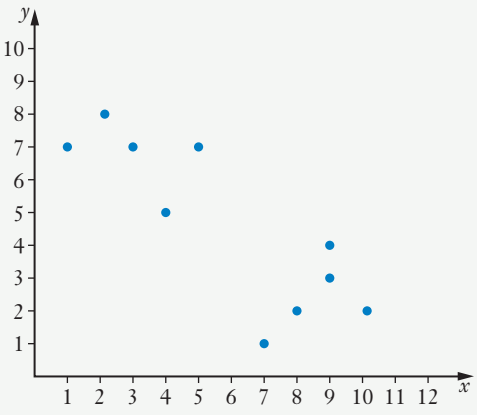
g No pattern

h Linear in positive direction

i Non-linear

j Non-linear

7 a



b Linear in a negative directon

8 a B **b** C **c** C **d** D

e A **f** C **g** B **h** A

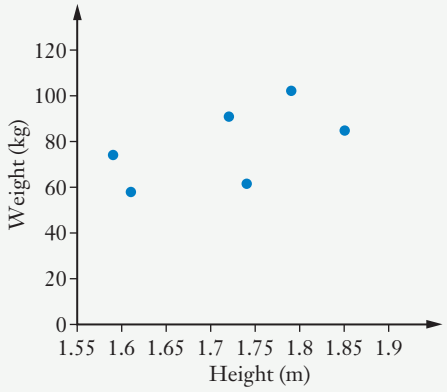
i C **j** D

Exercise 8.02

1 a G **b** B **c** F **d** A

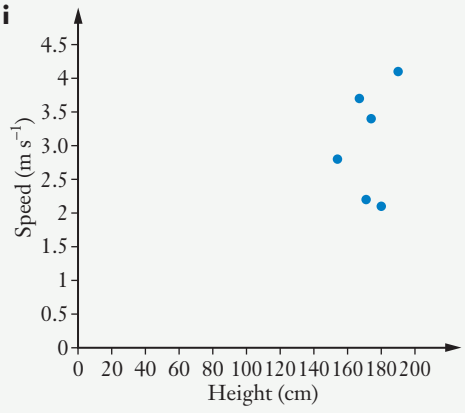
e C **f** D

2 a i



ii 0.571

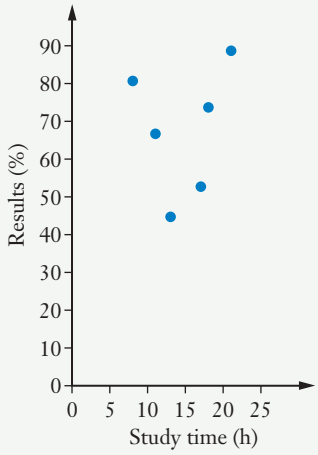
b i



ii 0.284

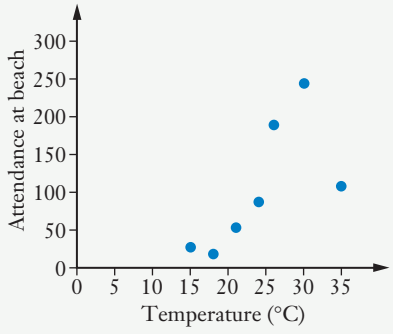
ISBN 9780170413220

c i



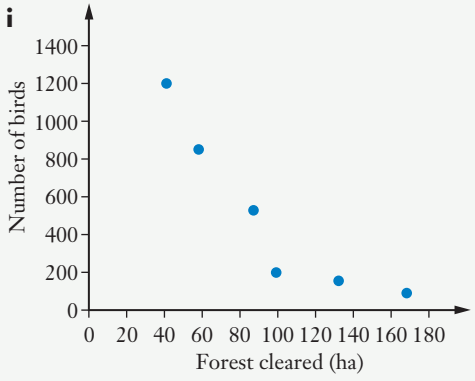
ii 0.181

d i



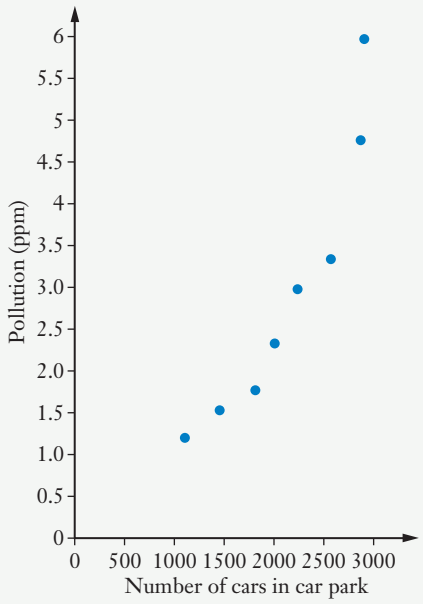
ii 0.685

e i



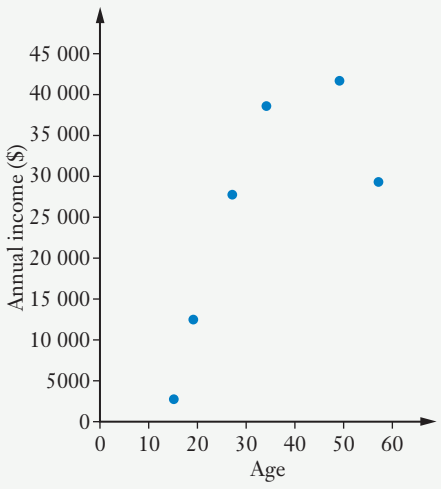
ii −0.908

f i



ii 0.930

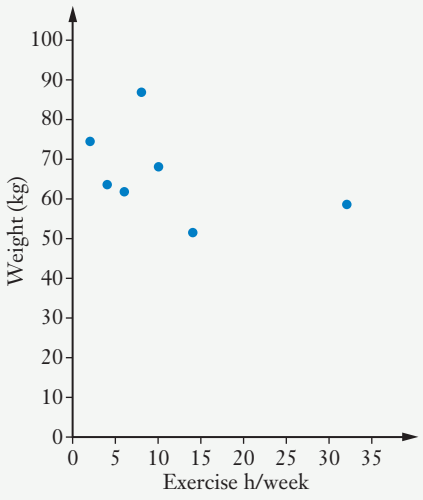
g i



ii 0.749

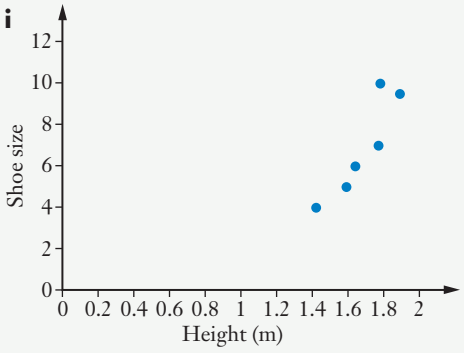
ISBN 9780170413220

h i



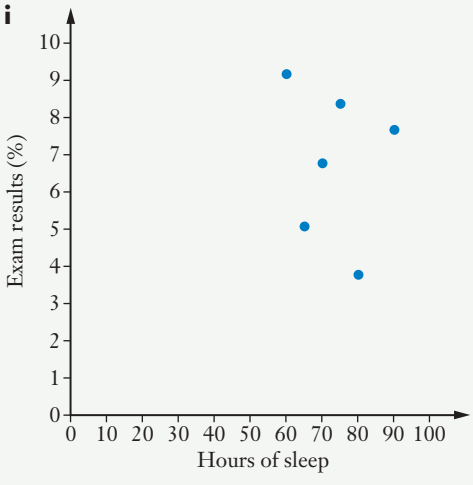
ii –0.430

i i



ii 0.905

j i



ii –0.182

3 d, e, f, i (Class discussion)

4 a 0.40 **b** –0.39
c 0.99 **d** –0.60

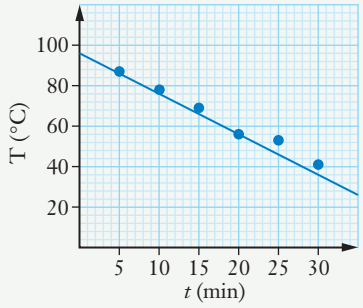
5 a, c and f (Class discussion)

Exercise 8.03

All answers are approximate.

1 a $y = 0.6x + 0.7$ **b** $N = -2t + 23$
c $V = 5.6x + 32$ **d** $P = 1.4t + 6.3$
e $A = -8x + 98$ **f** $x = 5.2t + 480$

2 a

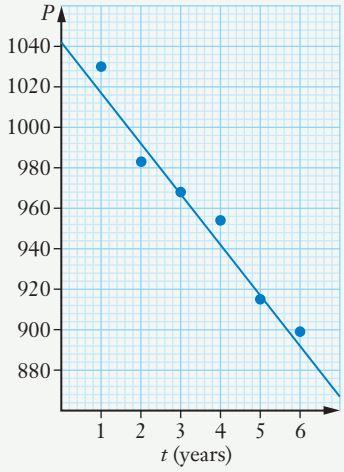


b $T = -2t + 95$

c i 61°C **ii** 25°C

d Good model when interpolating, but not for extrapolating because it can only cool to room temperature (23°C) but not below this.

3 a



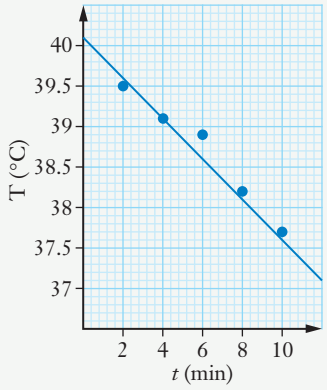
b $P = -25t + 1045$

c 870

d 42 years

ISBN 9780170413220

4 a

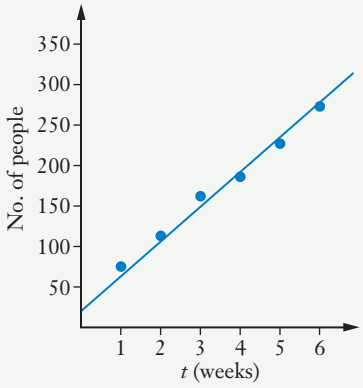


b $T = -0.24t + 40.1$

c 36.5°

d No (class discussion)

5 a



b $N = 37.5t + 42.5$

c 418

d No, because the number of people cannot keep increasing forever.

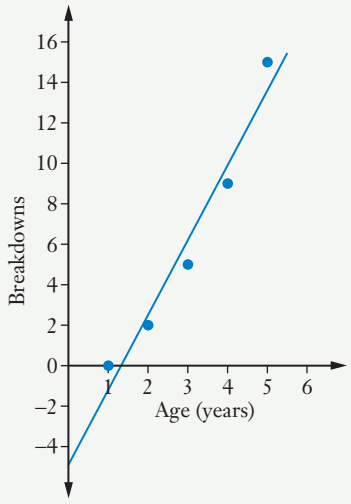
Exercise 8.04

1 a i $r = 0.9923$ **ii** $m = 2.43$

b i $r = 0.976$ **ii** $m = 3.89$

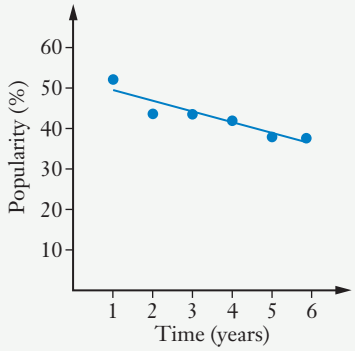
2 a i $y = 3.7x - 4.9$

ii



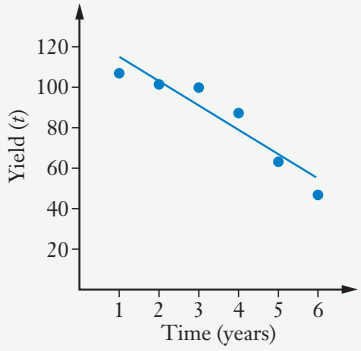
b i $y = -2.65x + 52.18$

ii



c i $y = -12.24x + 127.43$

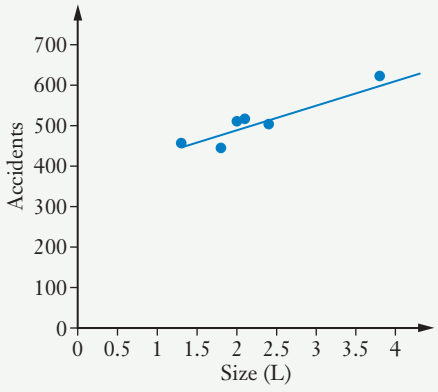
ii



d i $y = 69.88x + 355.43$

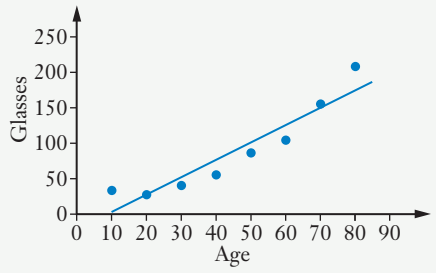
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ii



e **i** $y = 2.49x - 22.36$

ii



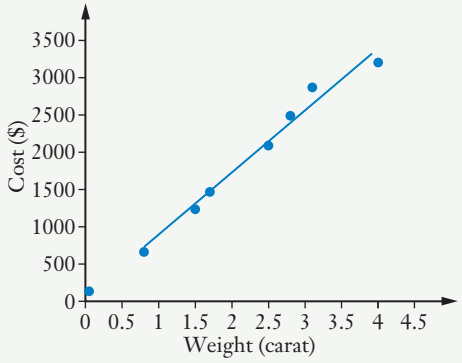
3 **a** $r = -0.954$, which shows a high negative correlation. This means that the regression line has a negative gradient and that the mass decreases as time increases.

b $m = -0.614t + 23.56$

c **i** 12.5 kg **ii** −13.3 kg

d The answer to **c ii** shows that extrapolation is not useful in this situation. The ice has melted to 0 volume before an hour has passed and the equation is no longer relevant.

4 **a**



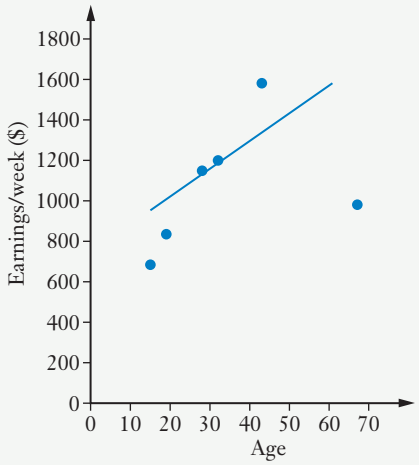
b 0.993. This is a high positive correlation.

c $y = 831.7x + 69.2$

d \$1732.59

e 11.94 carats

5 **a**



b 0.395

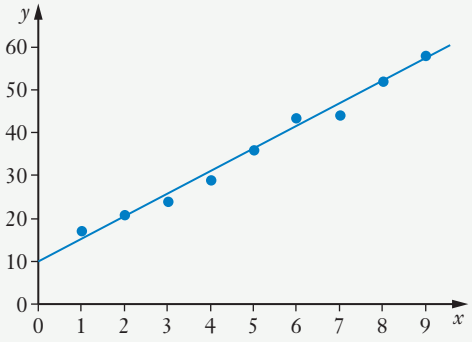
c $y = 6.6x + 853.5$ **d** \$1181.92

e No. For example. using the equation to find the age of a person earning \$1800 would give a 145-year-old!

Test yourself 8

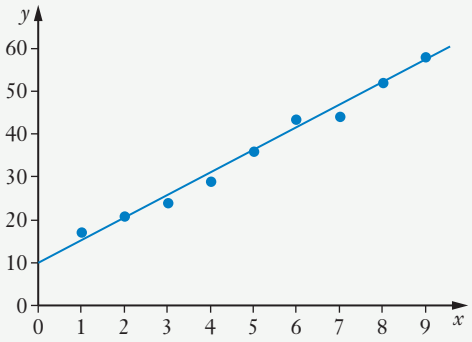
1 C **2** B **3** D **4** A **5** C

6 **a**



$y = 5x + 10$

b



$y = 5.1833x + 10.083$

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7 **a** C **b** A **c** D **d** C
e B **f** A **g** C **h** D

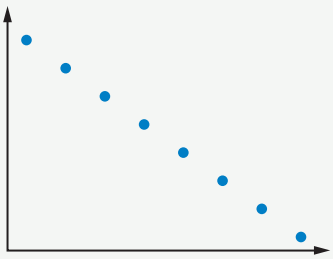
8 **a** 0.84 **b** $y = 0.758x + 10.88$
c 56 **d** 78

9 **c, d** are causal (Class discussion)

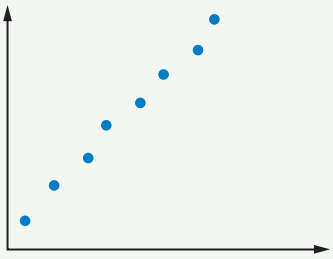
Challenge exercise 8

1 $r = 0.8$, $\overline{y} = 6.4$

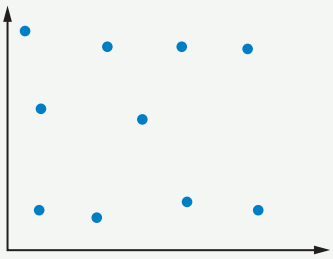
2 **a**



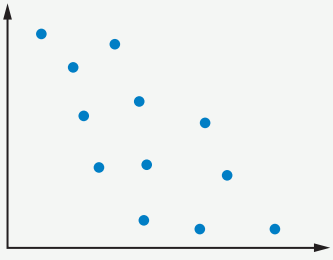
b



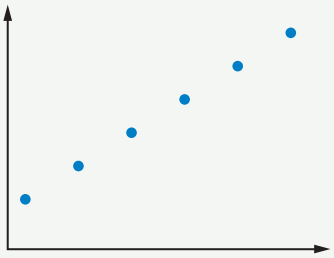
c



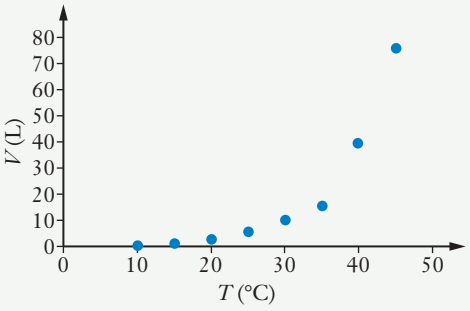
d



e

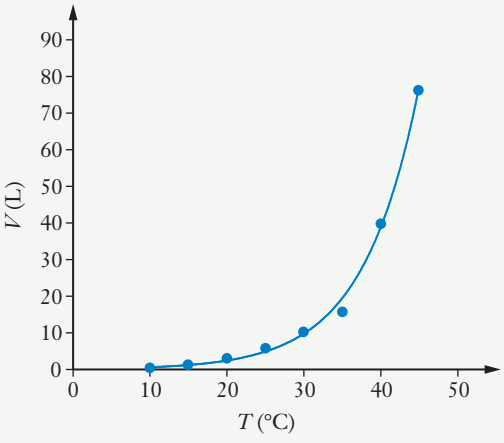


3 **a**



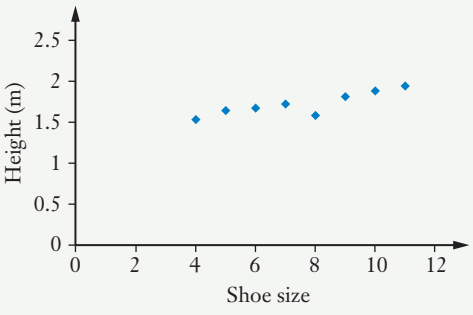
b The correlation is non-linear, so a least squares regression line would not be a good approximation

c



$V = 0.1563e^{0.1379T}$

4 **a**



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b 0.876

c $y = 0.052x + 1.34$

d **i** 0.992 **ii** $y = 0.054x + 1.35$

e No. Shoe sizes cannot keep increasing

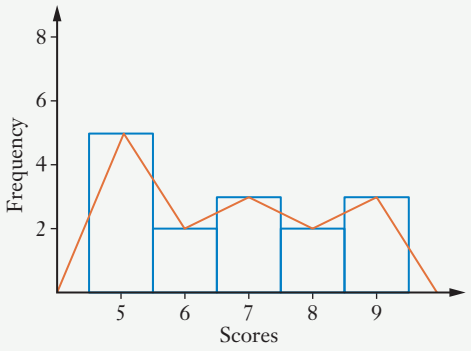
Practice set 3

1 A **2** A **3** D **4** D **5** B

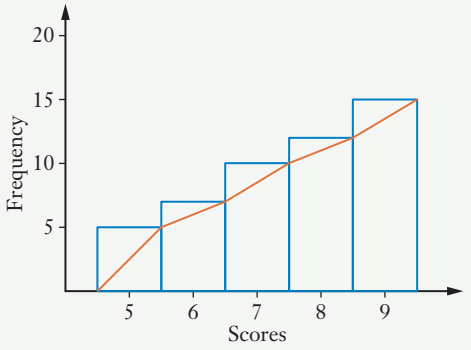
6 **a**

Score	Frequency
5	5
6	2
7	3
8	2
9	3

b



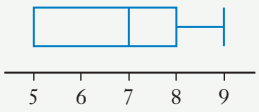
c



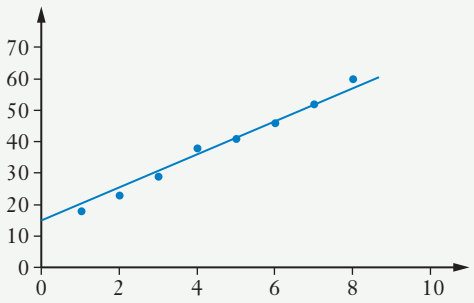
d 7

e 3

f

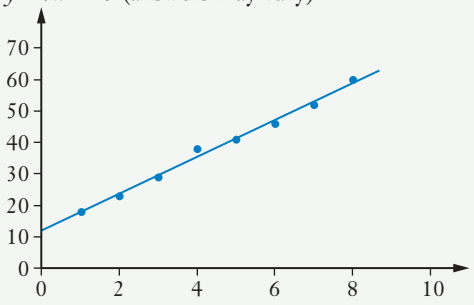


7 **a**



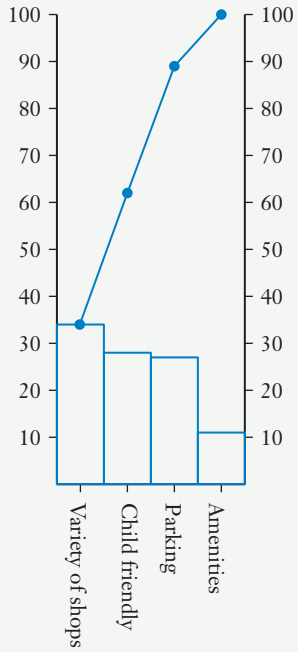
$y = 7x + 15$ (answers may vary)

b



$y = 5.869x + 11.964$

8



9 Mean 6.375, standard deviation 1.87, variance 3.48

10 **a** Mean 8.04, standard deviation 1.54

b 3 is not between 4 and 12, so 3 is an outlier.

c Mean 8.26, standard deviation 1.15

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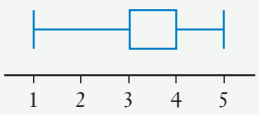
11 Mean 6.43, mode 6, median 6, range 5

12 **a** 52

b Mean 3.58, standard deviation 1.01

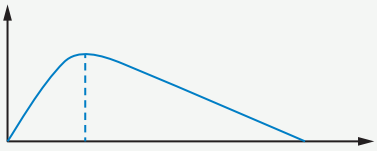
c 4

d

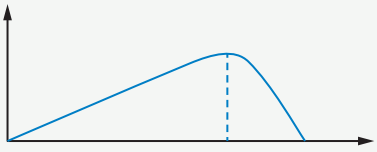


13 –0.82

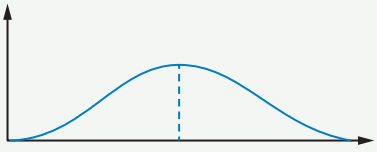
14 **a**



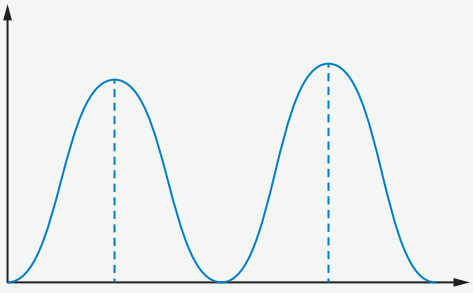
b



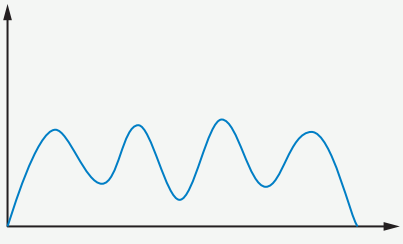
c



d



e



15 **a** categorical nominal

b quantitative continuous

c categorical ordinal

d quantitative discrete

e quantitative discrete

16 **a** C **b** D **c** B **d** A **e** D **f** C

17 **a** 3.5 **b** 2.1 **c** 4.5 **d** 2.5

18 (4, –143) min, (–2, 73) max, (1, –35) point of inflection

19 **a** $x = \frac{\pi}{6}, \frac{5\pi}{6}$

b $x = \frac{\pi}{4}, \frac{3\pi}{4}, \frac{5\pi}{4}, \frac{7\pi}{4}$

c $x = \frac{\pi}{3}, \frac{2\pi}{3}, \frac{4\pi}{3}, \frac{5\pi}{3}$

20 **a** 399 **b** 20 100

Chapter 9

Exercise 9.01

1 **a** 210 **b** 13th **c** 57

2 **a** 39 **b** 29th **c** 32

3 **a** $3n + 3$

b $S_n = \frac{1}{2}n[2 \times 6 + (n-1) \times 3]$

4 **a** 0.01 m **b** 91.5 m

5 **a** 7 **b** 10.5 m

6 **a** \$2050 **b** \$2100 **c** \$2150 **d** \$2500 **e** \$3500

7 **a** 1.25 m **b** 8

8 **a** 4.5–5 kg **b** 18th

9 **a** 49 **b** 4 mm

10 **a** $3k$ m **b** $3k(k+1)$ m **c** 9

Exercise 9.02

1 **a** **i** 93% **ii** 86.49% **iii** 80.44%

b 33.67% **c** 19 weeks

2 **a** 96.04% **b** 34 days **c** 114 days

3 **a** **i** \$23 200 **ii** \$26 912 **iii** \$31 217.92

b \$102 345.29 **c** 6.2 years

4 **a** 77.4% **b** 13.5 years **c** 31.4 years

5 **a** $\frac{4}{9}$ **b** $\frac{7}{9}$ **c** $1\frac{2}{9}$ **d** $\frac{25}{99}$ **e** $2\frac{9}{11}$ **f** $\frac{7}{30}$ **g** $1\frac{43}{90}$ **h** $1\frac{7}{450}$ **i** $\frac{131}{990}$ **j** $2\frac{361}{999}$

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6 0.625 m **7** 15 m
8 20 cm **9** 3 m
10 **a** 4.84 m **b** After 3 years
11 **a** 74.7 cm **b** 75 cm
12 300 cm **13** 3.5 m **14** 32 m
15 **a** 1, 8, 64, 512, …
b 16 777 216 people
c 19 173 961 people

Exercise 9.03

1 **a** $6895.85 **b** $6999.79 **c** $7633.37
d $6857.36 **e** $7207.26
2 **a** $2852.92 **b** $12 720.32 **c** $4038.13
d $5955.08 **e** $87 362
3 $893 262 **4** $3552.86
5 $21 173.72 **6** $1069.23
7 $4902.96
8 **a** $1125.68 **b** $2209.20 **c** $14 930
d $96 630 **e** $305 900 **f** $902.22
g $1300.26 **h** $3090.90 **i** $1061.50
j $3866.10
9 **a** $8705.49 **b** $4971.66 **c** $4631.99
d $9705.91 **e** $8227.07

Exercise 9.04

1 **a** $740.12 **b** $14 753.64
c $17 271.40 **d** $9385.69
e $5298.19
2 **a** $2007.34 **b** $2015.87 **c** $2020.28
3 **a** $4930.86 **b** $4941.03
4 **a** $408.24 **b** $410.51
5 **a** $971.40 **b** $972.12
6 **a** $1733.99 **b** $1742.21 **c** $1747.83
7 **a** $3097.06 **b** $13.47
8 **a** $22 800.81 **b** $945.92
9 $691.41 **10** $1776.58
11 $14 549.76 **12** $1 301 694.62
13 **a** $4113.51 **b** $555.32 **c** $9872.43
d $238.17 **e** $10 530.59
14 $4543.28 **15** 4 years **16** 8 years
17 **a** $x = 7$ **b** $x = 5$ **c** $x = 8$
d $x = 6.5$ **e** $x = 8.5$
18 $7.68 **19** Kate $224.37
20 Account A, $844.94
21 **a** **i** $39 400.53 **ii** $41 812. 16
b 27th year
22 **a** **i** $128 547 **ii** $175 196.37
iii $230 700.16
b 28th year
23 **a** **i** 4 years **ii** 17 years
b **i** 3.1% **ii** 1.8%
24 **a** 1.9990
b $A = 1.08^9$
= 1.9990 to 4 decimal places
25 FV interest factor is 1.5209.
$A = 1.15^3$
= 1.5209 to 4 decimal places

Exercise 9.05

1 **a** $10 125 **b** $3745.92 **c** $2720.63
d $20 410 **e** $6194.05
2 **a** $49 759.29 **b** $5524.36
c $94 334.25 **d** $2074.02
e $274 948.05 **f** $3981.08
g $20 103.20 **h** $15 559.48
i $327 214.50 **j** $1 474 272
3 **a** $10 789.40 **b** $22 839.56
c $69 720.25 **d** $9511.37
e $11 513.83
4 $477 076.25 **5** $2074.70
6 **a** $1469.39 **b** $2811.42 **c** $1266.10
d $614.91 **e** $30 242.55
7 $296.59
8 **a** **i** $47 000 **ii** $43 880 **iii** $40 635.20
b $43 756.80 **c** $41 833.42
9 **a** $125 750 **b** $126 507.50
c $127 272.58 **e** $125 376.88
d $125 757.53
10 **Graph A:**
a 18 months **b** $10 400
c 36 months (3 years)
Graph B:
a 27 months (2 years 3 months)
b $12 200
c 46 months (3 years 10 months)

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11 **a** 18 **b** 21
12 **a** 9% **b** 3%

Exercise 9.06

1 $40 728.17 **2** $3383.22
3 $65 903.97 **4** $2846.82
5 $6181.13 **6** $4646.71
7 $21 426.03
8 **a** $26 361.59 **b** $46 551.94
9 $45 599.17
10 **a** $7922.80 **b** $1584.56
11 $500 for 30 years ($11 640.86 better off)
12 Yes, $259.80 over **13** $818.72
14 **a** $37.38
b Proof (see worked solutions).

Exercise 9.07

1 **a** $19 234.54 **b** $3177.64
c $99 990.13 **d** $1798.81
e $45 659.71
2 **a** **i** $5978.52 **ii** $978.52
iii 6.5%
b **i** $24 225.60 **ii** $8325.60
iii 10.5%
c **i** $159 785.28 **ii** $79 785.28
iii 8.3%
d **i** $272 127 **ii** $37 127
iii 0.63%
e **i** $1710.48 **ii** $362.48
iii 13.4%
3 **a** $154.64 **b** $304.20 **c** $854.64
d $2605.80 **e** $2549.04 **f** $686.37
g $568.89 **h** $3021.75 **i** $3922
j $5680
4 **a** $3946.90 **b** $947 256
c $266 756 **d** 1.96%
5 **a** 5 years **b** 10 years **c** 20 years
d 30 years **e** 10 years **f** 25 years
g 10 years **h** 15 years **i** 10 years
j 20 years
6 **a** 6% **b** 4.5% **c** 2%
d 8% **e** 5.5% **f** 7%
g 2.5% **h** 3% **i** 7.5%
j 4%

Exercise 9.08

1 $1047.62 **2** $394.46 **3** $139.15
4 **a** $966.45 **b** $1265.79
5 $2519.59
6 **a** $868.46 **b** $55 907.60
7 **a** $77.81 **b** $2645.42
8 $78 700
9 **a** Get Rich $949.61, Capital Bank $491.27
b $33 427.80 more through Capital Bank
10 **a** $875.60 **b** $43 778.80
11 $61 292.20
12 NSW Bank totals $5791.25, Sydney Bank totals $5557.88 so Sydney Bank is better.
13 **a** $249.69 **b** $13 485.12
14 **a** $13 251.13 **b** $374.07
c $20 199.78
15 **a** $1835.68 **b** $9178.41
16 **a** $10.36
b Proof (see worked solutions).

Test yourself 9

1 C **2** B **3** A
4 $21 980.94 **5** $1672.74
6 **a** Each slat rises 3 mm so the bottom one rises up 30×3 mm or 90 mm.
b 87 mm
c 90, 87, 84, … is an arithmetic sequence with $a = 90$, $d = -3$.
d 42 mm **e** 1395 mm
7 **a** $121 320 **b** $58 820 **c** 18.8%
8 **a** $723.22 **b** $9995 **c** $2925.27
d $16 785.90 **e** $11 345.01
9 **a** $24 050 **b** $220 250
10 **a** $184 867.25 **b** $182 829.42
c $180 786.49
11 $1285.19
12 **a** 10 stacks **b** 110 boxes
13 **a** $\frac{4}{9}$ **b** $\frac{13}{18}$ **c** $1\frac{19}{33}$
14 $3400.01

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15 **a** \$59 000 **b** \$15 988.89

16 **a** \$2385.04 **b** \$2392.03

17 **a** \$1432.86 **b** \$343 886.91

18 **a** \$2651.56 **b** \$9872.43

19 **a** 39 words/min **b** 15 weeks

20 4.8 m

21 **a** **i** \$33 000 **ii** \$23 000

b **i** 14 years **ii** 28 years

c 32 years

Challenge exercise 9

1 \$1799.79

2 **a** \$40 **b** \$2880

3 \$8522.53

4 **a** **i** 115.8° **ii** 51.4°

b **i** 6.6 min **ii** 10.9 min

5 **a** $\$1000(1.06)^{25}$ **b** $\$1000(1.06)^{24}$

c $\$1000(1.06)^{23}$ **d** \$1000(1.06)

e $S_{25} = \dfrac{1000 \times 1.06 \times (1.06^{25} - 1)}{1.06 - 1}$

f \$58 156.38

6 **a** \$10 100 **b** \$11 268.25

c \$4212.41 **d** \$2637.22

7 \$466 563.74

Chapter 10

Exercise 10.01

1 **a** Discrete **b** Continuous

c Continuous **d** Discrete

e Continuous

2 **a, d** **3** **a, d**

4 $b = 7$ **5** $k = \dfrac{4}{625}$

6 **a** $a = \dfrac{1}{e(e^2 - 1)}$

b $a = \dfrac{1}{e(e^6 - 1)}$ **c** $a = \dfrac{1}{e^4 - 1}$

7 $[0, 6]$ **8** $b = 8$

Exercise 10.02

1 **a** $\frac{1}{2}$ **b** $\frac{1}{6}$ **c** $\frac{1}{2}$

d $\frac{2}{3}$ **e** $\frac{1}{3}$

2 **a** $y = \dfrac{x}{50}$

b **i** $\frac{81}{100}$ **ii** $\frac{9}{100}$ **iii** $\frac{33}{100}$

iv $\frac{8}{25}$ **v** $\frac{3}{4}$

3 **a** $a = \dfrac{3}{125}$

b **i** $\frac{27}{125}$ **ii** $\frac{63}{125}$ **iii** $\frac{117}{125}$

iv $\frac{1}{125}$ **v** $\frac{37}{125}$

4 **a** $a = \dfrac{4}{81}$

b **i** $\frac{80}{81}$ **ii** $\frac{16}{81}$ **iii** $\frac{5}{27}$

iv $\frac{1}{81}$

5 **a** $k = \dfrac{1}{e(e^5 - 1)}$

b **i** $\dfrac{e(e^3 - 1)}{e^5 - 1}$ **ii** $\dfrac{e^3 - 1}{e^5 - 1}$ **iii** $\dfrac{e^2(e^3 - 1)}{e^5 - 1}$

6 **a** $\displaystyle\int_0^{\frac{\pi}{2}} \sin x \, dx = [-\cos x]_0^{\frac{\pi}{2}}$

$= -\cos\dfrac{\pi}{2} - (-\cos 0)$

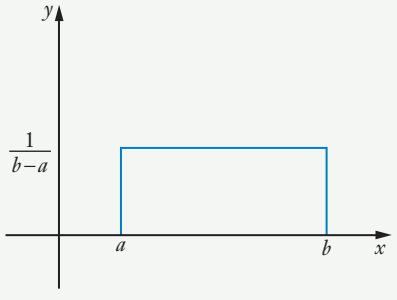
$= -0 + 1$

$= 1$

So $y = \sin x$ is a PDF in the domain $\left[0, \dfrac{\pi}{2}\right]$

b **i** $\frac{1}{2}$ **ii** $1 - \dfrac{1}{\sqrt{2}} = \dfrac{\sqrt{2} - 1}{\sqrt{2}}$ **iii** $\frac{\sqrt{3}}{2}$

7 **a**



$A = bh$

$= (b - a) \times \dfrac{1}{b - a}$

$= 1$ so PDF

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b **i** $\frac{3}{4}$ **ii** $\frac{1}{2}$ **iii** $\frac{1}{4}$

Exercise 10.03

1 **a** $F(x) = \frac{x^3}{27}$ **b** $F(x) = \frac{x^4}{1296}$

c $F(x) = \frac{e^x - 1}{e^4 - 1}$ **d** $F(x) = \frac{(x-2)^4}{625}$

e $F(x) = \frac{12x^2 - x^3 - 40}{135}$

2 **a** $F(x) = \frac{x^5 - 1}{7776}$

b **i** $\frac{121}{3338}$ **ii** $\frac{31}{7776}$ **iii** $\frac{781}{1944}$

iv $\frac{2251}{2592}$ **v** $\frac{31}{243}$

3 **a** $F(x) = \frac{x^4 - 81}{2320}$

b **i** $\frac{35}{464}$ **ii** $\frac{243}{464}$ **iii** $\frac{111}{145}$

iv $\frac{429}{464}$ **v** $\frac{13}{29}$

4 **a** $F(x) = \frac{e^{2x} - 1}{e^{10} - 1}$

b **i** 0.0024 **ii** 0.14 **iii** 0.98

iv 0.99 **v** 0.13

5 **a** $a = \frac{4}{6561}$ **b** $F(x) = \frac{x^4}{6561}$

c **i** $\frac{625}{6561}$ **ii** $\frac{256}{6561}$ **iii** $\frac{2465}{6561}$

iv $\frac{80}{81}$ **v** $\frac{1280}{6561}$

6 **a** $a = \frac{1}{\ln 6}$ **b** $F(x) = \frac{\ln x}{\ln 6}$

c **i** 0.61 **ii** 0.39 **iii** 0.10

iv 0.23 **v** 0.51

7 **a** Show that $\int_{\frac{3\pi}{2}}^{2\pi} \cos x \, dx = 1$

b $F(x) = \sin x + 1$

c **i** $\frac{2 - \sqrt{3}}{2}$ **ii** $\frac{1}{\sqrt{2}}$

iii $\frac{\sqrt{3} - 1}{2}$

8 **a** 2 **b** 3 **c** 3 **d** 7

e 4 **f** 4 **g** 6 **h** 8

i 4 **j** 7

9 **a** 3

b $F(x) = -\frac{1}{22}(x^3 - 9x^2 + 15x - 2)$

c $\frac{1}{2}$

10 **a** $F(x) = \frac{1}{464}(x^4 - 12x^3 + 48x^2 + 4x - 201)$

b **i** $\frac{9}{29}$ **ii** $\frac{393}{464}$ **iii** $\frac{73}{464}$

c 7 minutes

Exercise 10.04

1 **a** 6.35 **b** 5.89 **c** 6.09 **d** 3

e 3.11 **f** 7.57 **g** 8.79 **h** 4.45

i 5.29 **j** 3.73

2 **a** **i** 6.47 **ii** 6.05 **iii** 9.19

b **i** 4.24 **ii** 4.01 **iii** 5.62

c **i** 3.79 **ii** 3.62 **iii** 4.75

3 **a** 6.35 **b** 5.64

4 **a** 6.38 **b** 5.12 **c** 7.28 **d** 7.02

e 4.28 **f** 7.44

5 **a** 7.02 **b** 9.52 **c** 10.90

6 **a** $F(x) = \frac{x^4 - 16}{4080}$ **b** $\frac{203}{1360}$

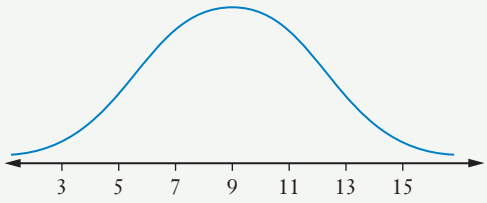
c $\frac{16}{17}$ **d** $\frac{29}{51}$

e 6.73 **f** 7.45

g 7.79 **h** 5.56

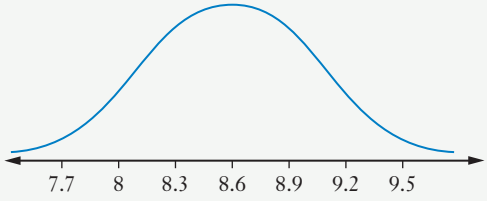
Exercise 10.05

1 **a**

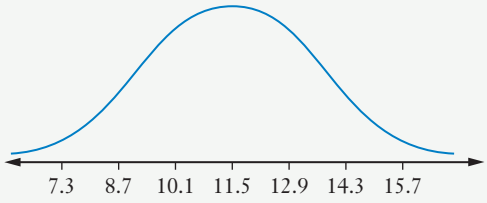


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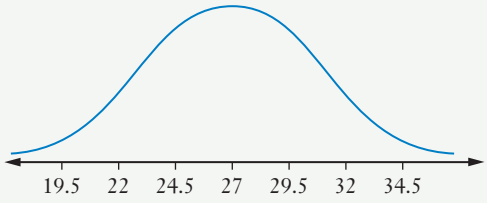
b



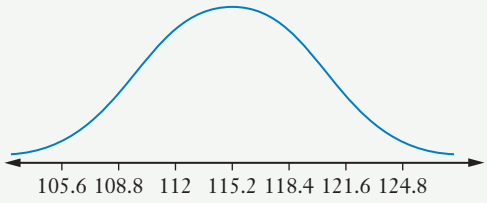
c



d

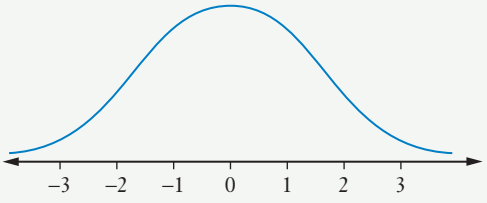


e



2 **a** $\mu = 23.7, \sigma = 4.2$ **b** $\mu = 5.4, \sigma = 0.9$
c $\mu = 59.7, \sigma = 5.4$ **d** $\mu = 209, \sigma = 10.6$
e $\mu = 11.3, \sigma = 2.2$

3

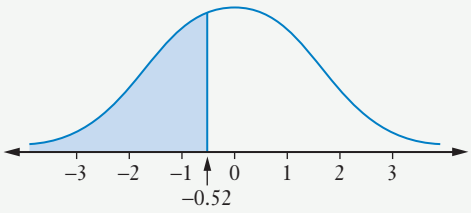


4 **a** 0.5 **b** 0.8413 **c** 0.9772
d 0.9987 **e** 0.1587 **f** 0.0228
g 0.0013 **h** 0.9332 **i** 0.0038
j 0.999

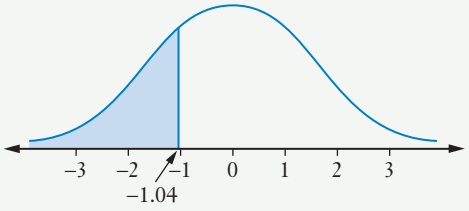
5 **a** 0.6772 **b** 0.0174 **c** 0.9778
d 0.031 **e** 0.9722 **f** 0.0837
g 0.9255 **h** 0.6826 **i** 0.9544
j 0.9974

6 **a** 0.84 **b** 0.67 **c** −0.53
d −0.84 **e** 1.23 **f** −1.17 or −1.18
g −0.52 **h** −0.67 **i** 0.33

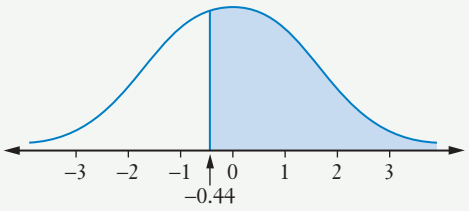
7 **a**



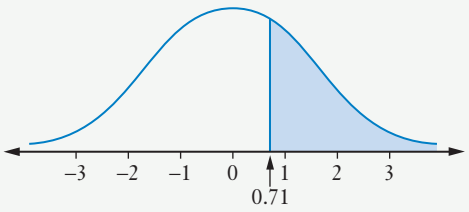
b



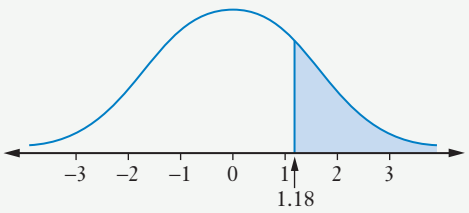
c



d



e

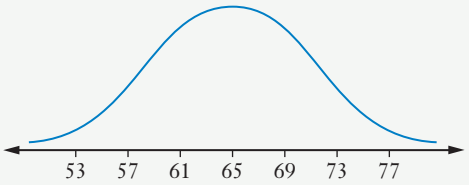


Exercise 10.06

1 **a** 68% **b** 95% **c** 99.7%
2 **a** 68% **b** 95% **c** 99.7%
3 **a** 68% **b** 95% **c** 99.7%
4 **a** 68% **b** 95% **c** 99.7%
d 34% **e** 49.85% **f** 97.35%

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5 a



b **i** 95% **ii** 34% **iii** 49.85%
iv 81.5% **v** 81.5%

6 a 68% **b** 34% **c** 47.5%
d 47.5% **e** 83.85%

Exercise 10.07

1 a **i** 0 **ii** 1 **iii** 2
iv 3 **v** –1 **vi** –2
vii –3
b **i** 19.95 **ii** 15.27

2 a 27 cm to 79.2 cm
b **i** 0 **ii** 1 **iii** –1
iv 2 **v** –2 **vi** 3
vii –3 **viii** 1.4

3 a 3.5° to 10.1°
b **i** 0 **ii** 1 **iii** 2
iv 3 **v** –1 **vi** –2
vii –3 **viii** –0.7

4 a 54.8 mL to 78 mL
b **i** 0 **ii** 1 **iii** 2
iv 3 **v** –1 **vi** –2
vii –3 **viii** 4.1
c **i** 73.36 mL **ii** 83.22 mL
iii 62.92 mL **iv** 53.06 mL

5 a **i** 2.7 **ii** –3.3 **iii** 2.4
iv –1.3 **v** 4.9 **vi** –1.8
vii 3.3 **viii** –2.6
b 53.2, 90 and 82.7 **c** 62.1 and 59.7
d 80, 78.6, 62.1, 59.7 and 56.4

6 a **i** 1.29 **ii** –1.57
b **i** 11.26 mm **ii** 16.02 mm
iii 18.68 mm **iv** 13.136 mm
v 16.93 mm

7 28 **8** 26.85 **9** 50

10 a 53.4 **b** 42.2 **c** 59
d 69.08 **e** 43.88

11 48.3

12 a **i** 12.2 to 19.8 **ii** 14.1 to 17.9
iii 10.3 to 21.7
b **i** 2.1 **ii** –1.3
c **i** 10.3 **ii** 18.09

13 a 99.6 to 109.8
b **i** –4.8 **ii** –0.3
c **i** 114.9 **ii** 98.07

Exercise 10.08

1 a **i** 99.7% **ii** 47.5% **iii** 68%
iv 49.85% **v** 83.85%
b **i** 4 **ii** Yes: outside normal range
c **i** –1.5 **ii** 0.0668 **iii** 0.2417

2 a **i** 68% **ii** 95% **iii** 99.7%
iv 34% **v** 81.5%
b **i** –3.3 **ii** Yes: outside normal range
c **i** 3.7 **ii** Yes: outside normal range

3 a 4.1 – no: outside normal range
b 4.6 min to 11.4 min
c 97.35%
d **i** –0.29 **ii** 11.41%
e **i** 0.381 **ii** 0.721 **iii** 0.8418
f **i** 98.9% **ii** 68.32% **iii** 98.5%

4 a **i** 95% **ii** 49.85% **iii** 39.83%
b 18.7 mL to 21.1 mL
c Unusual – outside range
d 0.0606

5 a 95% **b** 8.1 cm **c** 6.9 cm

6 a 2.2 years
b **i** 68% **ii** 88.54%
c Yes – outside normal range

7 a 25.5 cm to 30.5 cm
b –0.96 **c** 82.33%
d No – outside normal range

8 a 5% **b** 2.5% **c** **i** 0.3%
ii greater than 5.4 kg, less than 4.5 kg

9 a **i** 99.7% **ii** 12.1 cm **iii** 9.1 cm
b 8.3 cm, 12.6 cm

10 Yes: Minimum weight within normal limits is 251.3 g.

11 2.5%

12 a 2 mm **b** 820 mm
c 816 mm to 824 mm

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13 **a** 0.2 h **b** 2.5 h

14 **a** Epping 1.04, city 1.35 **b** City

15 **a** 1 **b** 2.04 **c** Cameron

Test yourself 10

1 C **2** A **3** D

4 **a** 0.75 **b** 0.4 **c** 0.55
d 0.45 **e** 0.7 **f** 10
g 3.6 **h** 17.8 **i** 12
j 15

5 **a** Yes **b** Yes **c** No

6 3.98

7 **a** $F(x) = \dfrac{x^3 - 1}{511}$

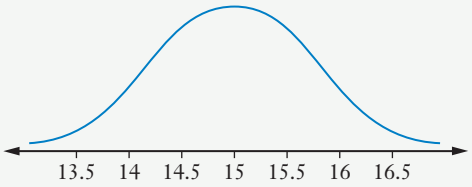
b **i** $\dfrac{26}{511}$ **ii** $\dfrac{124}{511}$ **iii** $\dfrac{296}{511}$
iv $\dfrac{64}{73}$ **v** $\dfrac{335}{511}$

8 **a** **i** 4 **ii** 2.9
b **i** 9 **ii** 7.1

9 **a** 2.27 kg to 4.13 kg
b **i** 2.26 **ii** 0.97
c 0.1541

10 [0, 4]

11 **a**



b



12 **a** 0.3% **b** 18.5%

13 **a** 5.7 **b** 6.4 **c** 5.35
d 6.09 **e** 4.87

14 Mean 2.9, standard deviation 0.7

15 **a** $F(x) = \dfrac{x^5}{3125}$ **b** $F(x) = \dfrac{x^7}{823543}$

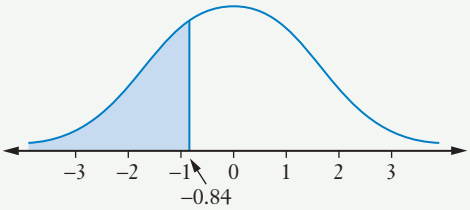
c $F(x) = \dfrac{e^x - 1}{e^6 - 1}$ **d** $F(x) = \dfrac{x^2 - 1}{80}$

16 **a** 0.7054 **b** 0.9066 **c** 0.0013
d 0.2389 **e** 0.8413 **f** 0.0062
g 0.8599 **h** 0.1272 **i** 0.1348

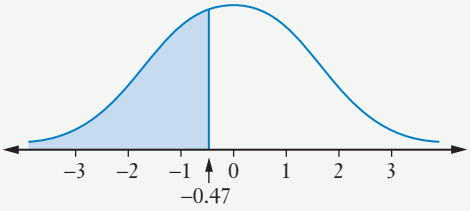
17 **a** 95% **b** 34% **c** 83.85%
d 90.5% **e** 25.86%

18 **a** $a = \dfrac{1}{e^5 - 1}$ **b** $a = \dfrac{1}{e(e^3 - 1)}$

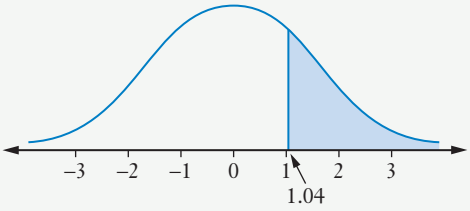
19 **a**



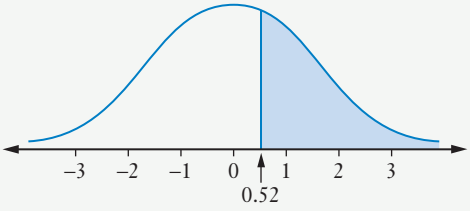
b



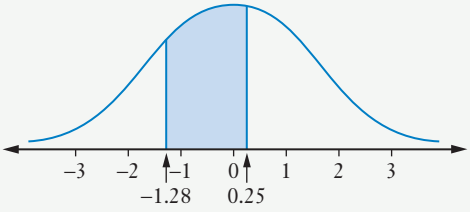
c



d



e



20 **a** 8 **b** 1.5 **c** 2

21 **a** 0.83 **b** 1 **c** Klare

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22 $F(x) = \frac{1}{600}\left[\frac{x^4}{4}\right]_1^7 = 1$ so PDF

23 **a** **i** 2.5 **ii** −1.5
b **i** 1.12 m **ii** 1.06 m
iii 1.16 m **iv** 1.09 m
v 1.13 m

24 89.98

25 49.17

Challenge exercise 10

1 $a = 1, b = 5$

2 $\mu = 13.2, \sigma = 0.4$

3 0

4 $F(x) = \frac{(x^2+1)^3 - 1000}{124000}$

5 Mean 18.9, standard deviation 3.5

6 Show area is 1.

Practice set 4

1 A **2** B **3** C **4** B **5** C

6 **a** $\frac{1}{3}e^{3x} + C$ **b** $2x^2 - 3x + C$
c $\frac{1}{4}\tan 4x + C$ **d** $\ln|x - 3| + C$

7 **a** \$40 995.50 **b** \$745.60

8 \$945

9 2.4 m

10 **a** $F(x) = \frac{x^3 - 1}{342}$
b **i** $\frac{62}{171}$ **ii** $\frac{7}{342}$ **iii** $\frac{158}{171}$
iv $\frac{31}{38}$ **v** $\frac{21}{38}$
c **i** 5.56 **ii** 6.83

11 **a** 2 **b** 7 **c** 77

12 **a** **i** \$119 000
ii \$117 995
iii \$116 984.98
b **i** See worked solutions.
ii \$99 020.88

13 \$2851.52

14 4.23

15 $\frac{8}{45}$

16 (−1, 9) maximum, (5, −99) minimum, (2, −45) point of inflection

17 \$180.76

18 **a** 3.9 L to 5.5 L **b** 68%
c **i** 3.25 **ii** 1.25
iii −2 **iv** −1.5
d **i** 0.9994 **ii** 0.0228
iii 0.9332 **iv** 0.1056
v 0.8716
e **i** 73.33%
ii 78.88%
iii 99.4%

19 **a** \$460.50 **b** \$449
c \$1084.54 **d** \$28.49

20 **a** $F(x) = \frac{(x+2)^3 - 8}{335}$
b $F(x) = \frac{x^4 - 1}{624}$
c $F(x) = 2\sin x$

21 2

22 **a** 0.9115 **b** 0.8106
c 0.1587 **d** 0.0207
e 0.9966

23 2nd exam

24 \$277.33

25 [1, 6]

26 **a** 13.02 **b** 10.55
c 16.348 **d** 8.6

27 8

28 18.5

29 **a** 5%, reject cans below 349.4 and above 350.2 mL
b 0.3%, reject cans below 349.2 and above 350.4 mL

30 **a** \$2748.78 **b** \$2751.11 **c** \$2751.63

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