

Answers

Chapter 1 Exercise 1

- 1 a 135° b 20° c 72° d 150° e 105° f 22.5° g 110° h 114.6° i 85.9° j 229.2° k 206.3° l 22.9°
 2 a $\frac{\pi}{6}$ b $\frac{7\pi}{6}$ c $\frac{3\pi}{4}$ d $\frac{7\pi}{4}$ e $\frac{4\pi}{3}$ f $\frac{7\pi}{18}$ g $\frac{2\pi}{5}$ h $\frac{3\pi}{10}$ 3 a 0.611 b 1.75 c 5.24 d 1.40 e 2.30 f 4.85
 4 a 30.7cm^2 b 4.71m^2 c 489cm^2 d 2430cm^2 5 a 6.28cm b 8.55m c 295cm d 113mm
 6 a 66.8cm b 293cm c 177mm 7 a 126cm b 2670cm^2 8 52.2cm^2 9 46.9m^2 10 200°
 11 9.30cm 12 30cm 13 99.5cm 14 7:2 15 a 17.9cm b 99.1cm^2

Chapter 1 Exercise 2

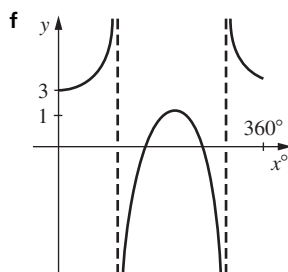
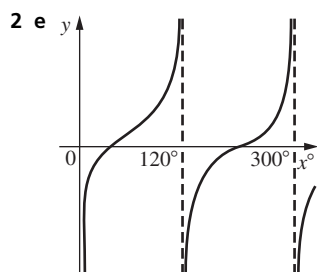
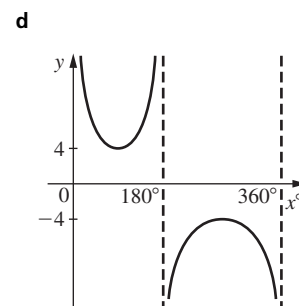
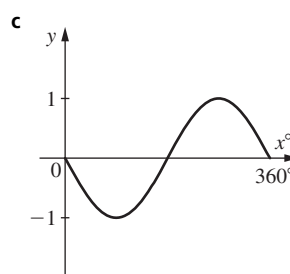
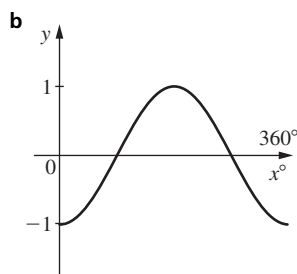
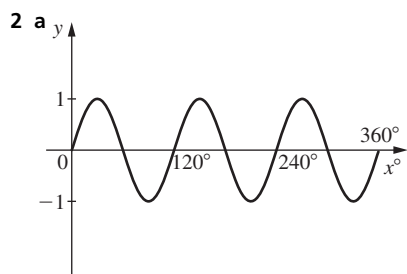
- 1 a $\frac{1}{2}$ b 0.174 c $-\frac{1}{\sqrt{2}}$ d -0.996 e $\frac{\sqrt{3}}{2}$ f $\frac{1}{\sqrt{2}}$ g $-\frac{\sqrt{3}}{2}$ h -0.737
 2 a $\frac{1}{2}$ b $\frac{1}{2}$ c 1 d $\frac{\sqrt{3}}{2}$ e $\frac{1}{2}$ f $\frac{1}{\sqrt{2}}$ g $\frac{1}{\sqrt{2}}$ h 0 i -1 j 0
 3 a $x^\circ = 30^\circ, 150^\circ$ b $x^\circ = 70.5^\circ, 289.5^\circ$ c $x^\circ = 41.8^\circ, 138.2^\circ$ d $x^\circ = 80.4^\circ, 279.6^\circ$ e $x^\circ = 22.0^\circ, 158.0^\circ$ f $x^\circ = 55.2^\circ, 304.8^\circ$
 4 a $\theta = \frac{\pi}{3}, \frac{5\pi}{3}$ b $\theta = \frac{\pi}{3}, \frac{2\pi}{3}$ c $\theta = \frac{\pi}{4}, \frac{3\pi}{4}$ d No Solution e $\theta = \frac{\pi}{6}, \frac{11\pi}{6}$ f $\theta = 0.290, 2.85$ g $\theta = 1.20, 5.08$ h $\theta = 0.775, 2.37$

Chapter 1 Exercise 3

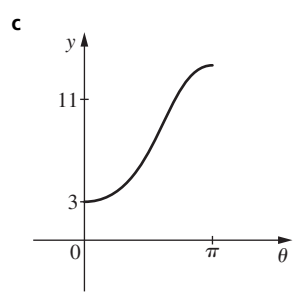
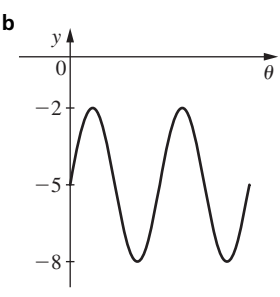
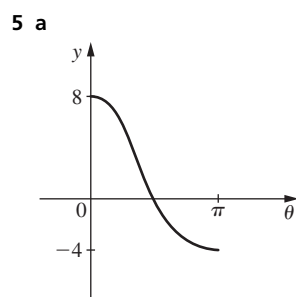
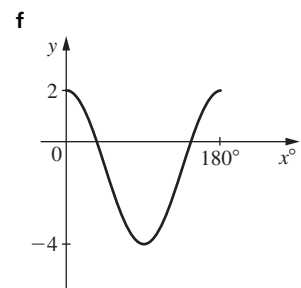
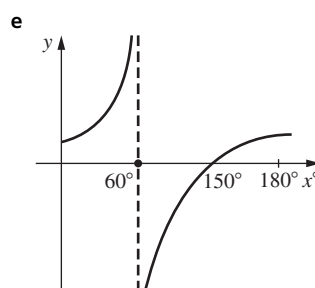
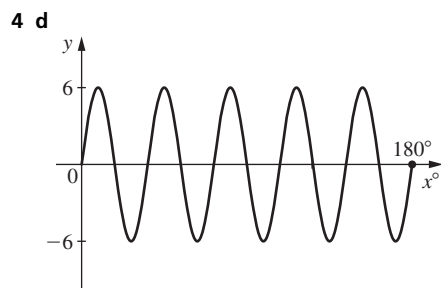
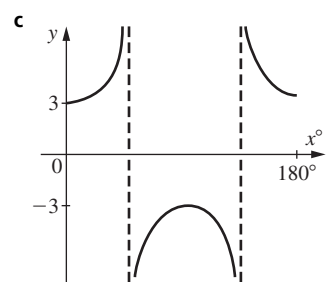
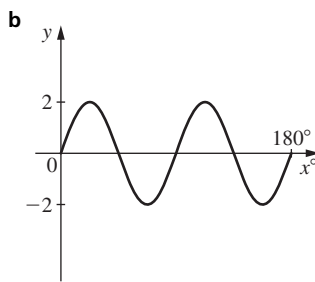
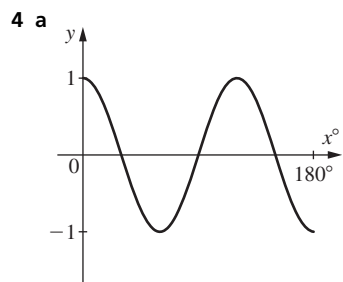
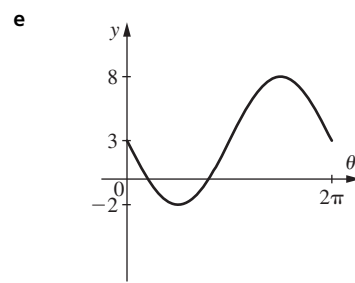
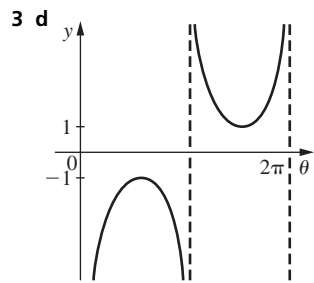
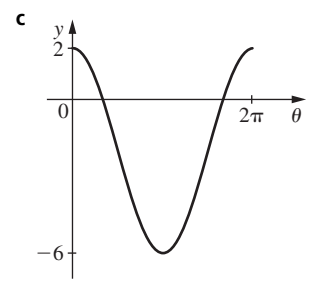
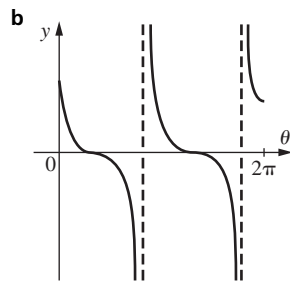
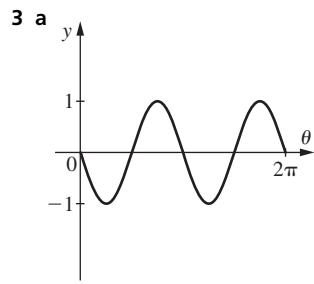
- 1 a 24cm^2 b 20.7cm^2 c 160cm^2 d 26.0m^2 2 8220m^2 3 a 84.9cm^2 b 120cm^2 4 63.7m^3
 5 311m^2 6 a $x = 5.82\text{cm}$ b $x = 6.37\text{cm}$ c $x = 7.64\text{m}$ d $n = 7.35\text{m}$ e $a = 14.2\text{mm}$
 7 a $x^\circ = 32.4^\circ$ b $x^\circ = 127.7^\circ$ 8 44.7° or 135.3° 9 10.75° or 169.25°
 10 a $x = 6.07\text{cm}$ b $x = 22.7\text{m}$ c $p = 381\text{mm}$ d $t = 10.7\text{cm}$ 11 2.63m 12 a 59.6° b 143.2° 13 68.7°
 14 $A = 39.4^\circ, B = 46.5^\circ, C = 94.1^\circ$ 15 a $x = 7.64\text{m}$ b $x^\circ = 50.9^\circ$ c $x^\circ = 83.8^\circ$ d $x = 15.8\text{cm}$ e $x = 16.9\text{m}$
 16 312km 17 21.6m 18 57.9° 19 204cm^2

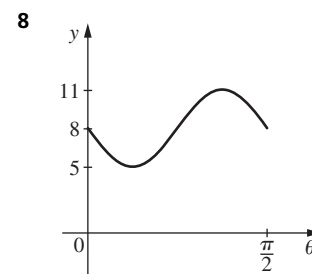
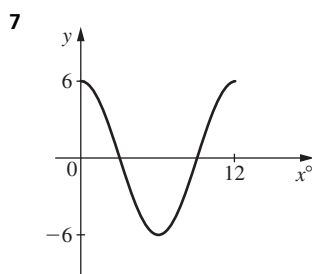
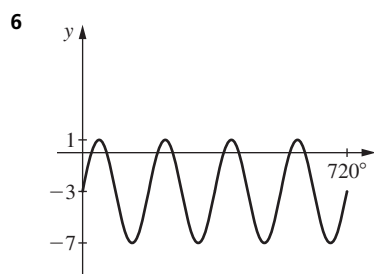
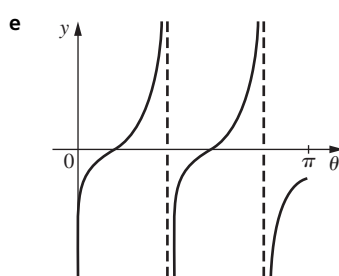
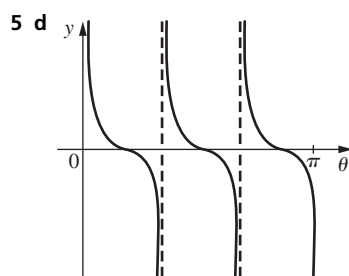
Chapter 1 Exercise 4

- 1 a 180° b 120° c $\frac{\pi}{2}$ d 90° e 360° f 120° g 180° h $\frac{\pi}{2}$ i 36° j 3°



Answers





9 a $y = 4 \cos 2\theta$ b $y = \sin x^\circ + 1$ c $y = \tan 2\theta$ d $y = -4 \cos x^\circ + 2$ e $y = -4 \sin 2\theta + 4$ f $y = -\frac{7}{2} \cos 4x^\circ - \frac{7}{2}$

9 g $y = -\cot(15x^\circ - 45^\circ)$ h $y = 3 \sin 24\theta + 8$ i $y = 2 \csc 3x^\circ$ j $y = 3 \sec \frac{3}{2}\theta$

Chapter 1 Exercise 5

1 a $-\frac{1}{2}$ b -1 c $\frac{1}{2}$ d $\frac{1}{2}$ e 1 f $-\frac{\sqrt{3}}{2}$ g $-\sqrt{3}$ h $-\frac{\sqrt{3}}{2}$ i $\frac{\sqrt{3}}{2}$ j $-\frac{\sqrt{3}}{2}$

2 a $\frac{1}{\sqrt{3}}$ b $\frac{1}{\sqrt{2}}$ c $\frac{\sqrt{3}}{2}$ d $-\sqrt{3}$ e $-\frac{1}{\sqrt{2}}$ f $-\frac{1}{\sqrt{3}}$ g 0 h $-\frac{\sqrt{3}}{2}$ i 1 j $4\sqrt{3}$

3 a $\sin 43^\circ$ b $\cos 50^\circ$ c $\tan 20^\circ$ d $-\sin 50^\circ$ e $-\cos 23^\circ$ f $-\tan 34^\circ$ g $-\cos 15^\circ$ h $-\sin 20^\circ$ i $-\tan 46^\circ$

4 a $x^\circ = 30^\circ, 150^\circ$ b $x^\circ = 30^\circ, 330^\circ$ c $x^\circ = 60^\circ, 240^\circ$ d $x^\circ = 135^\circ, 315^\circ$

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

Chapter 1 Exercise 6

1 a $60^\circ, 240^\circ$ b $60^\circ, 300^\circ$ c $60^\circ, 120^\circ$ d $210^\circ, 330^\circ$ e $150^\circ, 210^\circ$ f 180° g 90° h $30^\circ, 150^\circ$ i $45^\circ, 225^\circ$

2 a $\frac{\pi}{6}, \frac{11\pi}{6}$ b $\frac{7\pi}{6}, \frac{11\pi}{6}$ c $\frac{5\pi}{6}, \frac{11\pi}{6}$ d $\frac{\pi}{4}, \frac{5\pi}{4}$ e $\frac{\pi}{6}, \frac{5\pi}{6}$ f $\frac{\pi}{6}, \frac{7\pi}{6}$ g $\frac{\pi}{2}, \frac{5\pi}{6}$ h $\frac{\pi}{6}, \frac{11\pi}{6}$

3 a $15^\circ, 75^\circ, 195^\circ, 255^\circ$ b $10^\circ, 110^\circ, 130^\circ, 230^\circ, 250^\circ, 350^\circ$ c $11.25^\circ, 56.25^\circ, 101.25^\circ, 146.25^\circ, 191.25^\circ, 236.25^\circ, 281.25^\circ, 326.25^\circ$

3 d $60^\circ, 120^\circ, 240^\circ, 300^\circ$ e $25^\circ, 45^\circ, 145^\circ, 165^\circ, 265^\circ, 285^\circ$ f $40^\circ, 80^\circ, 160^\circ, 200^\circ, 280^\circ, 320^\circ$

4 a $\frac{\pi}{12}, \frac{5\pi}{12}, \frac{7\pi}{12}, \frac{11\pi}{12}, \frac{13\pi}{12}, \frac{17\pi}{12}, \frac{19\pi}{12}, \frac{23\pi}{12}$ b $\frac{\pi}{6}, \frac{2\pi}{3}, \frac{7\pi}{6}, \frac{5\pi}{3}$ c $\frac{\pi}{30}, \frac{5\pi}{30}, \frac{13\pi}{30}, \frac{17\pi}{30}, \frac{25\pi}{30}, \frac{29\pi}{30}, \frac{37\pi}{30}, \frac{41\pi}{30}, \frac{49\pi}{30}, \frac{53\pi}{30}$

4 d $\frac{5\pi}{12}, \frac{7\pi}{12}, \frac{17\pi}{12}, \frac{19\pi}{12}$ 5 $15^\circ, 105^\circ$ 6 $\frac{7\pi}{24}, \frac{11\pi}{24}, \frac{19\pi}{24}, \frac{23\pi}{24}$ 7 $1^\circ, 5^\circ, 13^\circ, 17^\circ$ 8 $-120^\circ, 60^\circ$ 9 $-\frac{8\pi}{9}, -\frac{4\pi}{9}, -\frac{2\pi}{9}, \frac{2\pi}{9}, \frac{4\pi}{9}, \frac{8\pi}{9}$

10 a $19.5^\circ, 160.5^\circ$ b $41.4^\circ, 318.6^\circ$ c $58.0^\circ, 238^\circ$ d $48.2^\circ, 311.8^\circ$ e $48.6^\circ, 131.4^\circ$

10 f $31.3^\circ, 288.7^\circ$ g $75.5^\circ, 284.5^\circ$ h $45^\circ, 135^\circ$ i $228.7^\circ, 341.3^\circ$ j $36.9^\circ, 143.1^\circ$

10 k $20.9^\circ, 69.1^\circ, 200.9^\circ, 249.1^\circ$ l $25.2^\circ, 94.8^\circ, 145.2^\circ, 214.8^\circ, 265.2^\circ, 334.8^\circ$

10 m $24.9^\circ, 60.9^\circ, 96.9^\circ, 132.9^\circ, 168.9^\circ, 204.9^\circ, 240.9^\circ, 276.9^\circ, 312.9^\circ, 348.9^\circ$ n $70.5^\circ, 289.5^\circ$

10 o $8.2^\circ, 171.8^\circ$ p $48.2^\circ, 311.8^\circ$ q $33.7^\circ, 213.7^\circ$ r $15^\circ, 75^\circ, 105^\circ, 165^\circ, 195^\circ, 255^\circ, 285^\circ, 345^\circ$ s $1.4^\circ, 4.6^\circ, 13.4^\circ, 16.6^\circ, \dots$

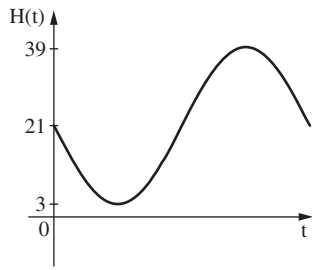
11 a $0.253, 2.89$ b $2.03, 4.25$ c $1.17, 4.31$ d $1.11, 5.18$ e $2.01, 0.08$ f $3.34, 6.08$ g $1.23, 4.37$ h $0.41, 1.68, 2.50, 3.78, 4.60, 5.87$

11 i $1.66, 3.06, 4.80, 6.20$ j $0.47, 1.26, 2.04, 2.83, 3.61, 4.40, 5.18, 5.97$ k $0.28, 0.76, 2.38, 2.86, 4.47, 4.95$ l $1.14, 5.15$ m $3.45, 5.98$

11 n $0.14, 3.28$ o $0.11, 0.67, 1.68, 2.25, 3.25, 3.82, 4.82, 5.39$ 12 $70.5^\circ, 289.5^\circ, 430.5^\circ, 649.5^\circ$ 13 $-\frac{35\pi}{36}, -\frac{19\pi}{36}, -\frac{11\pi}{36}, \frac{5\pi}{36}, \frac{13\pi}{36}, \frac{29\pi}{36}$

Answers

14 a 3 minutes b



14 c i 2 mins 15 secs ii 45 secs 15 a 7500 b 7060 c 12 years, 4500 fish

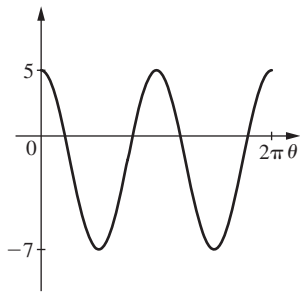
Chapter 1 Review Exercise

1 a 30° b 75° 2 a $\frac{2\pi}{3}$ b $\frac{13\pi}{12}$ 3 7.01cm^2 4 14.0m 5 20.6cm^2

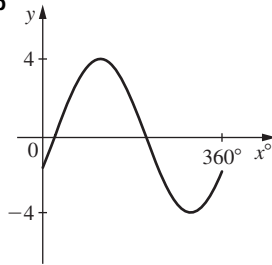
6 a 15.1cm b 44.8° c 48.9° d 8.63mm 7 $2.35 < BC < 5$

8 a $-\frac{1}{2}$ b $\frac{1}{\sqrt{2}}$ c $-\frac{1}{\sqrt{3}}$ d $-\frac{1}{2}$ e $\frac{1}{\sqrt{2}}$ f $-\frac{\sqrt{3}}{2}$ g $\sqrt{3}$ h $-\frac{1}{\sqrt{2}}$ i $-\frac{1}{\sqrt{3}}$ j 2 k $-\frac{2}{\sqrt{3}}$

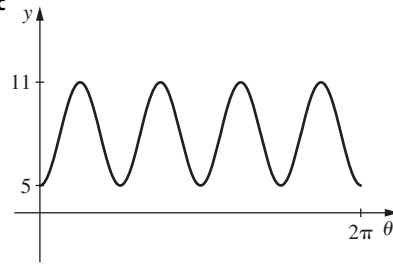
9 a



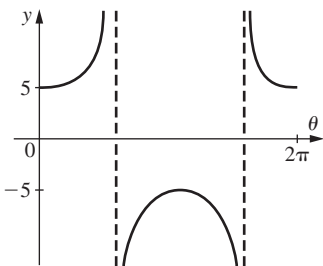
b



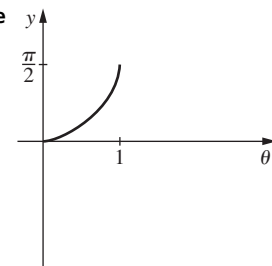
c



9 d



e



10 a $y = -3 \cos 2\theta - 1$ b $y = \frac{5}{2} \cos(x - 20)^\circ + \frac{5}{2}$ 11 a $\theta = \frac{\pi}{6}, \frac{5\pi}{6}$ b $\theta = \frac{5\pi}{6}, \frac{7\pi}{6}$ c $\theta = \frac{\pi}{4}, \frac{5\pi}{4}$

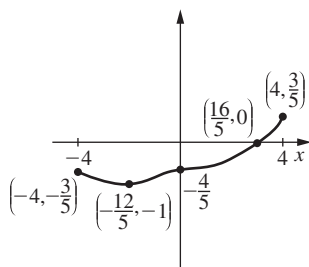
11 d $\theta = \frac{\pi}{12}, \frac{\pi}{6}, \frac{7\pi}{12}, \frac{2\pi}{3}, \frac{13\pi}{12}, \frac{7\pi}{6}, \frac{19\pi}{12}, \frac{5\pi}{3}$ e $\theta = \frac{5\pi}{12}, \frac{11\pi}{12}, \frac{17\pi}{12}, \frac{23\pi}{12}$ 12 a $x^\circ = 135^\circ, 315^\circ$ b $x^\circ = 90^\circ$ c $x^\circ = 210^\circ, 330^\circ$

12 d $x^\circ = 60^\circ, 240^\circ$ e $x^\circ = 15^\circ, 165^\circ, 195^\circ, 345^\circ$ f $x^\circ = 10^\circ, 50^\circ, 130^\circ, 170^\circ, 250^\circ, 290^\circ$

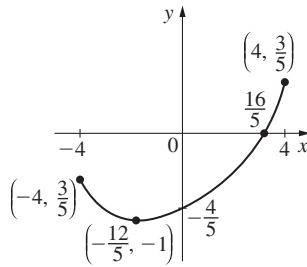
13 a $x^\circ = 64.6^\circ, 295.4^\circ$ b $x^\circ = 109.3^\circ, 160.7^\circ, 289.3^\circ, 340.7^\circ$ c $20.7^\circ, 80.7^\circ, 140.7^\circ, 200.7^\circ, 260.7^\circ, 320.7^\circ$ d $64.6^\circ, 295.4^\circ$

14 $-\frac{\pi}{3}, 0, \frac{\pi}{3}$ 15 $20.9^\circ, 69.1^\circ$ 16 a 14.5cm b 0.169s

17 a



b



c $x = 1.57$

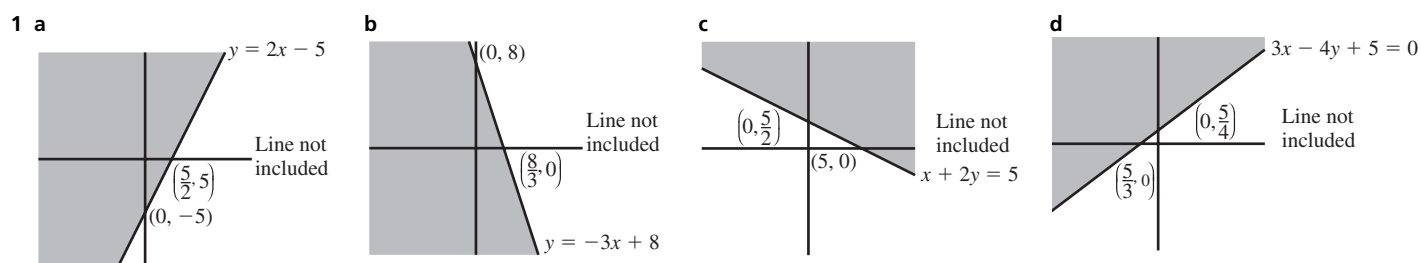
Chapter 2 Exercise 1

- 1 a $x = 4, x = 1$ b $x = 3, x = -2$ c $x = -\frac{1}{2}, x = -8$ d $x = -1, x = 3$
- 2 a $x = 2, x = 5$ b $x = -3, x = 8$ c $x = -4, x = \frac{3}{2}$ d $x = -\frac{3}{2}, x = \frac{2}{3}$ e $x = \frac{2}{3}, x = 3$
- 3 a $x = 4.73, x = 1.27$ b $x = -0.854, x = 5.85$ c $x = -0.314, x = -3.19$ d $x = -0.260, x = -1.54$ e $x = -2.14, x = 0.468$
- 4 a $x = -5.45, x = -0.551$ b $x = -1.61, x = 5.61$ c $x = -1.77, -0.566$ d $x = -3.91, x = 1.41$ e $x = -1.78, x = 0.281$

Chapter 2 Exercise 2

- 1 a $(x+1)^2 + 4$ b $\left(x - \frac{3}{2}\right)^2 + \frac{3}{4}$ c $-\left(x - \frac{3}{2}\right)^2 - \frac{11}{4}$ d $3(x+1)^2 - 11$ e $5\left(x + \frac{7}{10}\right)^2 - \frac{349}{100}$
- 2 a $(x+3)^2 - 5$ Minimum $(-3, -5)$ y intercept: 4 x intercepts: $-0.764, -5.24$
- 2 b $(x-2)^2 - 1$ Minimum $(2, -1)$ y intercept: 3 x intercepts: 3, 1
- 2 c $\left(x + \frac{5}{2}\right)^2 - \frac{17}{4}$ Minimum $\left(-\frac{5}{2}, -\frac{17}{4}\right)$ y intercept: 2 x intercepts: 4.56, 0.438
- 2 d $-(x+2)^2 + 7$ Maximum $(-2, 7)$ y intercept: 3 x intercepts: $-4.65, 0.646$
- 2 e $-(x-4)^2 + 19$ Maximum $(4, 19)$ y intercept: 3 x intercepts: $-0.359, 8.36$
- 2 f $2\left(x + \frac{5}{2}\right)^2 - \frac{47}{2}$ Minimum $\left(-\frac{5}{2}, -\frac{47}{2}\right)$ y intercept: -11 x intercepts: 0.928, -5.93
- 2 g $4\left(x - \frac{3}{8}\right)^2 + \frac{7}{16}$ Minimum $\left(\frac{3}{8}, \frac{7}{16}\right)$ y intercept: 1 x intercepts: none
- 2 h $3\left(x + \frac{5}{6}\right)^2 - \frac{1}{2}$ Minimum $\left(-\frac{5}{6}, -\frac{1}{12}\right)$ y intercept: 2 x intercepts: $-1, -\frac{2}{3}$
- 2 i $-2\left(x - \frac{3}{4}\right)^2 + \frac{23}{8}$ Maximum $\left(\frac{3}{4}, \frac{23}{8}\right)$ y intercept: 4 x intercepts: $-0.851, 2.35$
- 3 a Minimum $(-1.25, -10.125)$ y intercept: -7 x intercepts: $-3.5, 1$
- 3 b Maximum $(2.5, -0.75)$ y intercept: -7 x intercepts: none c Minimum $(-0.6, 14.2)$ y intercept: 16 x intercepts: none
- 3 d Maximum $(0.833, 11.1)$ y intercept: 9 x intercepts: $-1.09, 2.76$

Chapter 2 Exercise 3



- 2 a $x > -\frac{1}{4}$ b $x < 2$ c $x \geq -\frac{1}{5}$ d $x > 3, x < 5$ e $5 < x < 6$ f $-\frac{1}{2} \leq x \leq \frac{3}{4}$ g $3 \leq x \leq \frac{7}{2}$ h $x < -4, x > -3$
- 2 i $-2 < x < -1$ j $-3 \leq x \leq 2$ k $-8 \leq x \leq -\frac{1}{2}$ l $-\frac{4}{3} < x < -\frac{1}{2}$
- 3 a $x < 0.764, x > 5.24$ b $x < -0.854, x > 5.85$ c $x < 0.157, x > 1.59$ d $-2.14 \leq x \leq 0.468$ e $-0.207 \leq x \leq 1.21$

Chapter 2 Exercise 4

- 1 a Imaginary roots b Real distinct roots c Imaginary roots d Real distinct roots e Real equal roots f Imaginary roots
- 2 $p = \pm 28$ 3 $q = \frac{9}{8}$ 5 $a - b - 8ab^3 + 16a^2b = 0$ 7 $p = \frac{1}{2}$ 9 $m = \frac{32}{9}$ 11 a (ii) b (iii) c (i) d (iii)

Chapter 2 Review Exercise

- 1 $4 - (x - 2)^2$ 2 $-1 < x < 3$ 3 $k = 4.08, k = -2.58$ 4 i. $x = \frac{1}{3}, -2, y = \frac{7}{3}, 0$ ii $x = \frac{9}{2}, 6, y = \frac{9}{2}, 3$ 5 $-2.46 < k < 0.458$
 6 $m = \pm 2$ 8 $x = 16, x = 1$ 9 $k \leq 0, k \geq 8$ 10
 $a = \frac{9}{4}, b = \frac{7}{2}$. Maximum point is $(\frac{7}{2}, \frac{9}{4})$. Line of symmetry is $x = \frac{7}{2}$
 11 6 years old 12 $\cos C = \frac{c^2 + 3}{4c}$. True for all real values of c .

Chapter 3 Exercise 1

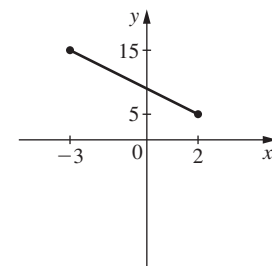
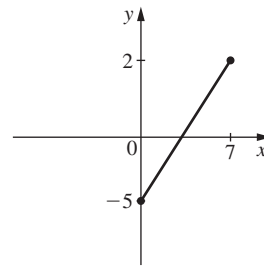
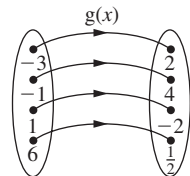
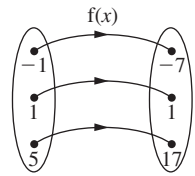
- 1 a 11 b 1 c 130 d 6 2 a -17 b 12 c -27 d $\frac{19}{4}$

3 $\{-7, 1, 17\}$

4 $\{-2, \frac{1}{2}, 2, 4\}$

5 $\{y: -5 \leq y \leq 2\}$

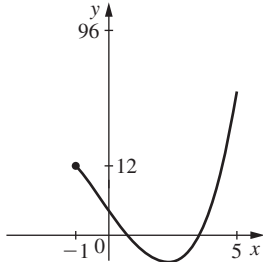
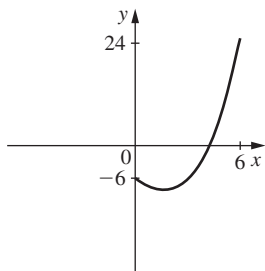
6 $\{y: 5 \leq y \leq 15\}$



7 $\{y: -\frac{25}{4} \leq y \leq 24\}$

8 $\{y: 0.959 \leq y \leq 221\}$

9 $\{y: 5 \leq y < \infty\}$



10 a Domain $\{x: -3 \leq x \leq 2\}$, Range $\{y: -9 \leq y \leq 11\}$

10 b Domain $\{x: 1 \leq x \leq 7\}$, Range $\{y: 2 \leq y \leq 18\}$

10 c Domain $\{x: -2 \leq x \leq 1\}$, Range $\{y: 0 \leq y \leq 4\}$ 11 a $6x - 2$ b $-3x - 2$ c $\frac{3}{x} - 2$ 12 a $4x^2 - 6x$ b $x^2 + 5x + 4$

12 c $36x^2 - 18x$ d $4x^2 - 10x + 4$ 13 a $\frac{-x}{x+2}$ b $\frac{2x}{1-2x}$ c $\frac{1}{2x-1}$ d $\frac{-x-2}{x}$ 14 x

Chapter 3 Exercise 2

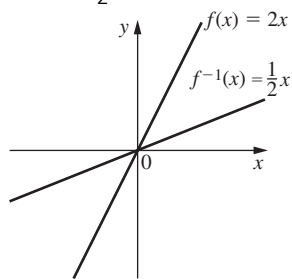
- 1 a 14 b 24 c 2 d $4x + 24$ 2 a 61 b 5 c 46 d $3x^2 - 7$ 3 a $\frac{\pi + 3}{3}$ b $\frac{\sqrt{3}}{2}$ c $\frac{\sqrt{3}}{2}$ d $\sin(\theta + \frac{\pi}{3})$
 4 a i $2x^2 - 1$ ii $(2x - 1)^2$ b i $9x^2 + 30x + 21$ ii $3x^2 - 7$ c i $(x^2 - 6)^3$ ii $x^6 - 6$ d i $\cos(3x^2)$ ii $3 \cos^2 x$
 4 e i $8x^3 + 36x^2 + 52x + 31$ ii $2x^3 - 2x + 17$ f i $(x^2 + 4)^6 - 2(x^2 + 4) + 3$ ii $(x^6 - 2x + 3)^2 + 4$ g i $\sin(2x^2 - 14)$ ii $\sin^2 2x - 7$
 5 a $6x - 3p + 4$ b $6x + 8 - p$ c $p = -2$ 6 a $12x^2 - 3$ b $6(2x - 3)^2$ c $216x^4$ d $4x - 9$ 7 a $\cos(x + \frac{\pi}{2})$ b $\cos x + \frac{\pi}{2}$
 7 c $x + \pi$ d $\cos(\cos(x))$ 8 a i $\frac{2}{3x-2}$ ii $\frac{x+3}{x-3}$ b i $\frac{9-9x}{x^2}$ ii $\frac{3}{x^2-3x}$ c i $\frac{2-3x}{x+1}$ ii $\frac{2-5x}{3-5x}$
 8 d i $\frac{2x}{3-x}$ ii $\frac{3x-1}{2}$ e i $\frac{1}{x+1}$ ii $\frac{2x+4}{x}$ 9 x

Chapter 3 Exercise 3

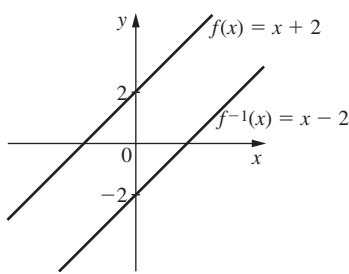
- 1 a yes b no c yes d no 2 a $f^{-1}(x) = \frac{x}{4}$ b $f^{-1}(x) = x + 5$ c $f^{-1}(x) = x - 6$ d $f^{-1}(x) = \frac{3}{2}x$ e $f^{-1}(x) = 7 - x$
- 2 f $f^{-1}(x) = \frac{9-x}{4}$ g $f^{-1}(x) = \frac{x-9}{2}$ h $f^{-1}(x) = (x+6)^{\frac{1}{3}}$ i $f^{-1}(x) = \frac{x^{\frac{1}{2}}}{2}$ 3 a $x \neq 3, x \in \mathbb{R}$ b $x \neq -4, x \in \mathbb{R}$ c $x \neq \frac{1}{2}, x \in \mathbb{R}$
- 3 d $x \geq -5, x \in \mathbb{R}$ e $x \leq 9, x \in \mathbb{R}$ f $x \geq \frac{1}{2}, x \in \mathbb{R}$ g $0 \leq x \leq \pi$ 4 a i $x \neq 6$ ii $f^{-1}(x) = \frac{6x+1}{x}$ b i $x \neq -7$ ii $f^{-1}(x) = \frac{3-7x}{x}$
- 4 c i $x \neq \frac{2}{3}$ ii $f^{-1}(x) = \frac{2x+5}{3x}$ d i $x \neq 2$ ii $f^{-1}(x) = \frac{2x-7}{x}$ e i $x \neq \frac{9}{4}$ ii $f^{-1}(x) = \frac{9x+8}{4x}$ f i $x \neq -\frac{6}{5}$ ii $f^{-1}(x) = \frac{4-6x}{5x}$
- 4 g i $x > 0$ ii $f^{-1}(x) = \sqrt{\frac{x}{6}}$ h i $x > 0$ ii $f^{-1}(x) = \sqrt{x+4}$ i i $x \geq 0$ ii $f^{-1}(x) = \sqrt{\frac{x-3}{2}}$ j i $x \leq 16, x \in \mathbb{R}$ ii $f^{-1}(x) = \sqrt{\frac{16-x}{9}}$
- 4 k i $x \geq 0$ ii $f^{-1}(x) = x^{\frac{1}{2}}$ l i \mathbb{R} ii $f^{-1}(x) = \left(\frac{x+5}{2}\right)^{\frac{1}{3}}$ 5 a $h(x) = 3x - 6$ b $h^{-1}(x) = \frac{(x+6)}{3}$

Chapter 3 Exercise 4

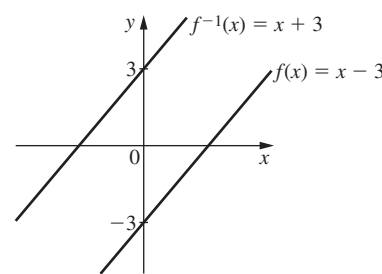
1 a $f^{-1}(x) = \frac{x}{2}$



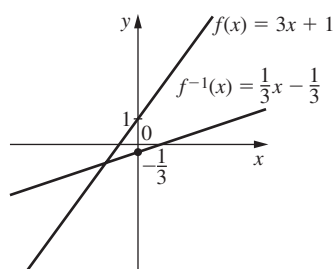
b $f^{-1}(x) = x - 2$



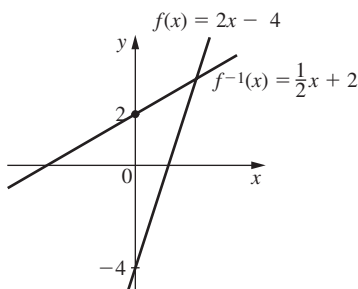
c $f^{-1}(x) = x + 3$



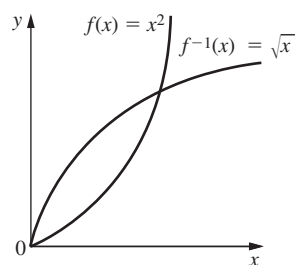
1 d $f^{-1}(x) = \frac{x-1}{3}$



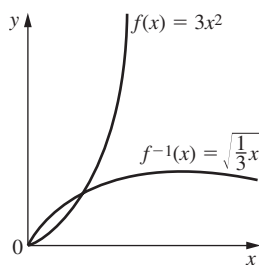
e $f^{-1}(x) = \frac{x+4}{2}$



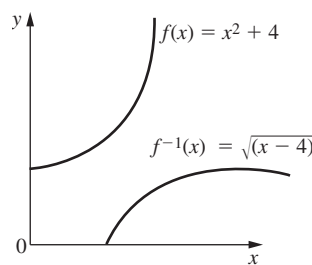
2 a $f^{-1}(x) = \sqrt{x}$



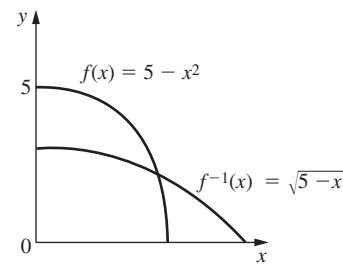
b $f^{-1}(x) = \sqrt{\frac{x}{3}}$



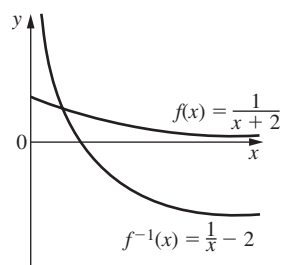
c $f^{-1}(x) = \sqrt{x-4}$



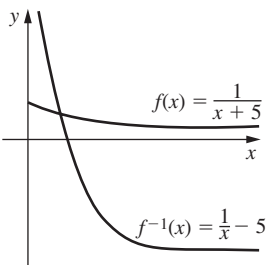
d $f^{-1}(x) = \sqrt{5-x}$



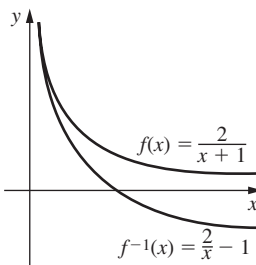
3 a $f^{-1}(x) = \frac{1-2x}{x}$



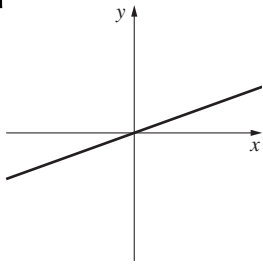
b $f^{-1}(x) = \frac{1-5x}{x}$



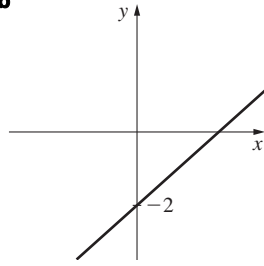
c $f^{-1}(x) = \frac{2-x}{x}$



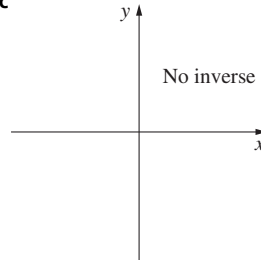
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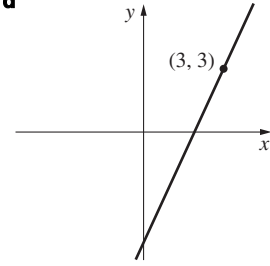
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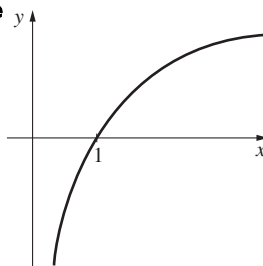
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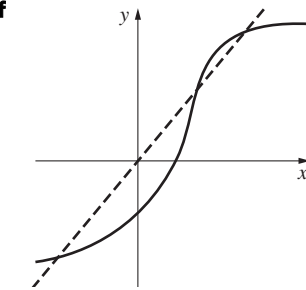
d



4 e



f

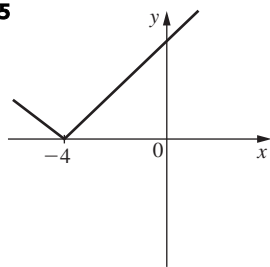


Chapter 3

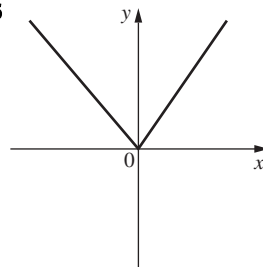
Exercise 5

1 $f(x) = \begin{cases} 2 - x, & x < 2 \\ x - 2, & x \geq 2 \end{cases}$ 2 $f(x) = \begin{cases} -2x - 1, & x < \frac{1}{2} \\ 2x + 1, & x \geq \frac{1}{2} \end{cases}$ 3 $f(x) = \begin{cases} 12 + x - x^2, & -3 < x < 4 \\ x^2 - x - 12, & x \geq 4 \\ 2x^2 - 5x - 3, & x \leq -\frac{1}{2} \end{cases}$ 4 $f(x) = \begin{cases} 3 + 5x - 2x^2, & -\frac{1}{2} < x < 3 \\ 2x^2 - 5x - 3, & x \geq 3 \end{cases}$

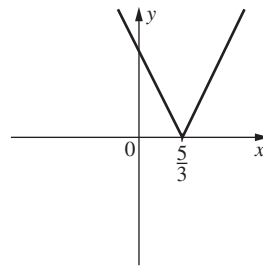
5



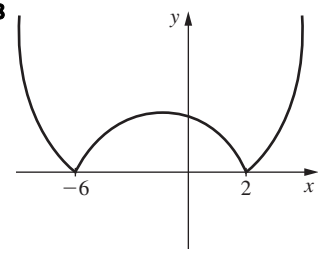
6



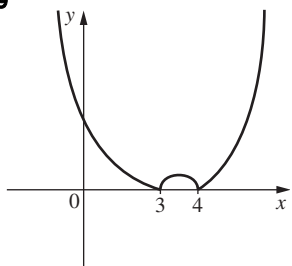
7



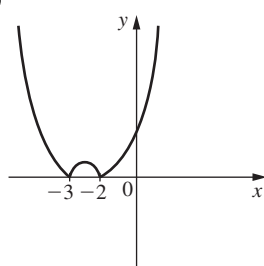
8



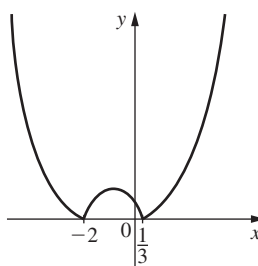
9



10



11



12 $x = -5, x = 1$ 13 $x = 4, x = 6$

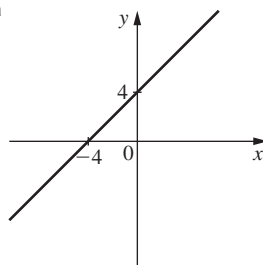
14 $x = -4, x = -1$ 15 $x = 2, x = 5$ 16 $x = -3.37, x = -2.56, x = 1.56, x = 2.37$ 17 $x = -2.91, x = -2, x = \frac{3}{2}, x = 2.41$

18 $-7 < x < 3$ 19 $-4 \leq x \leq 5$ 20 $2 < x < \frac{5}{2}$ 21 $-6.80 \leq x \leq -5, 1 \leq x \leq 2.80$ 22 $-4.72 < x < -3, \frac{1}{2} < x < 2.22$

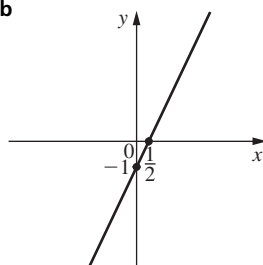
Chapter 3

Exercise 6

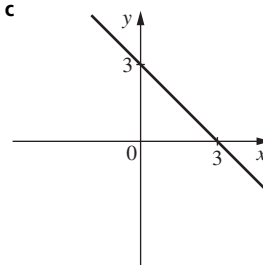
1 a



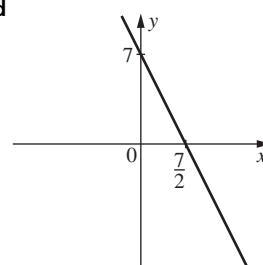
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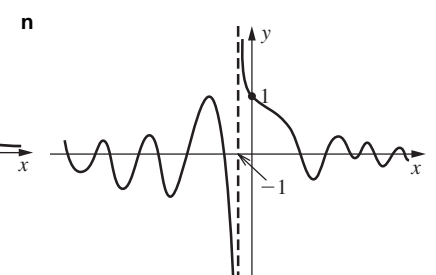
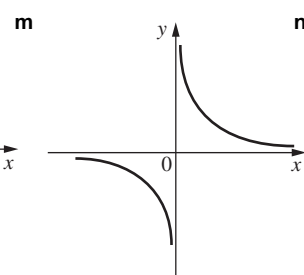
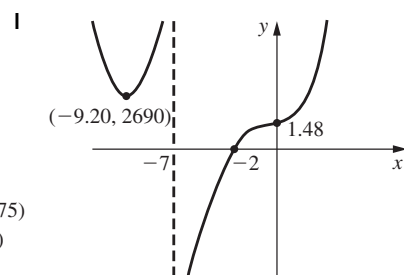
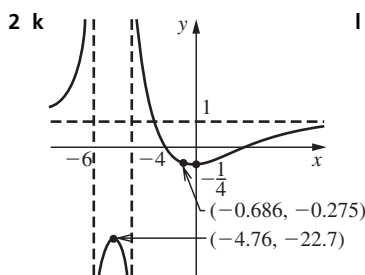
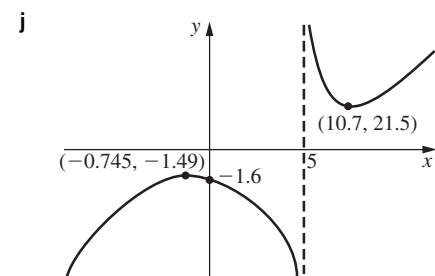
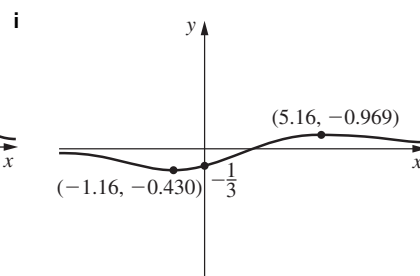
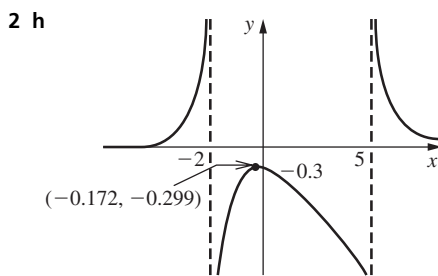
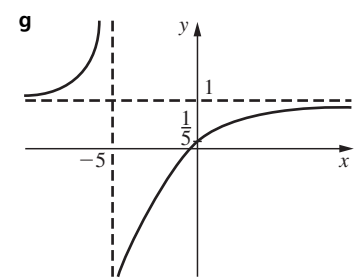
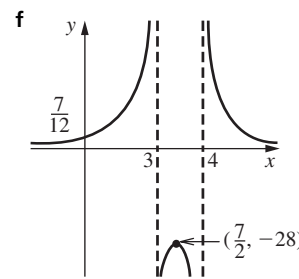
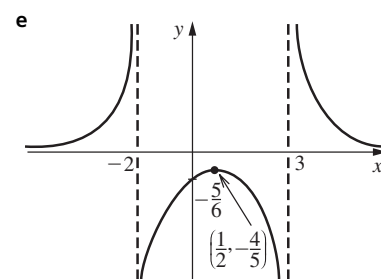
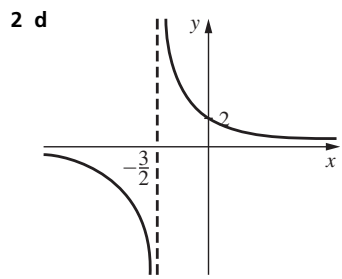
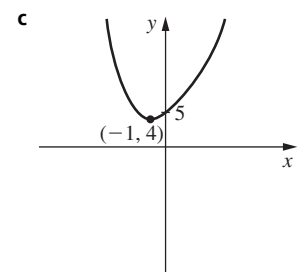
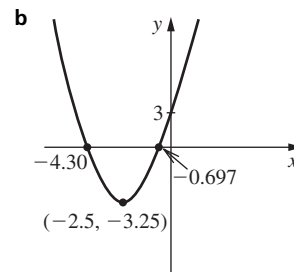
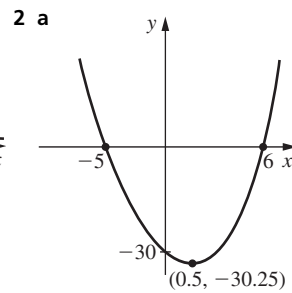
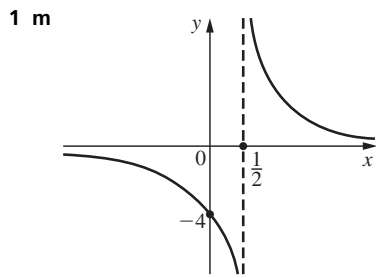
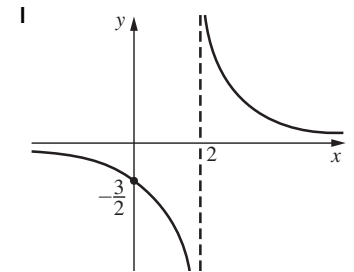
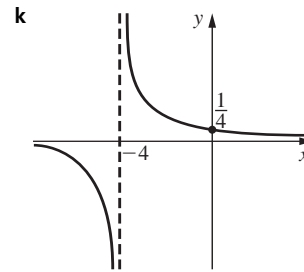
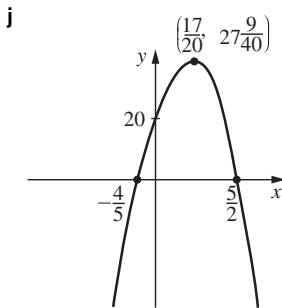
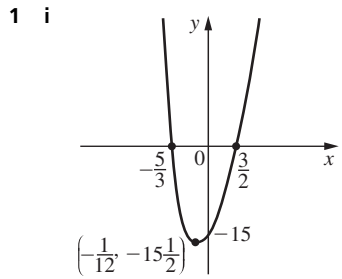
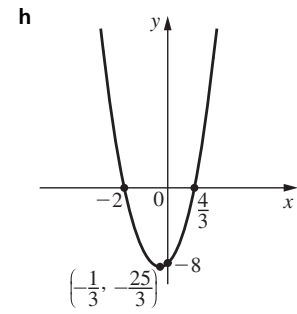
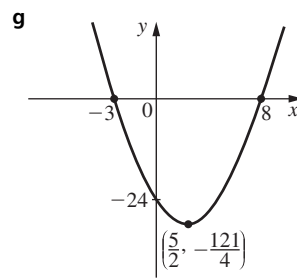
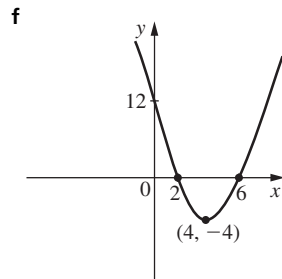
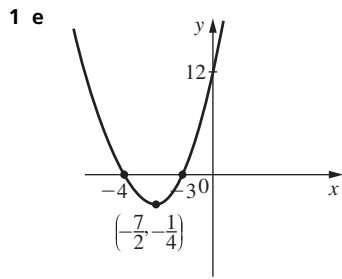


c



d

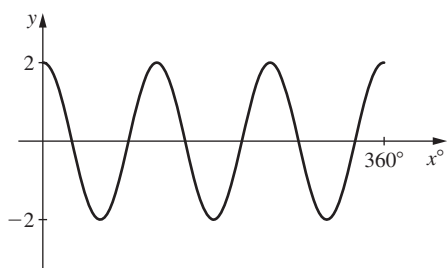




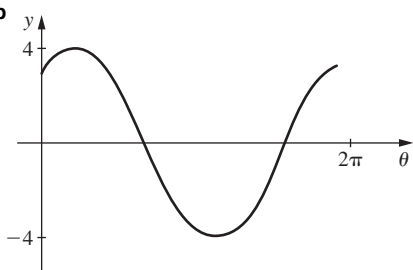
Chapter 3

Exercise 7

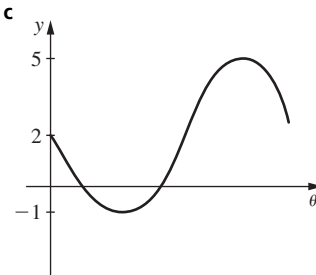
1 a



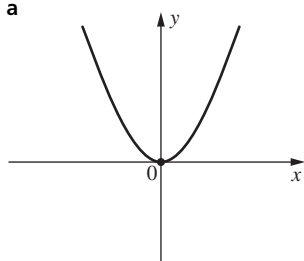
b



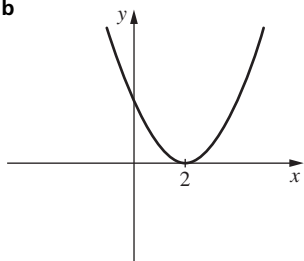
c



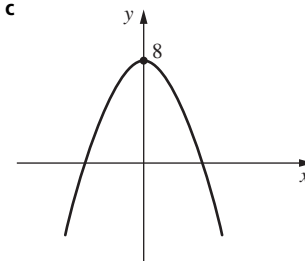
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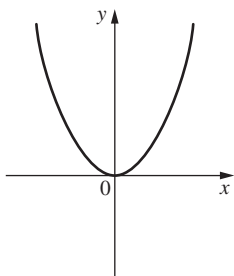
b



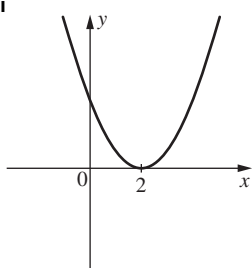
c



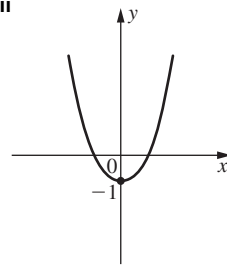
3 a i



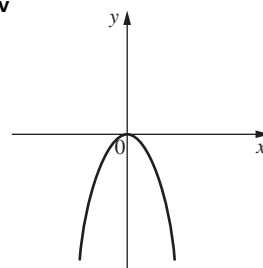
ii



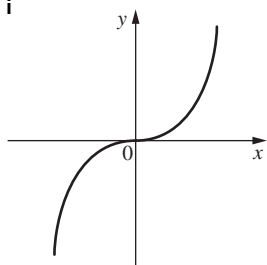
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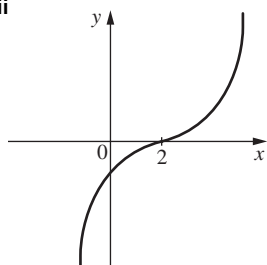
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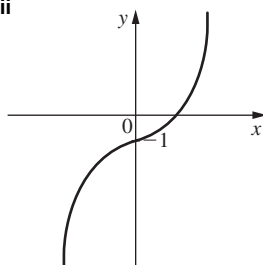
3 b i



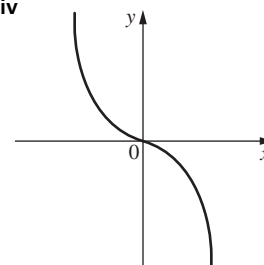
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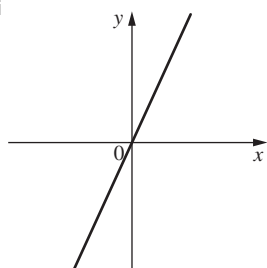
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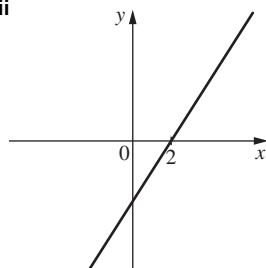
iv



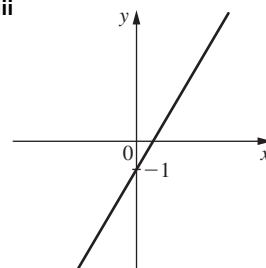
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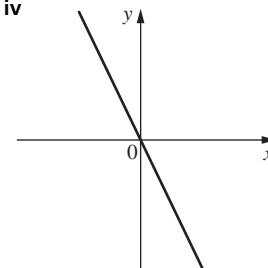
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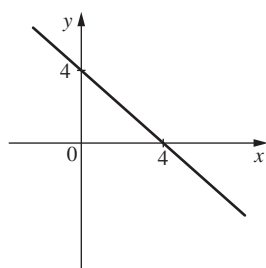
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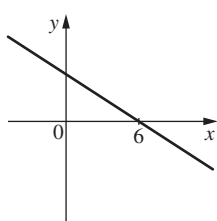
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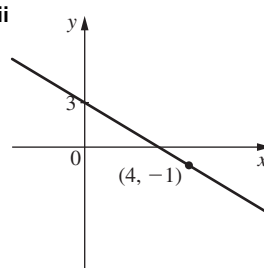
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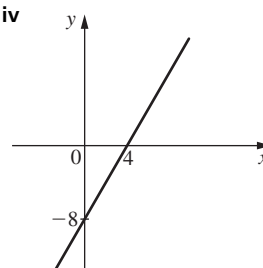
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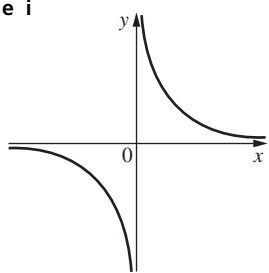
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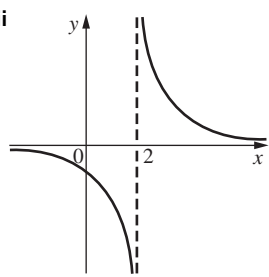
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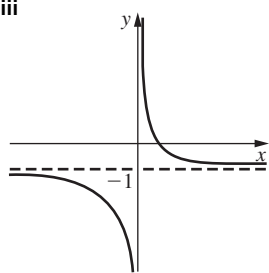
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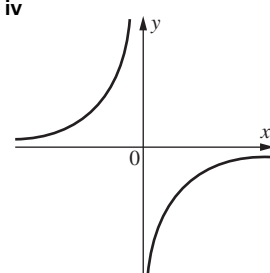
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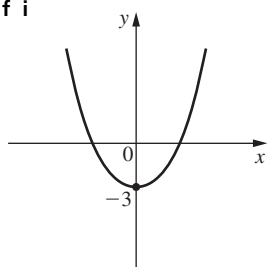
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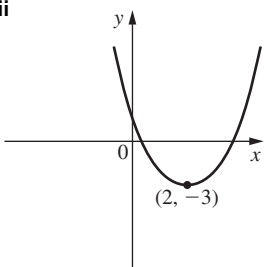
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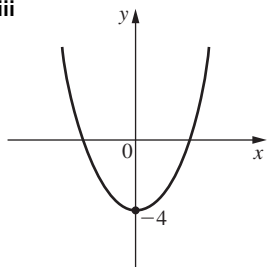
3 f i



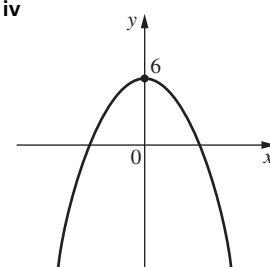
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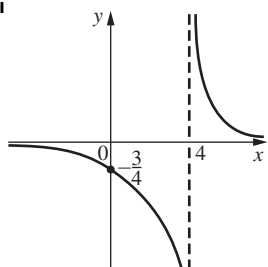
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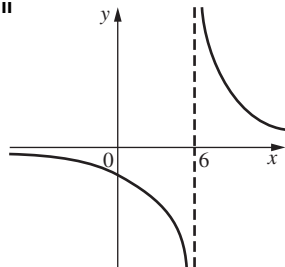
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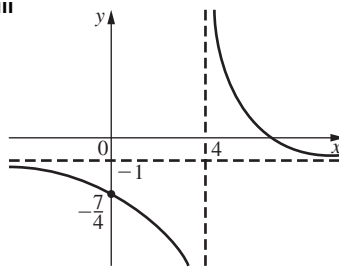
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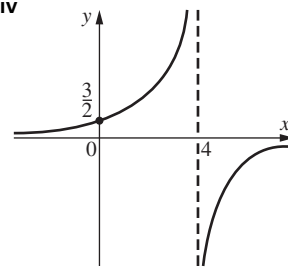
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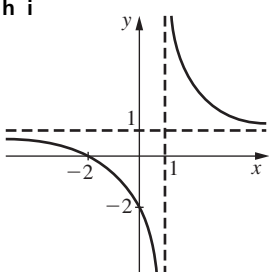
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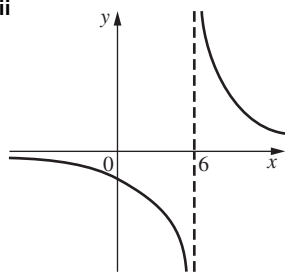
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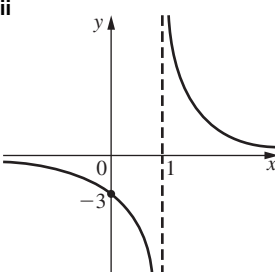
3 h i



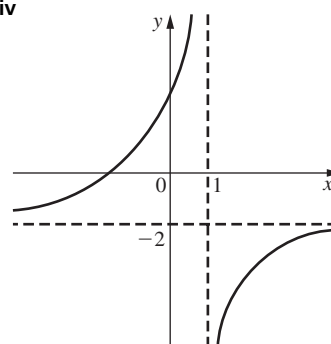
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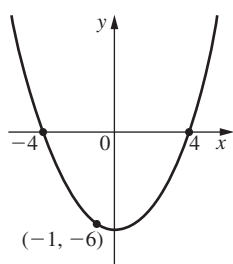


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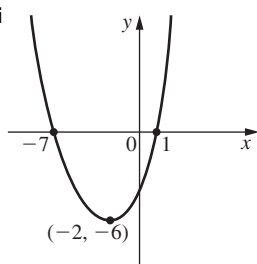


4 a $1 - 2x - x^2$ b $1 - 3x - 3x^2 - x^3$ c $-3x - 1$ d $x - 1$ e $\frac{2x + 1}{x + 1}$ f $4 - 2x - x^2$ g $\frac{2x - 9}{x - 3}$ h $\frac{x - 3}{x}$

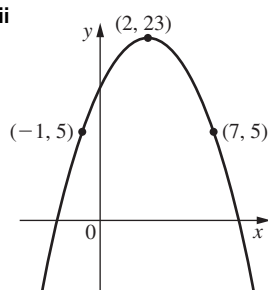
5 a i



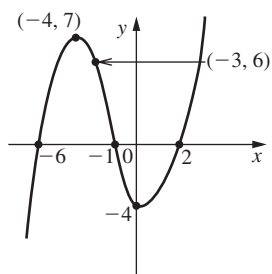
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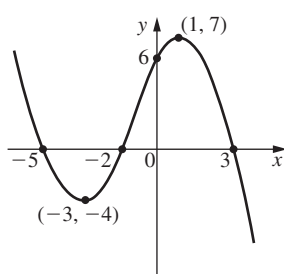
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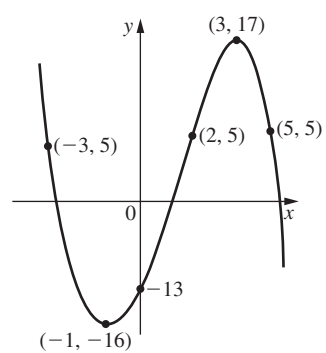
5 b i



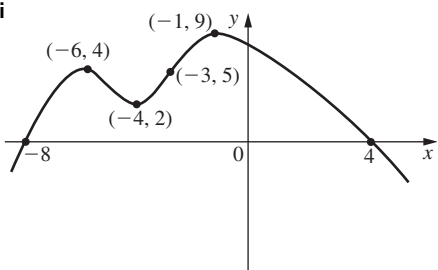
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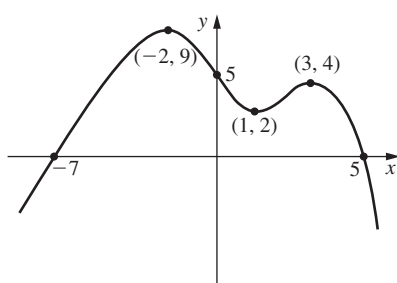
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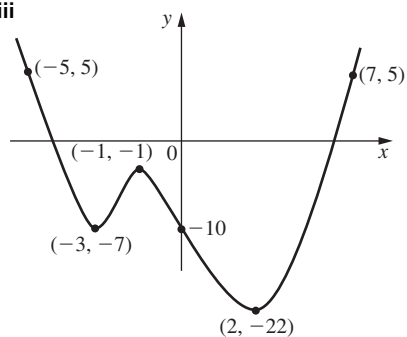
5 c i



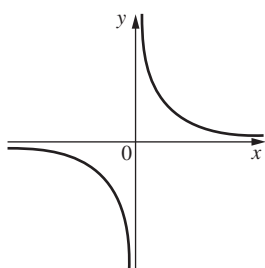
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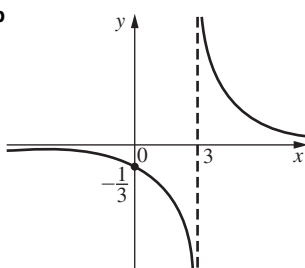
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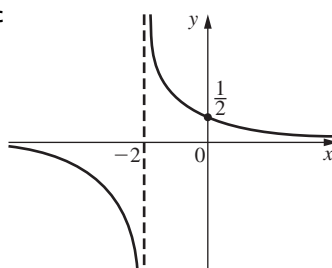
6 a



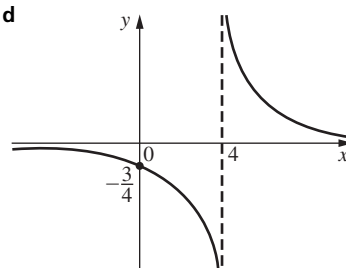
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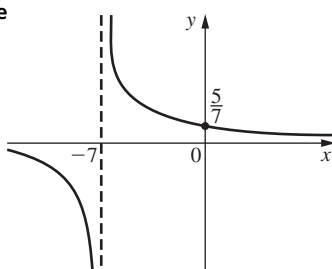
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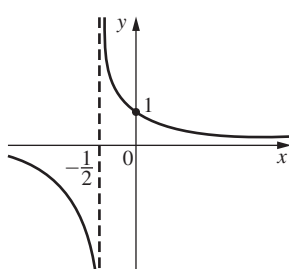
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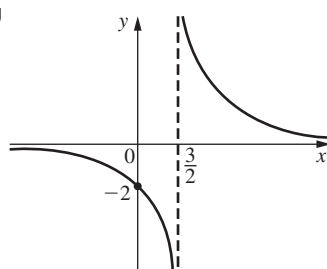
6 e



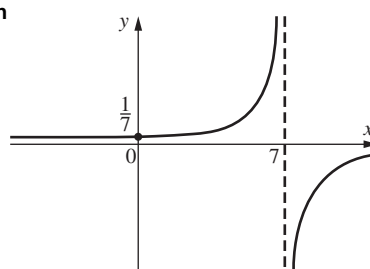
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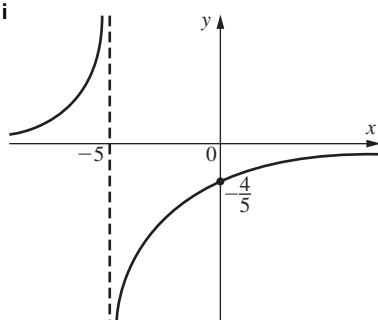
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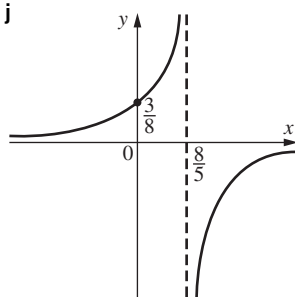
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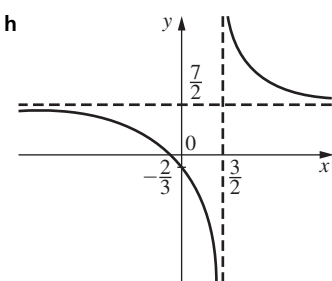
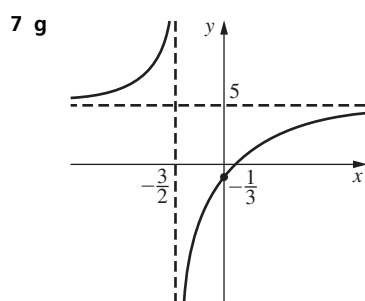
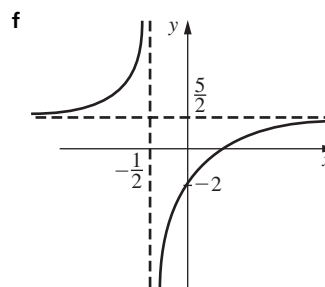
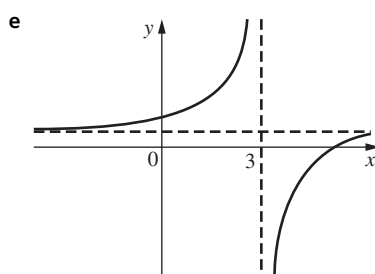
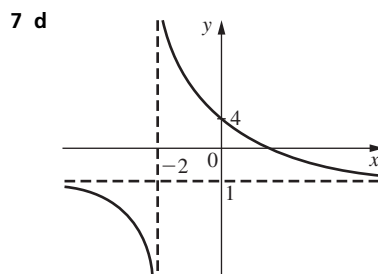
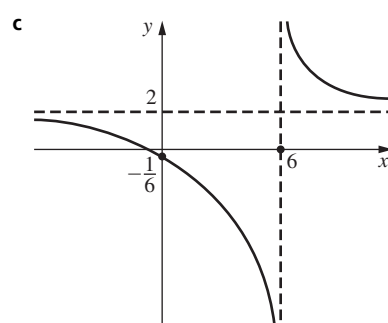
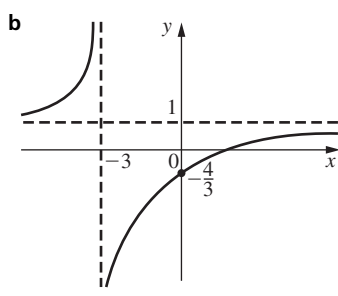
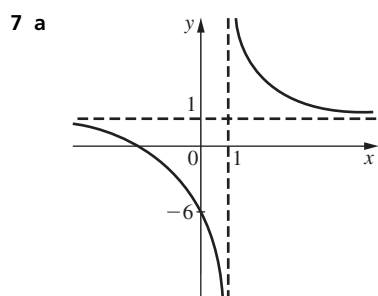


6 i



j

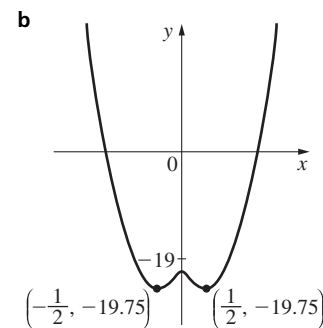
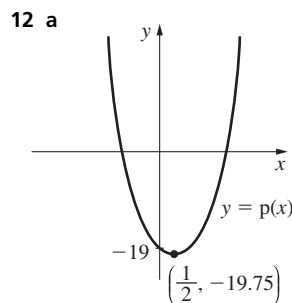
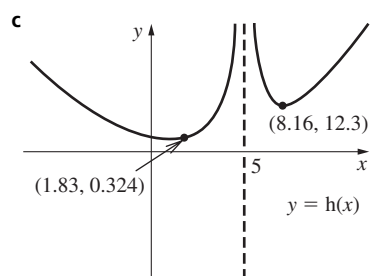
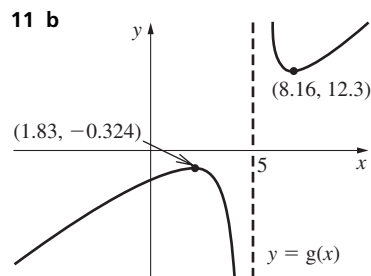
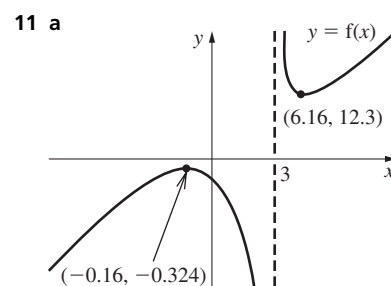
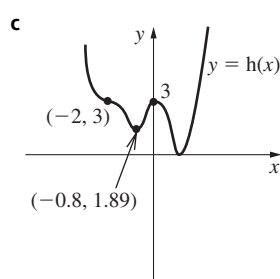
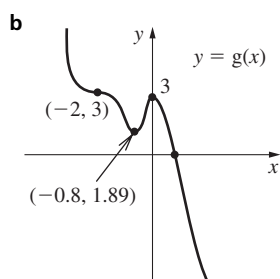
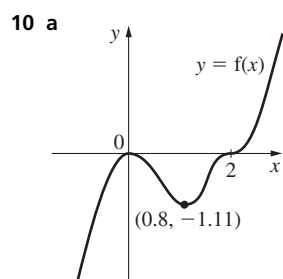




8 a $x = \frac{1}{2}$ **b** $x = \frac{10}{3}$ **c** $x = -\frac{1}{5}$ **d** $x = \frac{2}{3}$ **e** $x = \frac{37}{8}$

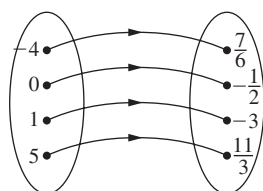
9 a $x > 0$ **b** $x \geq \frac{13}{4}$ **c** $x > 0$ **d** $x > \frac{9}{2}$

9 e $x > \frac{4}{3}$ **f** $x \geq 4$ **g** $x > \frac{7}{4}$ **h** $x > \frac{3}{2}$



Chapter 3 Review Exercise

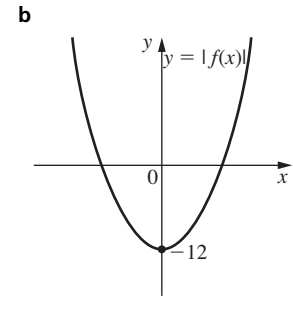
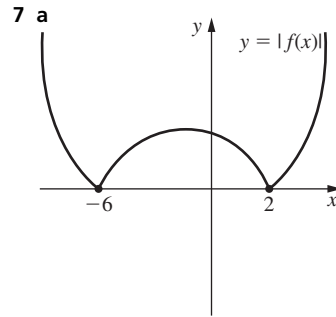
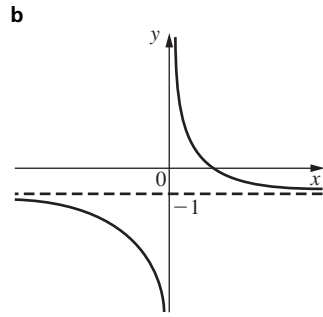
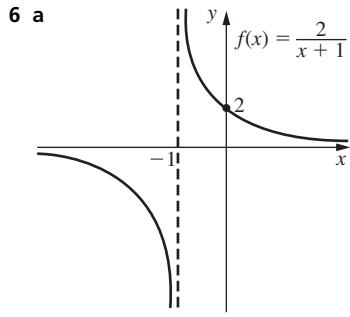
1 $\frac{7}{2}$ **2** $\left\{\frac{7}{6}, -\frac{1}{2}, -3, \frac{11}{3}\right\}$



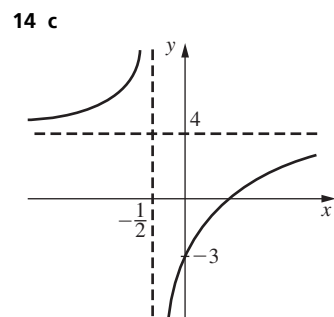
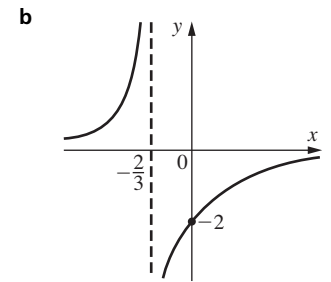
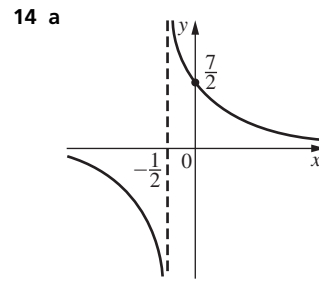
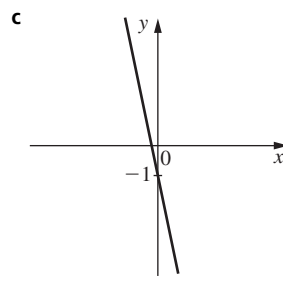
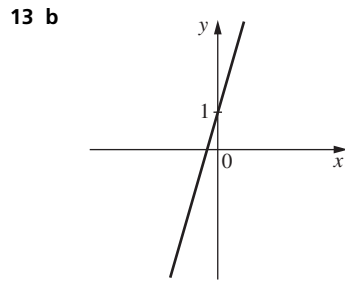
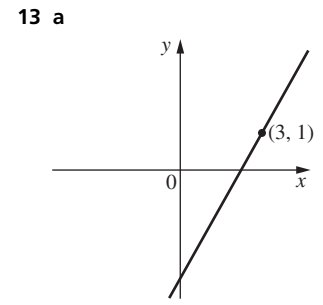
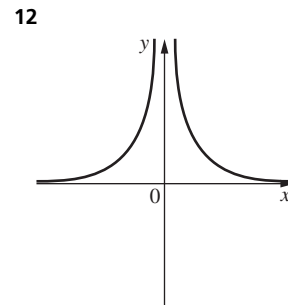
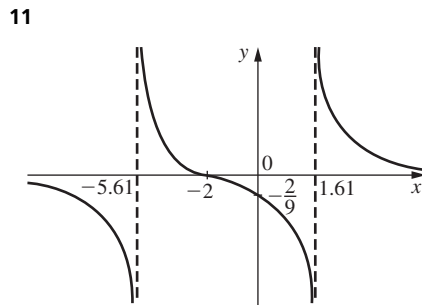
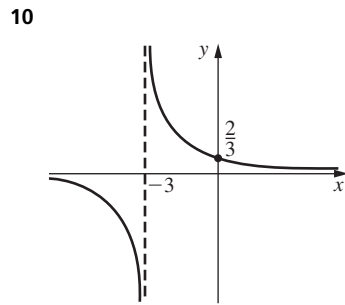
3 a $21x - 4$ **b** $14x - 11$ **c** $\frac{7-4x}{x}$ **4 a** $\frac{5x-8}{x-1}$ **b** $\frac{8-3x}{7-3x}$ **c** $9x - 16$ **d** x

5 a $x > 0, f^{-1}(x) = \sqrt{x+6}$ **b** $x \neq -5, f^{-1}(x) = \frac{1-5x}{x}$ **c** $x \neq -\frac{3}{2}, f^{-1}(x) = \frac{7-3x}{2x}$

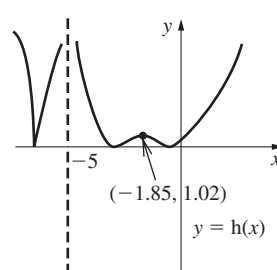
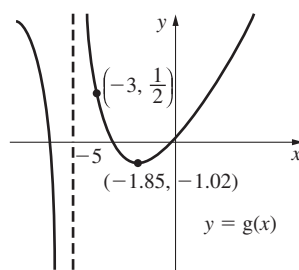
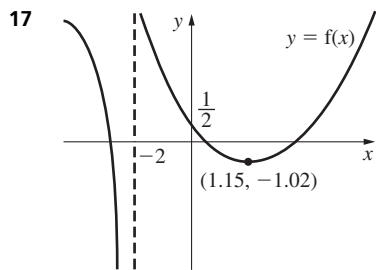
Answers



8 $x = -8, x = -1$ **9** $\frac{4}{5} < x < 2$



15 $x = \frac{19}{15}$ **16** $x \geq \frac{5}{12}$



18 a $-\frac{1}{2} < y < 2$ **b** $f^{-1}(x) = \frac{-2x-1}{x-2}$ **19** $-3 \leq x \leq \frac{1}{3}$ **20** $f^{-1}(x) = \sqrt{\frac{-x-1}{x-1}}$

21 a $x < \frac{1}{\sqrt{2}}$ **b** $0 \leq y < \infty$ **22** $x < -1$ and $x > 4$

Chapter 4 Exercise 1

- 1 14 2 -47 3 21 4 a 51 b 1224 c 674 d -70 5 $\frac{9}{4}$ 6 a $Q(x) = x + 8, R = 13$ b $Q(x) = x^2 - 3x + 2, R = 1$
 6 c $Q(x) = 2x^2 + 13x + 70, R = 427$ d $Q(x) = x^2 + x - 5, R = 11$ e $Q(x) = x^3 - x^2 - 4x + 7, R = 0$
 6 f $Q(x) = \frac{x^4}{2} + \frac{x^3}{4} + \frac{x^2}{8} - \frac{7x}{16} - \frac{87}{32}, R = -\frac{439}{32}$ g $Q(x) = \frac{t^2}{2} - \frac{t}{4} - \frac{27}{8}, R = \frac{99}{8}$ h $Q(x) = -\frac{3x^3}{4} - \frac{7x^2}{16} - \frac{59x}{64} + \frac{177}{256}, R = \frac{2797}{256}$
 7 a $f(x) = (3x - 1)(x - 2)$ b $f(x) = (x^2 + 11x + 47)(x - 5) + 242$ c $f(x) = (4x^2 - 5x + 6)(x + 3) - 35$
 7 d $f(x) = (5x^4 - 20x^3 + 76x^2 - 304x + 1219)(x + 4) - 4878$ e $f(x) = (2x^5 - 2x^4 - 3x^3 + 3x^2 - 3x + 3)(x + 1) + 6$
 7 f $f(x) = \left(\frac{x^2}{2} - \frac{13x}{4} + \frac{3}{8}\right)(2x - 1) - \frac{13}{8}$ g $f(x) = \left(x^3 - \frac{x^2}{2} - \frac{7x}{4} + \frac{7}{8}\right)(2x + 1) + \frac{81}{8}$

Chapter 4 Exercise 2

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

Chapter 4 Exercise 3

- 1 17 2 $\frac{133}{16}$ 3 $p = 24$ 4 $k = 2$ 5 $k = 10, (x - 3)(x - 1)(2x - 1)$ 6 $a = 2, (x + 2)(x - 3)(x + 3)$ 7 $p = 0, q = -1$
 8 $k = -46, (2x + 1)(x - 4)(x + 6)$ 9 $p = 11, q = -21$ 10 $k = 5$

Chapter 4 Exercise 4

- 1 $x = -1, x = -3$ 2 $x = -\frac{1}{2}, x = 6$ 3 $x = -2, x = 5, x = \frac{1}{2}, x = 4$ 4 a $x = -1, x = 3, x = 4$ b $x = -7, x = -2, x = 2$
 4 c $x = -11, x = -3$ d $x = -3, x = -2, x = 4, x = 5$ e $x = -2, x = 4$ f $x = -2, x = \frac{1}{2}, x = 8$ g $x = -\frac{2}{3}, x = \frac{1}{2}, x = \frac{3}{2}$
 5 $x = -2, x = 1, x = 9$ 7 $x = 3$ 8 a $p = 30$ b $x = 2, x = 3, x = 5$ 9 a $k = 83$ b $x = -6, x = \frac{1}{2}, x = 7$
 10 a $1 \leq x \leq 7$ b $2 \leq x \leq 5$ c $0 \leq x \leq 1$ d $3 \leq x \leq 7$ e $\frac{1}{2} \leq x \leq 35$ 11 $6 < t < 10$

Chapter 4 Exercise 5

- 1 $y = x^2 + 3x - 4$ 2 $y = -x^2 + 6x$ 3 $y = 10 + 3x - x^2$ 4 $y = 2x^2 - 4x - 6$ 5 $y = 3x^2 - 12x + 12$ 6 $y = x^3 + 2x^2 - 11x - 12$
 7 $y = \frac{1}{2}x^3 - \frac{3}{2}x^2 - 5x + 12$ 8 $y = -2x^3 + 2x^2 + 28x - 48$ 9 $y = x^4 - 2x^3 - 13x^2 + 14x + 24$
 10 $y = 20x^4 - 180x^3 + 420x^2 + 20x - 600$ 11 $y = -2x^4 + 6x^3 + 18x^2 - 46x + 24$

Chapter 4 Exercise 6

- 3 $x + 3$ 4 $2x + 1$ 5 $3x - 11, 15$ 7 $x + 5 + \frac{-14x - 21}{x^2 + 5}$ 8 $x - \frac{9}{2} + \frac{-30x + 85}{2(x^2 + 7)}$
 9 $3x^3 - 6x^2 + 10x - 20 + \frac{47}{x + 2}$ 10 $2x^3 + 6x + \frac{18x + 13}{x^2 - 3}$ 11 $-\frac{x^3}{2} + \frac{x^2}{4} + \frac{27x}{8} - \frac{67}{16} + \frac{211}{16(2x + 1)}$ 12 $-x^4 + x^2 + 5x - 1 + \frac{12 - 5x}{x^2 + 1}$
 13 $x = -4, x = -3, x = 1, x = 2$ 14 $x = -2, x = 2, x = -6$

Chapter 4 Exercise 7

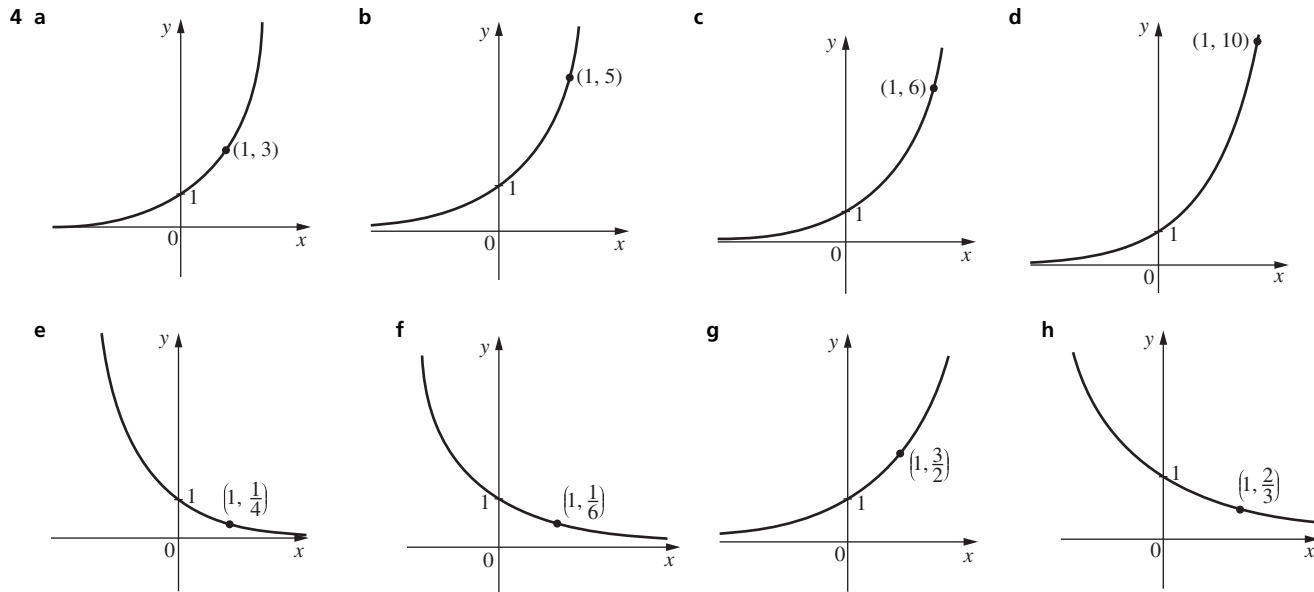
- 1 $x = -1, x = \frac{1}{2}, x = 3$ 2 $x = -7, x = -1, x = -\frac{1}{2}, x = 4$ 3 $x = -2, x = -\frac{1}{2}, x = 3$ 4 $x = 3$ 5 $x = -4.29, x = -0.428, x = 2.72$
 6 $x = 5.50$ 7 $x = 0.388, x = 1$ 8 $x = 4.92, x = 1.02, x = -2.19, x = -3.74$ 9 $x = 10.2, x = 0.203, x = -1.44$
 10 $x = -0.953$ 11 $f(x) = -4x^3 + 10x^2 + 28x - 16, x = -2, x = 0.388, x = 3.86$ 12 $(x + 5)(x - 1)(x - 4)$
 13 $(3x + 4)(3x - 4)(2x - 1)(2x + 1)$ 14 a $x < -6.964$ and $-0.239 < x < 1.203$ b $-3.877 < a < 59.877$
 15 a $-1.575 < x < 2.130$ and $x < -6.556$ b $7.89 < a < 29.1$

Chapter 4 Review Exercise

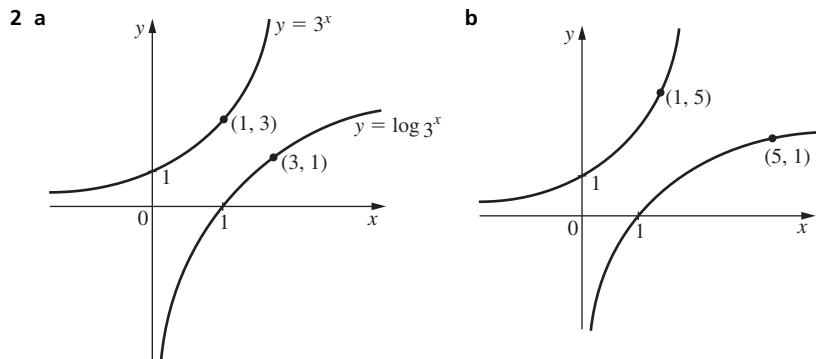
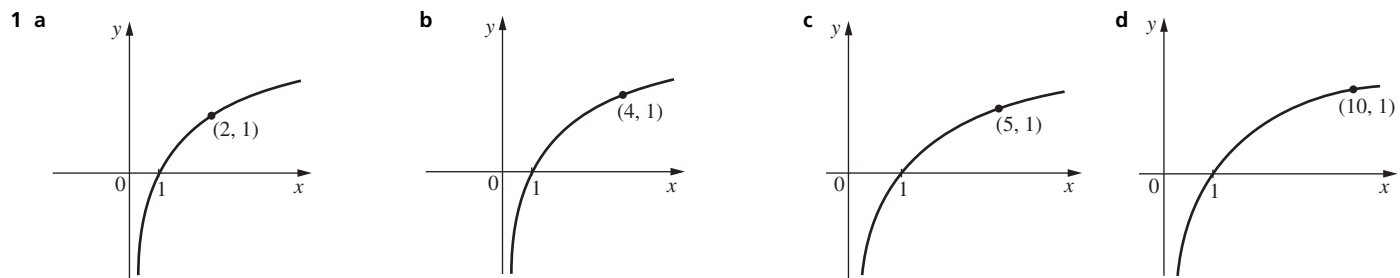
- 1 -35 2 $3x^3 + 4x^2 + 8x + 22 + \frac{45}{x-2}$ 3 $f(x) = \left(x^4 + \frac{x^3}{2} + \frac{x^2}{4} + \frac{17x}{8} + \frac{17}{16}\right)(2x-1) - \frac{95}{16}$ 4 $(x-3), (x-9)$
 5 $f(x) = (2x+3)(x-4)(x+1)$ 6 $g(x) = (2x+1)(x-5)(x+2)(3x-2)$ 7 $k(x) = (x-4)(x+1)(x^2+5)$ 8 $x = -7, x = 3$
 9 $x = -4, x = \frac{1}{2}, x = 1$ 10 $f(x) = 2(x+3)(2x-1)(x-4)^2$ 11 $x = -1.47$ 12 $x = 6.59, x = 2.38, x = -1.97$
 13 $\frac{x^2}{2} - \frac{11x}{4} + \frac{35}{8} - \frac{67}{8(2x-1)}$ 14 $x^2 - 5 + \frac{3x}{x^2+1}$ 15 $a = -\frac{4}{5}, b = -\frac{6}{5}$ 16 $a = -6$ 17 $a = 4$ 18 $k = 6$

Chapter 5 Exercise 1

- 1 a p^9 b p^5 c x^{15} d $21y^5$ e $16x^{12}$ f t^2 g $2p^2$ h $6p^7$ 2 a 4 b 3 c $\frac{1}{10}$ d 1 e 125 f $\frac{1}{3}$ g $\frac{1}{4}$ h $\frac{1}{8}$ i 9
 3 a x^6 b $\frac{4}{3}y^4$ c $10p^{-6}$ d t^2 e $6m^{-\frac{3}{2}}$ f $12x^5 + 15x$ g $2x + 1$ h $x + 2 + x^{-1}$



Chapter 5 Exercise 2



- 3 a 2 b 2 c 2 d 3 e 3 f 5
 3 g 3 h 6 i 2 j 2 k 3 l 1 m 1 n 0
 4 a $\frac{1}{3}$ b $\frac{1}{2}$ c $\frac{1}{2}$ d $\frac{1}{2}$ e $\frac{1}{2}$ f $\frac{1}{6}$
 4 g $\frac{2}{3}$ h $\frac{3}{4}$ 5 a -4 b -3 c -2
 5 d -3 e -4 f $-\frac{1}{3}$ g $-\frac{1}{2}$
 6 a 1 b 2 c $\frac{1}{2}$ d -1 e -1

Chapter 5 Exercise 3

- 1 a $\log_a 18$ b $\log_a 15$ c $\log_a 5$ d $\log_a 64$ e $\log_a 24$ f $\log_a 4$ g $\log_a 32$ h $\log_a 6$ i $\log_a \frac{1}{8}$ j $\log_a 72$ k $\log_a 12$
 2 a $\log_3 15$ b $\log_2 \left(\frac{5}{2}\right)$ c $\log_2 \left(\frac{8}{9}\right)$ d $\log_a \left(\frac{xy^2}{t^3}\right)$ 3 a 2.699 b 2 c 1 d $\frac{1}{2}$ e 2 f 2 g 1 h 0 i -3 j 4 k $-\frac{7}{2}$
 4 a $\log_a 3x^3$ b $\log_a \left(\frac{2}{x}\right)$ c $\log_a(x-1)$ d $\log_a \left(\frac{(x+2)^2}{3}\right)$ 5 a 2 b $\frac{1}{2}$ c $\frac{3}{2}$ d $\frac{2}{3}$ e 2 f $\frac{1}{2} \log_x y = \frac{1}{\log_y x}$ 6 $y = 4x^3$
 7 $y = 9x^4$ 8 $y = px^5$ 10 a $x = 7$ b $x = 57$ c $x = 6$ d $x = 9$ e $x = 8$ f $x = \frac{1}{6}$ g $x = 25$ h $x = 9$
 11 a $x = 2$ b $x = 4$ c $x = 3$ d $x = 63$ e $x = \frac{26}{3}$ f $x = 10$ 12 $S_1 = 400$

Chapter 5 Exercise 4

- 1 a 3 b 0.903 c 1.415 d 0.477 e -0.301 2 a 2.30 b 2.20 c 3.43 d -0.693 e 2.01 f -1.11
 3 a 2 b 3.17 c 2.18 d 2.04 e 2.72 f 1.39 g 1.13 h 1.85 i $-\frac{1}{2}$ j -1.11 k -1.07 l $-\frac{2}{3}$ m -0.226
 3 n -0.209 o 1.07 p 0.824 q -1.49 r -0.513
 4 a b c
 5 a $x = 4, x = 1024$ b $x = \frac{1}{4}, x = \frac{1}{8}$
 5 c $x = \frac{1}{49}, x = 117649$

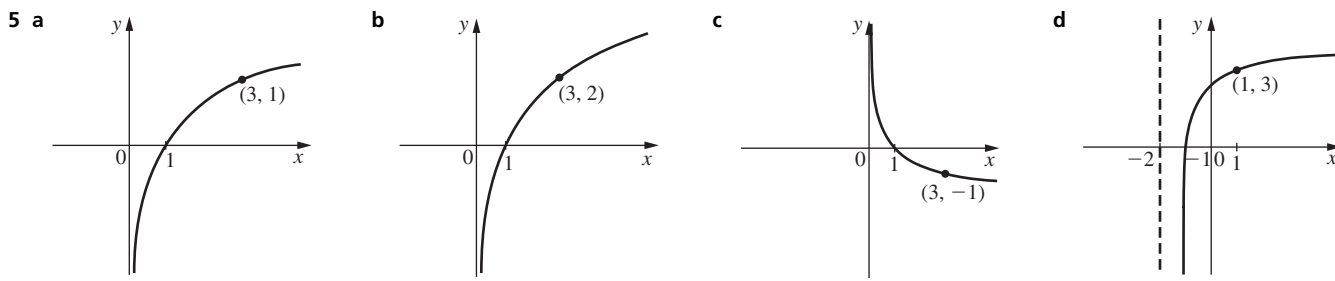
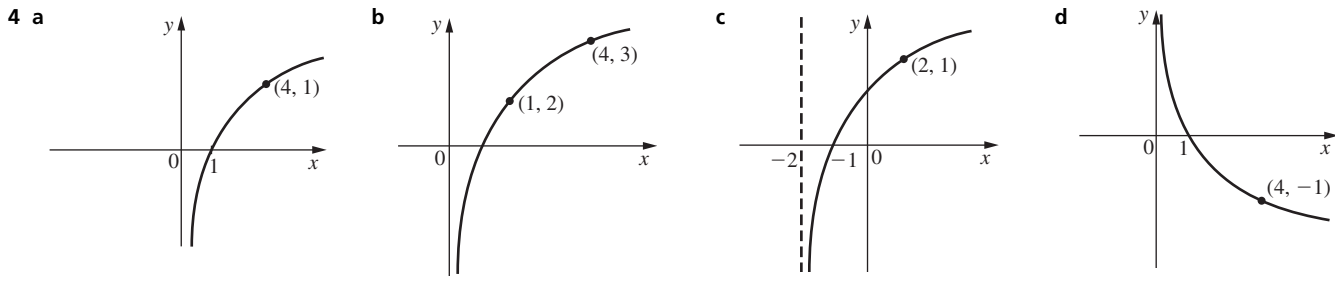
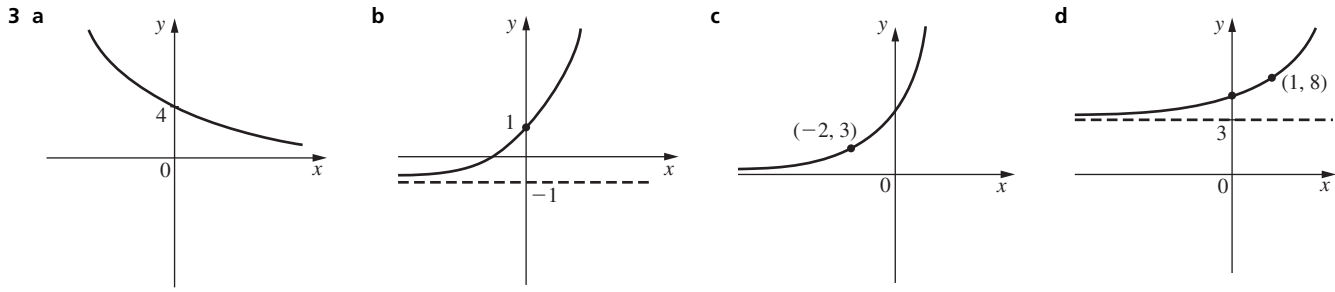
Chapter 5 Exercise 5

- 1 a $x = 8$ b $x = 3.36$ c $x = 1.86$ d $x = 3.53$ e $x = 0.862$ f $x = 0.416$ 2 a $x = 2.48$ b $x = 3.40$ c $x = 5.60$
 2 d $x = 1.50$ e $x = -0.981$ 3 a $x = 8100$ b $x = 7.39$ c $x = 22000$ d $x = 8890000$ e $x = 1.22$
 4 a $x = 9$ b $x = 6$ c $x = 4$ d $x = 6$ 5 a 40 b 132 c 3.84 days 6 37.8 months 7 a 80°C b 10.8 mins
 8 a 2100g b 1650g c 57.8 years 9 a 20100 km b 22.7 years 10 a 220 b 57 c 2027
 11 a $k = 0.0133$ b 67.2 hours c 9.6 hours longer 12 a $k = 0.0114$ b 60.6 years 13 $\frac{\ln \frac{4}{3}}{\ln 6}$ 14 $\frac{\ln 2}{\ln 6}$ 15 $\frac{\ln \frac{2}{5}}{\ln 5}$ 16 $\frac{\ln \frac{64}{3}}{\ln \frac{9}{2}}$
 17 $x = 2 - \log_2 5$ 18 $x = -1 + \log_4 3$ 19 $x = -\frac{3}{2} + \log_4 5$ 20 $x = \log_6 4$ 21 $x = 0$ 22 $x = 0.631$

Chapter 5 Exercise 6

- 1 a b c d
 2 a b c d

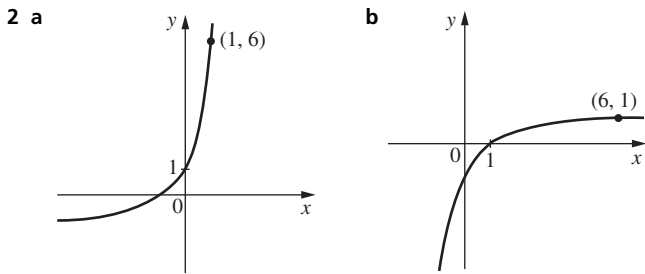
Answers



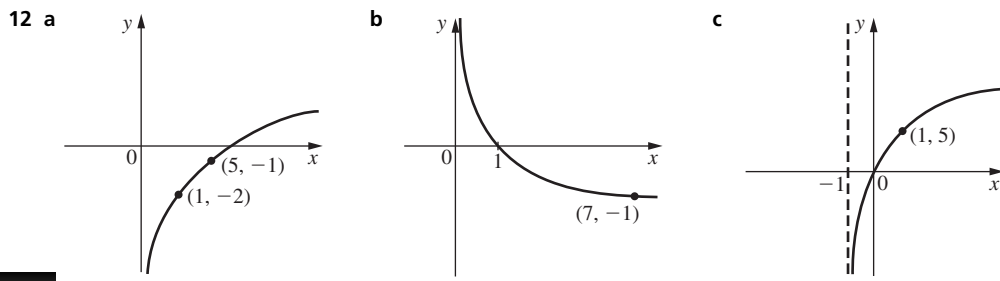
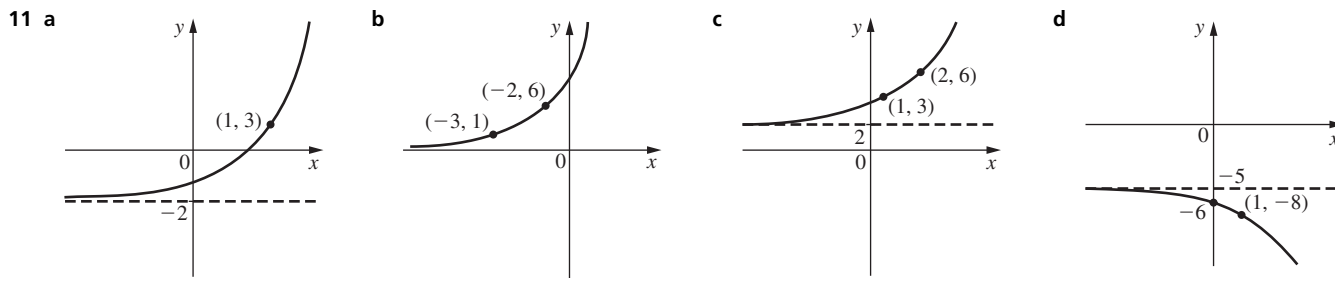
6 $k = 5$ 7 $k = 2, p = 3$ 8 $a = 3$ 9 $a = 4, p = 3$ 10 $p = 3, a = 6$

Chapter 5 Review Exercise

1 a x^6 b $15p^{-\frac{1}{2}}$ c $2 + 4x^{-2}$



3 a 5 b 3 c $\frac{1}{3}$ d -2 4 a $\log_a 48$ b $\log_p 2$ c $\log_a 25a$
 5 a $\log_3 8x$ b 1 6 a $x = 9$ b $x = 81$ c $x = 3$ d $\frac{11}{8}$
 7 a 1.40 b 0.631 7 c 0.289 d 2.32 8 a 8100 b 24200000
 8 c 44.7 9 a $x = 5.25$ b $x = 0.356$ c $x = 2.08$ d $x = 1.34$
 10 a 5 b 5 c 6



- 13 $k = 7$ 14 $p = 3, q = 5$ 15 a $k = 0.0633$ b Yes as it will be 34 units at the end of the trip. The pressure will be ok for a total of 8.07 hours.
 16 $x = \pm 6$ 17 $\frac{\ln 9}{\ln 8}$ 18 $-1 + \log_5 3$ 19 $x = 4, y = 4$ 20 $x = -5, y = 6; x = 1, y = 0$ 21 $x = \frac{15}{7}, y = \frac{10}{7}$ 22 a $x < -\frac{2}{3}, x > \frac{3}{2}, x \in \mathbb{R}$
 b $y \in \mathbb{R}$ 23 $x = \pm 8$ 24 a $k = \frac{3}{2}, m = 1$ b $x = \sqrt{8}$

Chapter 6 Exercise 1

- 1 $u_n = 2n + 3$ 2 $u_n = 5n - 4$ 3 $u_n = 6n + 2$ 4 $u_n = -9n + 69$ 5 $u_n = -4n + 8$ 6 $u_n = 11n - 4, u_{20} = 216$
 7 $u_n = 110n + 90, u_{13} = 1520$ 8 $u_n = -7n + 24, u_{19} = -109$ 9 $u_n = \frac{1}{2}n + \frac{1}{2}, u_{15} = 8$ 10 $n = 143$ 11 $n = 23$ 12 $n = 27$
 13 $u_n = 4n - 3$ 14 $u_n = 9n + 7$ 15 $u_n = -6n + 50$ 16 $u_n = -\frac{1}{2}n - 4$ 17 $k = 2$ 18 $k = 8$ 19 $k = 3$ 20 $k = -9, k = 6$

Chapter 6 Exercise 2

- 1 $\frac{n}{2} + \frac{3}{2}n^2$ 2 $n^2 + 7n$ 3 $-\frac{3}{2}n^2 + \frac{163n}{2}$ 4 $2014n - 6n^2$ 5 $\frac{n}{3} + \frac{n^2}{6}$ 6 203 7 354 8 1050 9 5586 10 $\frac{n(n+1)}{2}$
 11 n^2 12 a $d = 2$ b 348

Chapter 6 Exercise 3

- 1 $u_6 = \frac{1}{4}, u_n = 2^{4-n}$ 2 $u_6 = \frac{5}{64}, u_n = 80\left(\frac{1}{4}\right)^{n-1}$ 3 $u_6 = 486, u_n = 2(3)^{n-1}$ 4 $u_6 = -160, u_n = 5(-2)^{n-1}$ 5 $u_6 = \frac{-25}{8}, u_n = 100\left(-\frac{1}{2}\right)^{n-1}$
 6 $u_6 = 384, u_n = 12(2)^{n-1}$ 7 $u_6 = 18750, u_n = 6(5)^{n-1}$ 8 a $\frac{255}{16}$ b 107 c 6560 d -425 e 66.4 f 3060 g 585936
 9 $S_n = \frac{x(1-x^n)}{1-x}$ 10 $S_n = \frac{1-(-x)^n}{1+x}$ 11 $S_n = \frac{(1-(-3x)^n)}{1+3x}$ 12 $u_n = 5(2)^{n-1}$ 13 $u_n = 270\left(\frac{1}{3}\right)^{n-1}$ 14 $u_n = 4(-3)^{n-1}$
 15 $u_n = \frac{1}{8}(-4)^{n-1}$ 16 $k = -2$ or $k = 10$ 17 $k = 1$ or $k = 3$ 18 $k = 8$ 19 $n = 9$ 20 $n = 5$ 21 $n = 8$ 22 $a = \frac{4}{3}, r = -4$

Chapter 6 Exercise 4

- 1 $S_\infty = 40$ 2 $S_\infty = \frac{243}{2}$ 3 Does not converge 4 $S_\infty = -\frac{512}{13}$ 5 Does not converge 6 $S_\infty = 12$ 7 $S_\infty = 300$ 8 $S_\infty = 50$
 9 $S_\infty = \frac{36}{7}$ 10 $-1 < x < 1$ 11 $x < -1$ or $x > 1$ 12 $\frac{58}{9}$ 13 $\frac{214}{99}$ 14 $\frac{727}{99}$ 15 a 1950 b $\frac{58025}{32}$ c $\frac{32}{9}$

Chapter 6 Exercise 5

- 1 28 days 2 \$2720.98 3 98691 dkk 4 22 years 5 4.3% 6 £ 8820.36 7 a 17623 rats b 14.2 months 8 a 187 leopards b 2012
 9 a 3.07m b 10

Chapter 6 Exercise 6

- 1 a 35 b 252 c 896 2 a $\sum_{r=1}^5 4r$ b $\sum_{r=1}^{n+2} 5r - 7$ c $\sum_{r=1}^{\infty} 4r + 5$
 3 a $3n^2 + n$ b $\frac{2}{3}n^3 + \frac{3}{2}n^2 + \frac{17}{6}n$ c $-\frac{8}{3}n^3 - 2n^2 + \frac{53}{3}n$ d $\frac{1}{2}(k+1)(7k+8)$

Chapter 6 Exercise 7

- 1 a 30 b 336 c 56 d 126 e 70 2 360 3 2002 4 a 39916800 b 990 c 330 5 1712304 6 76275360 7 12870
 8 a 216 b 120 9 a $n = 6$ b $n = 5$ c $n = 4$ d $n = 6$ 10 a $n = 4$ b $n = 10$ c $n = 9$ 11 a $n = 7$ b $n = 3$ c $n = 3$

Chapter 6

Exercise 8

- 1 a $a^4 + 4a^3b + 6a^2b^2 + 4ab^3 + b^4$ b $729x^6 + 2916x^5 + 4860x^4 + 4320x^3 + 2160x^2 + 576x + 64$ c $1 - 4x + 6x^2 - 4x^3 + x^4$
 1 d $32p^5 - 240p^4q + 720p^3q^2 - 1080p^2q^3 + 810pq^4 - 243q^5$ 2 a $x^3 + 3x + 3x^{-1} + x^{-3}$ b $x^5 + 10x^3 + 40x + \frac{80}{x} + \frac{80}{x^3} + \frac{32}{x^5}$
 2 c $x^6 - 6x^4 + 15x^2 - 20 + \frac{15}{x^2} - \frac{6}{x^4} + \frac{1}{x^6}$ d $16t^4 - 8t^2 + \frac{3}{2} - \frac{1}{8t^2} + \frac{1}{256t^4}$ 3 $x^6 + 9x^5 + 30x^4 + 45x^3 + 30x^2 + 9x + 1$
 4 a 40 b 7000 c 3840 d 6480 e -150994944 f 21 g -8 h 90720 5 a 242 b -54 c -243 d -54
 6 a $x^7 - x^6 - 69x^5 + 109x^4 + 1616x^3 - 3360x^2 - 12800x + 32000$ b $x^6 - 6x^5 + 15x^4 - 26x^3 + 39x^2 - 42x + 37 - \frac{30}{x} + \frac{12}{x^2} - \frac{8}{x^3}$
 6 c $x^7 - 2x^5 - 6x^3 + 8x + \frac{17}{x} - \frac{6}{x^3} - \frac{20}{x^5} - \frac{8}{x^7}$ 7 a 22 b 952 c -5888 8 1360 9 a 1.04 b 0.210 c 15800000
 10 $-22688x^2 + 12480x - 3200$ 11 Proof: $p^2 = -\frac{1}{5}$

Chapter 6

Review Exercise

- 1 -7 2 a $r = 4$ b $S_n = 16(4^n - 1)$ 3 a $S_n = \frac{3n^2}{2} + \frac{n}{2}$ b $n = 30$ 4 a $r = \frac{2}{3}$ b $a = 9$
 5 a 1, 5, 9 b $u_n = 4n - 3$ 6 a $|x| < \frac{3}{2}$ b 5 7 a $8n - 3$ b 50 8 $a = \pm 3$ 9 $a = 9$ 10 a $n = 6$ b $A = 15, r = 4$
 11 a = 2, b = -3 12 a $x^5 + 10x^4 + 40x^3 + 80x^2 + 80x + 32$ b 32.8080401 13 a $r = \frac{1}{2}$ b $d = -\frac{9}{20}$ 14 a 59 b $n = 12, d = 0.25$
 14 c i 99 ii 100 15 280 and 84 16 $k = \frac{54}{5p^3}$ 17 34642080 18 4455 19 $6n - \frac{5}{6}n(n+1)(2n+1), -972$ 20 $n = 10$

Chapter 7

Exercise 1

- 1 a $\pm \frac{\sqrt{3}}{2}$ b $\pm \frac{1}{\sqrt{2}}$ c $\pm \frac{2\sqrt{6}}{7}$ d No possible value 2 a $\pm \frac{1}{2}$ b $\pm \frac{3}{5}$ c No possible value d $\pm \frac{2\sqrt{6}}{5}$ 4 $\pm \frac{1}{3}$
 5 a 3 $\sin \theta$ b $\tan \theta$ c $-\sin \theta$ d $7 \cot^2 \theta$ 7 a 0.464, 2.68, 3.61, 5.82 b $\frac{\pi}{2}, \frac{3\pi}{2}$ c 0.785, 2.90, 3.93, 6.04
 7 d $\frac{\pi}{4}, \frac{5\pi}{4}$ e 3.53, 5.90 f 1.05, π , 5.24

Chapter 7

Exercise 2

- 1 a $\frac{1 + \sqrt{3}}{2\sqrt{2}}$ b $\frac{\sqrt{3} - 1}{2\sqrt{2}}$ c $\frac{1 + \sqrt{3}}{\sqrt{3} - 1}$ 2 a and b $\frac{\sqrt{3} - 1}{2\sqrt{2}}$ 3 $\frac{1 - \sqrt{3}}{2\sqrt{2}}$ 4 $-\frac{(1 + \sqrt{3})}{2\sqrt{2}}$ 8 a 0 b $\frac{\sqrt{3}}{2}$
 9 a $\frac{4}{5}$ b $\frac{117}{125}$ c $-\frac{44}{117}$ 10 $\frac{16}{65}$ 11 0.951 12 $-\frac{2}{7}$ 13 0.2829, -0.3877 14 52.5°, 232.5° 16 $\frac{6}{10}$ 17 a $\frac{24}{25}$ b $-\frac{7}{25}$
 17 c $\frac{336}{625}$ d $\frac{527}{625}$ 18 a 40.9°, 220.9° b 0°, 180° c 7.6°, 187.6° 19 a 2.88, 6.02 b 2.36, 5.50 c 1.70, 4.84

Chapter 7

Exercise 3

- 1 a $\frac{\sqrt{3}}{2}$ b $\frac{1}{2}$ c $-\sqrt{3}$ 2 $\frac{120}{169}$ 3 $\frac{161}{289}$ 4 a $\frac{1}{\sqrt{5}}$ b $\frac{2}{\sqrt{5}}$ 5 $\cos \theta(1 - 8 \sin^2 \theta \cos^2 \theta) - 4 \sin \theta \cos \theta(1 - 2 \sin^2 \theta)$
 6 $2 \cos \theta[16 \sin^5 \theta - 16 \sin^3 \theta + 3 \sin \theta]$ 7 $-\frac{119}{169}$

Chapter 7

Exercise 4

- 3 $\frac{\sqrt{2 + \sqrt{3}}}{2}$ 4 $\frac{\sqrt{2 + \sqrt{2}}}{2}$ 5 a $\frac{\pi}{6}, \frac{\pi}{3}, \frac{7\pi}{6}, \frac{4\pi}{3}$ b $\frac{\pi}{6}, \frac{5\pi}{6}, \frac{7\pi}{6}, \frac{11\pi}{6}$ 6 a 30°, 90°, 150°, 270° b 0°, 180°
 6 c 60°, 90°, 270°, 300° d 90° e 60°, 300° f 60°, 300° g 41.41°, 180°, 318.59° h 210°, 330°
 7 a $\frac{\pi}{3}, \pi, \frac{5\pi}{3}$ b $0, \frac{2\pi}{3}, \pi, \frac{4\pi}{3}$ c $\frac{\pi}{3}, \frac{2\pi}{3}, \frac{4\pi}{3}, \frac{5\pi}{3}$ d $\frac{\pi}{6}, \frac{\pi}{2}, \frac{5\pi}{6}, \frac{3\pi}{2}$ e $0, \frac{2\pi}{3}, \frac{4\pi}{3}$ f π g $0, \pi, \frac{7\pi}{6}, \frac{11\pi}{6}$
 8 a $-\pi, 0$ b $-\frac{\pi}{3}, \frac{\pi}{3}$ c No solution d $-\pi, -\frac{2\pi}{3}, \frac{2\pi}{3}$ 9 a 0.841, 1.82, 4.46, 5.44 b 0.605, 2.54

Chapter 7 Exercise 5

- 1 a $10 \cos(x - 53.1)^\circ$ b $13 \cos(x - 67.4)^\circ$ c $\sqrt{10} \cos(x - 288.4)^\circ$ d $\sqrt{5} \cos(x - 153.4)^\circ$ 2 a $2 \cos\left(\theta - \frac{11\pi}{6}\right)$ b $\sqrt{2} \cos\left(\theta - \frac{7\pi}{4}\right)$
 2 c $\sqrt{5} \cos(\theta - 4.25)$ d $2 \cos\left(\theta - \frac{2\pi}{3}\right)$ 3 a $17 \cos(x + 28.1)^\circ$ b $\sqrt{\frac{37}{2}} \cos(x + 54.5)^\circ$ 4 a $2 \sin\left(\theta + \frac{2\pi}{3}\right)$ b $\sqrt{2} \sin\left(\theta + \frac{3\pi}{4}\right)$
 5 a $\sqrt{10} \sin(x - 108.4)^\circ$ b $2 \sin(x - 240)^\circ$ 6 a $\sqrt{2} \cos(2x - 45)^\circ$ b $2 \sin(3x + 60)^\circ$ c $6 \cos\left(\theta - \frac{11\pi}{6}\right)$ d $\sqrt{2} \cos\left(30\theta - \frac{3\pi}{4}\right)$
 7 a Minimum $(135^\circ, -5\sqrt{2})$ Maximum $(315^\circ, 5\sqrt{2})$ b Minimum $(150^\circ, 3)$ Maximum $(330^\circ, 7)$
 7 c Minimum $(157.5^\circ, -8.90), (337.5^\circ, -8.90)$ Maximum $(67.5^\circ, 10.9), (247.5^\circ, 10.9)$
 8 a Minimum $(5.33, -\sqrt{12})$ Maximum $(2.19, \sqrt{12})$ b Minimum $\left(\frac{\pi}{18}, -2\right), \left(\frac{13\pi}{18}, -2\right), \left(\frac{25\pi}{18}, -2\right)$ Maximum $\left(\frac{7\pi}{18}, 2\right), \left(\frac{19\pi}{18}, 2\right), \left(\frac{31\pi}{18}, 2\right)$
 8 c Minimum $\left(\frac{5\pi}{24}, -5.83\right), \left(\frac{11\pi}{24}, -5.83\right), \left(\frac{17\pi}{24}, -5.83\right), \left(\frac{23\pi}{24}, -5.83\right), \left(\frac{29\pi}{24}, -5.83\right), \left(\frac{35\pi}{24}, -5.83\right), \left(\frac{41\pi}{24}, -5.83\right), \left(\frac{47\pi}{24}, -5.83\right)$
 8 c Maximum $\left(\frac{\pi}{12}, -0.172\right), \left(\frac{\pi}{3}, -0.172\right), \left(\frac{7\pi}{12}, -0.172\right), \left(\frac{5\pi}{6}, -0.172\right), \left(\frac{13\pi}{12}, -0.172\right), \left(\frac{4\pi}{3}, -0.172\right), \left(\frac{19\pi}{12}, -0.172\right), \left(\frac{11\pi}{6}, -0.172\right)$
 9 a $\frac{\pi}{2}, \pi$ b $0, \frac{5\pi}{3}$ c $0, \frac{3\pi}{2}$ d $0, \frac{\pi}{3}, \frac{\pi}{2}, \frac{5\pi}{6}, \pi, \frac{4\pi}{3}, \frac{3\pi}{2}, \frac{11\pi}{6}$ 10 a $102.4^\circ, 195.7^\circ$ b $7.3^\circ, 34.0^\circ, 127.3^\circ, 154.0^\circ, 247.3^\circ, 274.0^\circ$

Chapter 7 Review Exercise

- 1 $\pm \frac{\sqrt{3}}{2}$ 2 b i $\frac{120}{169}$ ii $-\frac{119}{169}$ 6 $\frac{\pi}{6}, \frac{\pi}{3}, \frac{\pi}{2}, \frac{2\pi}{3}, \frac{5\pi}{6}$ 7 a $5 \cos(\theta - 0.644)$ b $\theta = 0.644$ 8 0.905 9 $\frac{1 - \sqrt{3}}{2\sqrt{2}}$ 10 $-\frac{13}{85}$ 11 $\frac{2}{\sqrt{2 - \sqrt{2}}}$
 12 $-\frac{35}{12}$ 13 $\sqrt{112} \sin(\theta - 3.86)$ 14 $11.25^\circ, 22.5^\circ, 56.25^\circ, 67.5^\circ$ 17 b $\alpha = 0.464, k = -0.559, p = 0.5$ c $A = \frac{\sqrt{5} + 2}{4}, \theta = 1.34$

Chapter 8 Exercise 1

- 1 $f'(x) = 5$ 2 $f'(x) = 8$ 3 $f'(x) = -2$ 4 $f'(x) = 2x$ 5 $f'(x) = 3x^2$ 6 $f'(x) = 4x^3$ 7 $f'(x) = 4x$ 8 $f'(x) = 10x$ 9 $f'(x) = 12x^2$
 10 $f'(x) = 0$ 11 $f'(x) = \frac{-3}{x^2}$ 12 $f'(x) = 2x$ 13 $f'(x) = -3$ 14 $f'(x) = 2x - 4$ 15 $f'(x) = 2 + \frac{1}{x^2}$

Chapter 8 Exercise 2

- 1 $f'(x) = 18x$ 2 $f'(x) = 30x^2$ 3 $f'(x) = 24x^3$ 4 $f'(x) = -15x^4$ 5 $f'(x) = 0$ 6 $f'(x) = 7$ 7 $f'(x) = 11$ 8 $f'(x) = 8$ 9 $f'(x) = -\frac{8}{x^3}$
 10 $f'(x) = \frac{5}{2\sqrt{x}}$ 11 $f'(x) = 2x + 5$ 12 $f'(x) = -\frac{25}{2\sqrt{x^7}}$ 13 $\frac{dy}{dx} = 3x^2 + 10x - 7$ 14 $\frac{dy}{dx} = 12x + \frac{2}{x^2}$ 15 $\frac{dy}{dx} = \frac{1}{4\sqrt[4]{x^3}}$ 16 $\frac{dy}{dx} = \frac{5\sqrt[3]{x^2}}{3}$
 17 $\frac{dy}{dx} = \frac{4}{3} + \frac{4}{x^2}$ 18 $\frac{dy}{dx} = \frac{27}{10}(\sqrt{x^7} - \sqrt{x})$ 19 $f'(3) = 2$ 20 $g'(6) = -\frac{10}{9}$ 21 $\frac{dy}{dx} = 6$ 22 $\frac{dy}{dx} = \frac{3081}{128}$ 23 (5, 7)
 24 $\left(-\frac{1}{2}, \frac{199}{24}\right)$ and $\left(5, -\frac{217}{6}\right)$

Chapter 8 Exercise 3

- 1 a Tangent $y = 6x - 3$, Normal $y = -\frac{1}{6}x + \frac{19}{6}$ b Tangent $y = x - 4$, Normal $y = -x$ c Tangent $y = -4x - 3$, Normal $y = \frac{1}{4}x + \frac{5}{4}$
 1 d Tangent $y = \frac{1}{6}x + \frac{3}{2}$, Normal $y = -6x + 57$ e Tangent $y = -8x + 12$, Normal $y = \frac{1}{8}x + \frac{31}{8}$ f Tangent $y = 18x + 47$, Normal $y = -\frac{1}{18}x - \frac{43}{6}$
 2 At A, $y = 4x - 4$, At B, $y = 3x - 3$ 3 $y = \frac{1}{3}x + \frac{4}{3}$ 4 Q(-3, -20) 5 $y = 2x + 11$ 6 $\left(\frac{1}{4}, -\frac{9}{4}\right)$ 7 $y = -7x - \frac{28}{3}$ and $y = 19x - 57$
 8 $y = 3x - \frac{38}{9}$ 9 $y = 5x - 15$ and $y = -5x - 10$, $y = -5x + 15$ and $y = 5x + 10$ 10 $y = 2x - 8$, $y = -\frac{x}{7} + \frac{4}{7}$, $17\frac{1}{7}$

Chapter 8 Exercise 4

- 1 a (4, -13) Minimum Turning Point b (-2, 23) Maximum Turning Point and (2, -9) Minimum Turning Point c (0, 0) Minimum Turning Point
 1 d $\left(-\frac{1}{3}, -\frac{25}{3}\right)$ Minimum Turning Point e $\left(-\frac{1}{2}, -4\right)$ Maximum Turning Point and $\left(\frac{1}{2}, 4\right)$ Minimum Turning Point

- 2 a $(-2, -13)$ Minimum Turning Point b $(-1, 25)$ Maximum Turning Point c $(\frac{4}{3}, \frac{256}{27})$ Maximum Turning Point and $(4, 0)$ Minimum Turning Point
 2 d $(1, 10)$ Maximum Turning Point and $(2, 9)$ Minimum Turning Point e $(0, 0)$ Rising Point of Inflexion
 3 a $(1, -\frac{8}{3})$ Maximum Turning Point and $(3, -4)$ Minimum Turning Point b $(\frac{5}{2}, 0)$ Minimum Turning Point c $(-\frac{1}{2}, -12)$ Maximum Turning Point
 3 d $(0, 0)$ Minimum Turning Point e $(-1.57, 12.5)$ Maximum Turning Point and $(0, 2)$ Minimum Turning Point 4 2

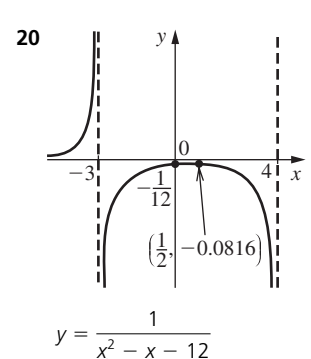
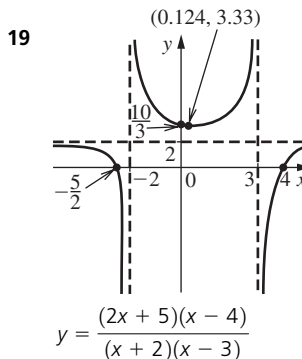
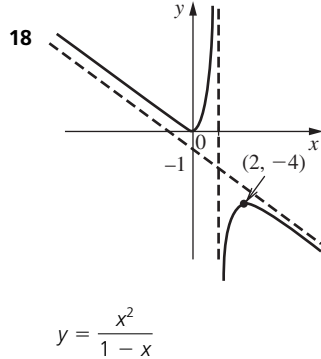
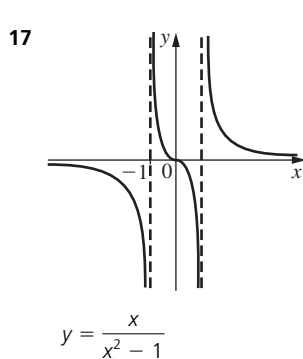
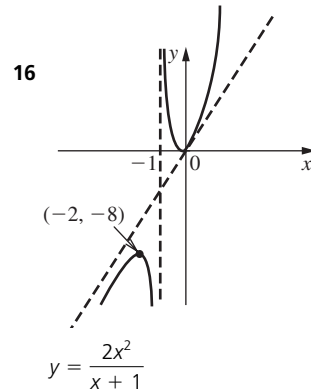
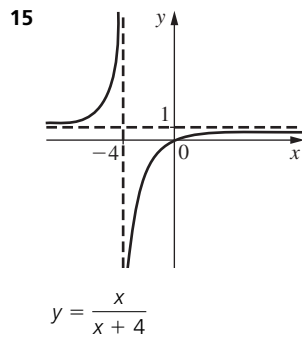
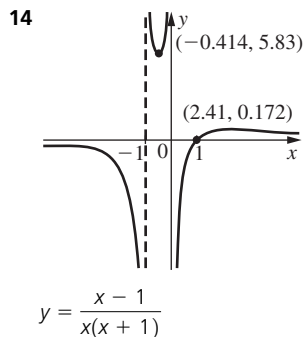
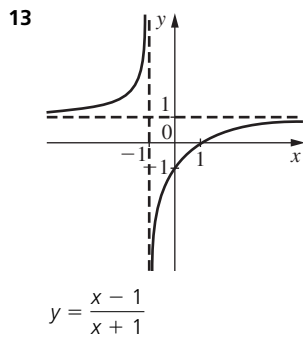
Chapter 8 Exercise 5

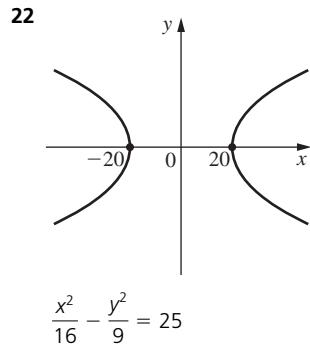
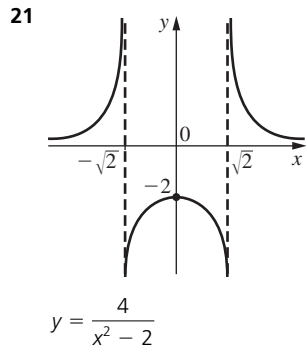
- 1 a $(-2, \frac{224}{3})$ Non-Stationary, $(0,0)$ Stationary, $(2, -\frac{224}{3})$ Non-Stationary b $(-1, 15)$ Non-Stationary c i None ii None
 iii None Quadratic functions have no points of inflexion 2 a $(0,0)$ Stationary b $(1, -3)$ Non-Stationary c $(-2, -35)$ Non-Stationary
 2 d $x = -\frac{b}{3a}, y = \frac{8b^3}{27a^2} - \frac{bc}{3a} + d$ There is always one point of inflexion for cubic functions
 3 a $(-1, 3)$ Non-Stationary and $(1, 3)$ Non-Stationary b $(\frac{1}{6}, 4.11)$ Non-Stationary and $(-1, -9)$ Non-Stationary
 3 c $(0,0)$ Stationary d No points of inflexion, $(0, -3)$ is a minimum turning point. 4 $y = -21x + 36$ 5 $\sqrt{1312} \approx 36.2$

Chapter 8 Exercise 6

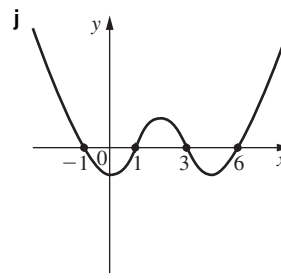
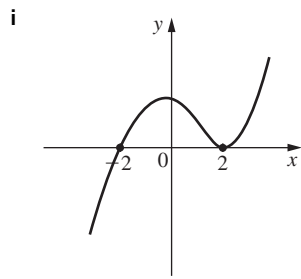
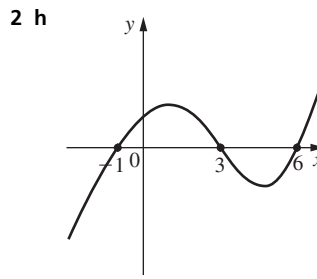
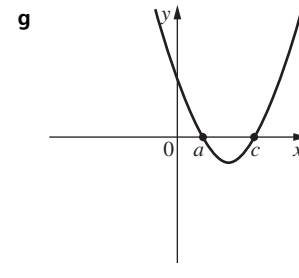
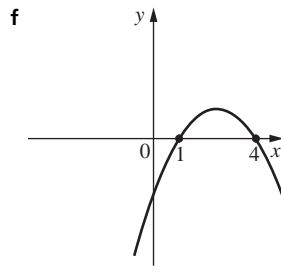
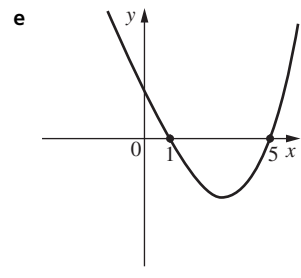
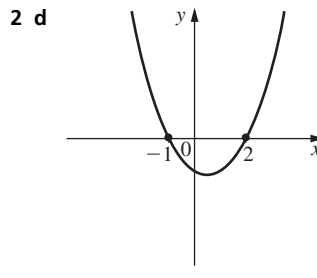
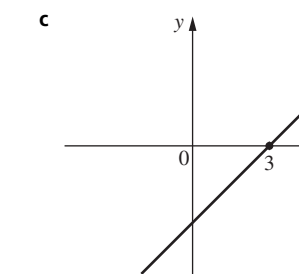
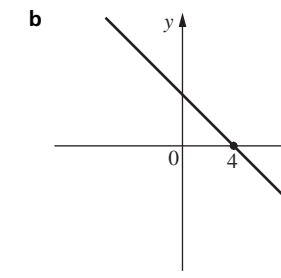
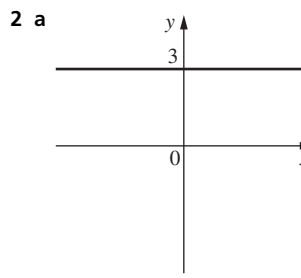
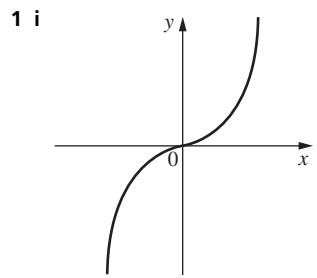
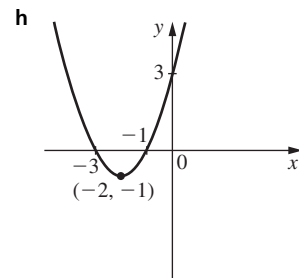
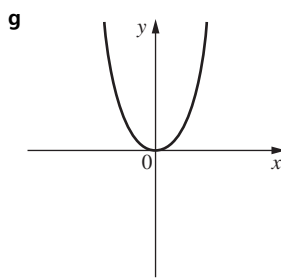
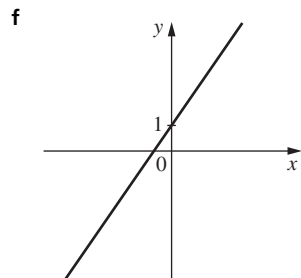
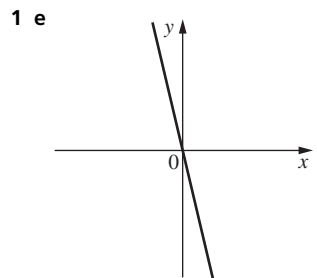
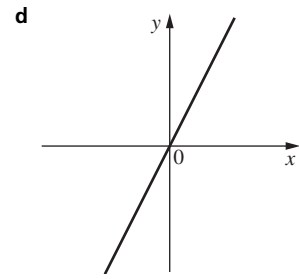
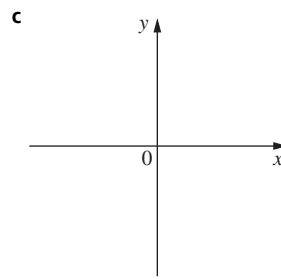
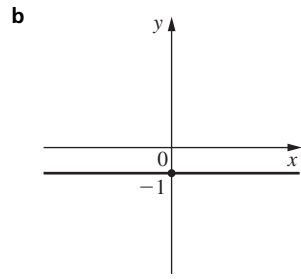
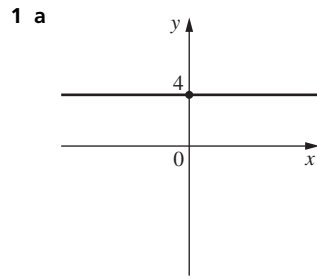
- 1 Vertical: $x = 0$, Horizontal $y = 0$ 2 Vertical: $x = 3$, Horizontal $y = 1$ 3 Vertical: $x = 0$, Oblique $y = x$
 4 Vertical: $x = 2$, Horizontal $y = 1$ 5 Vertical: $x = -2$, Oblique $y = x - 2$ 6 Vertical: $x = 3$, Oblique $y = 2x + 9$
 7 Vertical: None, Oblique $y = x - 2$ 8 Vertical: None, Oblique $y = x$ 9 Vertical: $x = -1$ and $x = 4$, Horizontal $y = 0$
 10 Vertical: $x = -1$ and $x = 1$, Horizontal $y = 1$ 11 Vertical: $x = -3$ and $x = 3$, Horizontal $y = 3$
 12 Vertical: $x = -2$ and $x = 3$, Oblique $y = 4x + 4$

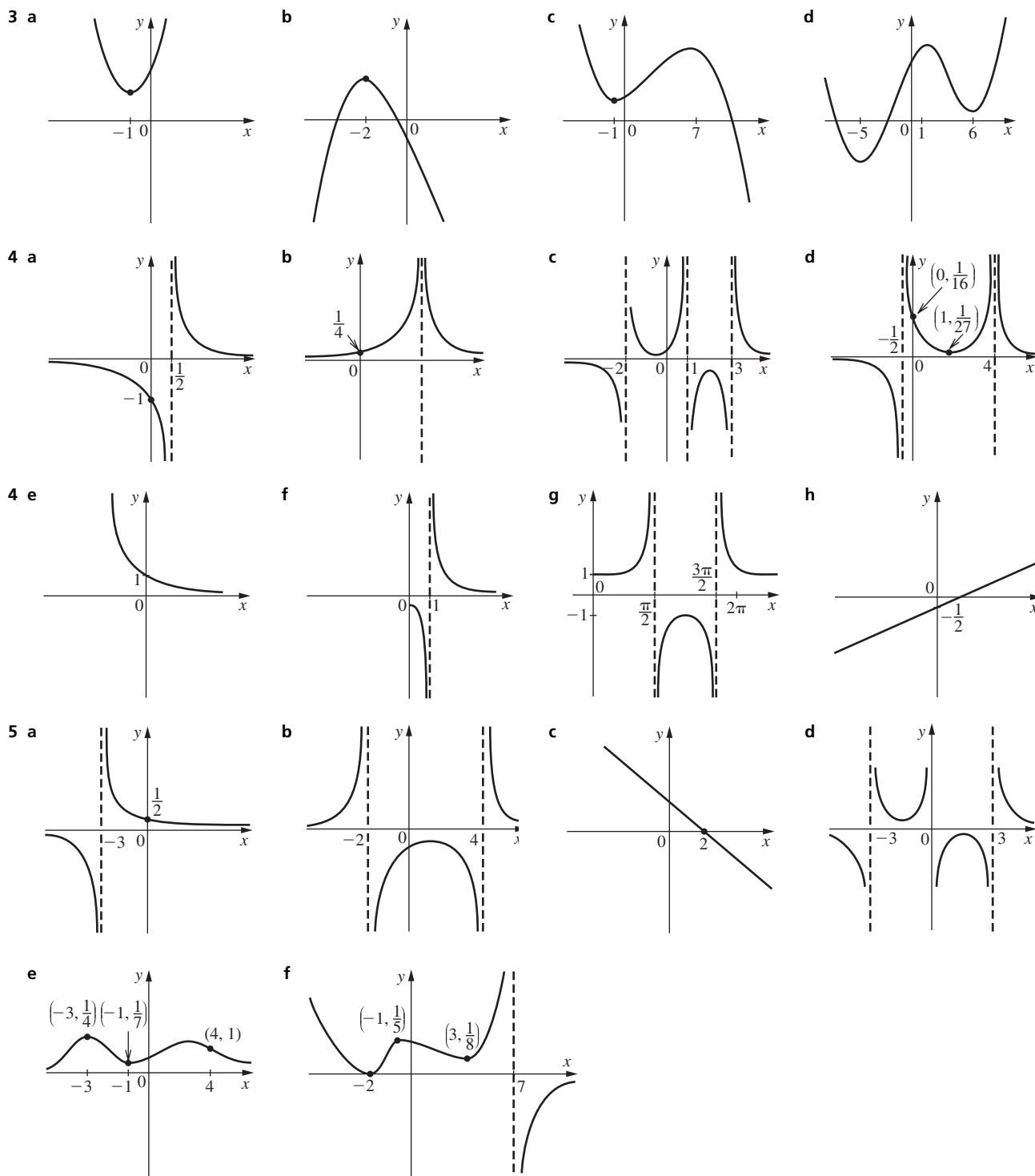
Graphs of the following functions, including asymptotes, stationary points and intercepts:





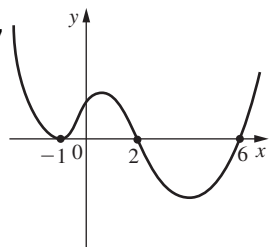
Chapter 8 **Exercise 7**



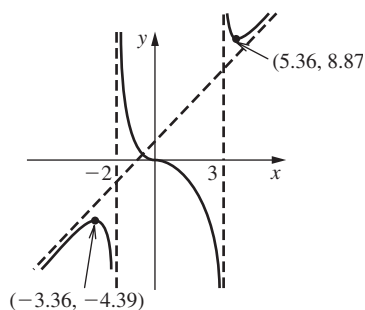


Chapter 8 Review Exercise

1 $f(x) = 3x^2 - 4$ 2 $\frac{3}{16}$ 3 $\frac{dy}{dx} = \frac{3}{4}x^{-\frac{1}{2}} - \frac{17}{4}x^{\frac{15}{2}}$ 4 $x < 0, x > 4$ 5 $h(x) = 45x^2 + 60x + 19, h'(x) = 90x + 60$ 6 $x = 2, y = -6x + 16$

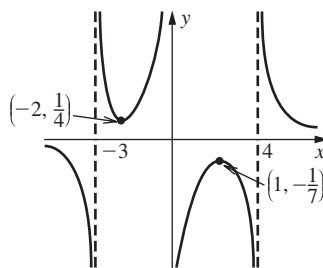
7  8 $(-\frac{1}{2}, \frac{9}{2})$ max TP, $(\frac{2}{3}, -\frac{50}{27})$ min TP 9 $y = 5x + 1, y = -\frac{1}{2}x + \frac{15}{2}, (\frac{13}{11}, \frac{76}{11})$

10

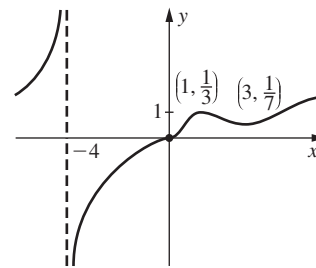


11 $y = 1, x = 1, x = 4$ 12 $a = -4, b = 18$

13 a



b



Chapter 9 Exercise 1

- 1 $\frac{dy}{dx} = \sec^2 x$ 2 $\frac{dy}{dx} = \cos x + \operatorname{cosec} x \cot x$ 3 $\frac{dy}{dx} = \cos x + 12x$ 4 $\frac{dy}{dx} = -5 \sin x$ 5 $\frac{dy}{dx} = -7 \operatorname{cosec}^2 x$ 6 $\frac{dy}{dx} = -3 \sec x \tan x$
 7 $\frac{dy}{dx} = 18x + 4 \sin x$ 8 $\frac{dy}{dx} = 7 - 5 \cos - \sec x \tan x$

Chapter 9 Exercise 2

- 1 $f'(x) = 2(x + 4)$ 2 $f'(x) = 4(2x + 3)$ 3 $f'(x) = 6(3x - 4)$ 4 $f'(x) = 20(5x - 4)^3$ 5 $f'(x) = -3(5 - x)^2$ 6 $f'(x) = -8(7 - 2x)^3$
 7 $\frac{dy}{dx} = -20(9 - 4x)^4$ 8 $\frac{dy}{dx} = 48(2x + 3)^5$ 9 $\frac{dy}{dx} = \frac{3}{2}(3x + 8)^{-\frac{1}{2}}$ 10 $\frac{dy}{dx} = \frac{10}{3}(2x - 9)^{\frac{2}{3}}$ 11 $\frac{dy}{dx} = 2(6x - 5)^{-\frac{2}{3}}$
 12 $\frac{dy}{dx} = -\frac{3}{2}(3x - 2)^{-\frac{3}{2}}$ 13 $f'(x) = -20(5x - 4)^{-2}$ 14 $f'(x) = 56(3 - 8x)^{-2}$ 15 $\frac{dP}{dk} = 18(4 - 3k)^{-3}$ 16 $\frac{dN}{dp} = \frac{75}{2}(8 - 5p)^{-\frac{3}{2}}$
 17 $\frac{dy}{dx} = 4 \cos 4x$ 18 $\frac{dy}{dx} = -3 \sin 3x$ 19 $\frac{dy}{dx} = -\frac{1}{2} \cos \frac{1}{2}x$ 20 $\frac{dy}{dx} = 6 \sec^2 6x$ 21 $\frac{dy}{dx} = 9 \sec 9x \tan 9x$ 22 $\frac{dy}{dx} = 6 - 3 \operatorname{cosec}^2 3x$
 23 $\frac{dy}{dx} = -2 \operatorname{cosec} 2x \cot 2x + 12(3x + 2)^3$ 24 $\frac{dy}{dx} = 5 \cos 5x + 30(3x + 4)^{-\frac{1}{2}}$ 25 $\frac{dy}{dx} = 3 \sin^2 x \cos x$ 26 $\frac{dy}{dx} = 8 \tan 4x \sec^2 4x$
 27 $\frac{dy}{dx} = 12x^3 + 3 \cos^2 x \sin x$ 28 $\frac{dy}{dx} = -30(3x - 4)^{-6} - 2 \sec^2 2x \tan 2x$ 29 $\frac{dy}{dx} = -3 \sin\left(3x - \frac{\pi}{4}\right)$ 30 $\frac{dy}{dx} = \frac{1}{2(x + 1)^{\frac{3}{2}}} \sec^2(\sqrt{x + 1})$

Chapter 9 Exercise 3

- 1 $f'(x) = 3e^{3x}$ 2 $f'(x) = 7e^{7x}$ 3 $f'(x) = -4e^{4x}$ 4 $f'(x) = -10e^{-5x}$ 5 $f'(x) = 54e^{-9x}$ 6 $f'(x) = 2xe^{x^2}$ 7 $f'(x) = 2e^{2x+3}$ 8 $f'(x) = \frac{1}{x}$
 9 $f'(x) = \frac{1}{x}$ 10 $f'(x) = -\frac{2}{x}$ 11 $f'(x) = \frac{2x}{x^2 + 2}$ 12 $\frac{dy}{dx} = \ln 4 \cdot 4^x$ 13 $\frac{dy}{dx} = \ln 10 \cdot 10^x$ 14 $\frac{dy}{dx} = 6 \ln 5 \cdot 5^x$ 15 $\frac{dy}{dx} = 3e^{3x} - \ln 3 \cdot 3^x$
 16 $\frac{dy}{dx} = \frac{1}{x} - \ln 2 \cdot 2^x$ 17 $\frac{dy}{dx} = \frac{1}{x \ln 2}$ 18 $\frac{dy}{dx} = \frac{1}{x \ln 8}$ 19 $\frac{dy}{dx} = \ln 4 \cdot 4^x - \frac{1}{x \ln 5}$ 20 $\frac{dy}{dx} = 4e^{4x} - 2 \cos 2x + \frac{1}{x}$ 21 $\frac{dy}{dx} = -\tan x$
 22 $\frac{dy}{dx} = \operatorname{cosec} x \sec x$ 23 $\frac{dy}{dx} = \frac{1}{x} \sec^2(\ln x)$

Chapter 9 Exercise 4

- 1 $\frac{dy}{dx} = x(2 \sin x + x \cos x)$ 2 $\frac{dy}{dx} = x^2(3 \cos x - x \sin x)$ 3 $\frac{dy}{dx} = 3xe^x(2 + x)$ 4 $\frac{dy}{dx} = e^{3x}(3 \sin x + \cos x)$ 5 $\frac{dy}{dx} = \frac{\sin x}{x} + \ln x \cos x$
 6 $\frac{dy}{dx} = \cos^2 x - \sin^2 x$ 7 $\frac{dy}{dx} = 3 \cos 3x \cos 2x - 2 \sin 3x \sin 2x$ 8 $\frac{dy}{dx} = 2x(x - 1)(2x - 1)$ 9 $\frac{dy}{dx} = x^2(x - 2)^3(7x - 6)$
 10 $\frac{dy}{dx} = 6x^2(3x + 2)(5x + 2)$ 11 $\frac{dy}{dx} = (2x + 1)^2(8x - 11)$ 12 $\frac{dy}{dx} = 2(x + 5)(3x - 2)^3(9x + 28)$ 13 $\frac{dy}{dx} = 6(5 - 2x)^2(3x + 4)(1 - 5x)$
 14 $\frac{dy}{dx} = (3x + 4)^2[9 \sin x + (3x + 4) \cos x]$ 15 $\frac{dy}{dx} = 5^x(\ln 5 \cdot \cos x - \sin x)$ 16 $\frac{dy}{dx} = x^2\left(3 \log_6 x + \frac{1}{\ln 6}\right)$ 17 $\frac{dy}{dx} = e^{4x} \sec 3x(4 + 3 \tan 3x)$
 18 $\frac{dy}{dx} = 3(2x + 1)^2 \operatorname{cosec} 3x[2 - (2x - 1) \cot 3x]$ 19 $\frac{dy}{dx} = 4^x\left(\ln 4 \log_8 x + \frac{1}{x \ln 8}\right)$ 20 $\frac{dy}{dx} = \ln(2x + 3) + \frac{2x}{2x + 3}$
 21 $\frac{dy}{dx} = 8x\left[\ln(x^2 + 2x + 5) + \frac{x(x + 1)}{x^2 + 2x + 5}\right]$ 22 $\frac{dy}{dx} = e^{3x} \sec\left(2x - \frac{\pi}{4}\right)\left[3 + 2 \tan\left(2x - \frac{\pi}{4}\right)\right]$
 23 $\frac{dy}{dx} = -3x^{-5}\left(4 \tan\left(3x + \frac{\pi}{2}\right) - 3x \sec^2\left(3x + \frac{\pi}{2}\right)\right)$ 24 $\frac{dy}{dx} = x((2 \ln x + 1) \sin x + x \ln x \cos x)$ 25 $\frac{dy}{dx} = e^{3x}(x + 2)[(3x + 8) \tan x + (x + 2) \sec^2 x]$

Chapter 9 Exercise 5

$$\begin{aligned}
 1 \quad f'(x) &= \frac{e^x(\cos x + \sin x)}{\cos^2 x} & 2 \quad f'(x) &= \frac{6x(x+6)}{(x+3)^2} & 3 \quad f'(x) &= \frac{7 \tan x - 7x \sec^2 x}{\tan^2 x} & 4 \quad f'(x) &= \frac{1 - \ln x}{4x^2} & 5 \quad f'(x) &= \frac{e^x(x-5)}{(x-4)^2} \\
 6 \quad f'(x) &= \frac{-6}{(x-3)^2} & 7 \quad f'(x) &= \frac{-3(x+12)}{2x^3\sqrt{x+9}} & 8 \quad f'(x) &= \frac{4^x(2x \ln 4 - 1)}{2x^3} & 9 \quad f'(x) &= \frac{x-2}{(x-1)^{\frac{3}{2}}} & 10 \quad \frac{dy}{dx} &= \frac{e^{3x}(3x-2)}{9x^3} \\
 11 \quad \frac{dy}{dx} &= \frac{\frac{1}{x \ln 6}(x+6) - \log_6 x}{(x+6)^2} & 12 \quad \frac{dy}{dx} &= \frac{\frac{1}{x} \ln(x-4) - \frac{1}{x-4} \ln x}{(\ln(x-4))^2} & 13 \quad \frac{dy}{dx} &= \frac{-2}{(e^x - e^{-x})^2} & 14 \quad \frac{dy}{dx} &= \frac{2(\cos 2x - 3 \sin 2x)}{e^{6x}} \\
 15 \quad \frac{dy}{dx} &= \frac{12(3x-2)^4(4x+19)}{(2x+3)^4} & 16 \quad \frac{dy}{dx} &= \frac{(1-x) \sin x + x \cos x}{e^x} & 17 \quad \frac{dy}{dx} &= \frac{xe^{3x}(3x^2 + 15x + 10)}{(x+5)^3} & 18 \quad \frac{dy}{dx} &= \frac{\tan\left(x + \frac{\pi}{4}\right) - 2}{e^{2x} \cos\left(x + \frac{\pi}{4}\right)} \\
 19 \quad \frac{dy}{dx} &= \frac{-2(3x+1) \operatorname{cosec}^2\left(2x - \frac{\pi}{3}\right) \ln(3x+1) - 3 \cot\left(2x - \frac{\pi}{3}\right)}{e^{2x}}
 \end{aligned}$$

Chapter 9 Exercise 6

$$\begin{aligned}
 1 \quad \frac{dy}{dx} &= \frac{-3x^2 - y}{x} & 2 \quad a \quad \frac{x}{2+3y}, \frac{(2+3y)^2 - 3x^2}{(2+3y)^3} & b \quad \frac{\cos x - 4y}{4x+1}, \frac{-(4x+1) \sin x - 8 \cos x - 32y}{(4x+1)^2} & c \quad \frac{-1}{x}, \frac{1}{x^2} \\
 3 \quad \frac{dy}{dx} &= \frac{1}{6\sqrt{xy^2}}
 \end{aligned}$$

Chapter 9 Exercise 7

$$\begin{aligned}
 1 \quad \frac{dy}{dx} &= \frac{1}{\sqrt{25-x^2}} & 2 \quad \frac{dy}{dx} &= \frac{-1}{\sqrt{64-x^2}} & 3 \quad \frac{dy}{dx} &= \frac{10}{100+x^2} & 4 \quad \frac{dy}{dx} &= \frac{2}{\sqrt{9-4x^2}} & 5 \quad \frac{dy}{dx} &= \frac{-3}{\sqrt{1-9x^2}} & 6 \quad \frac{dy}{dx} &= \frac{2e^x}{4+e^{2x}} \\
 7 \quad \frac{dy}{dx} &= \frac{-1}{2\sqrt{-(x+4)(x+3)}} & 8 \quad \frac{dy}{dx} &= \frac{1}{2x^2-2x+1} & 9 \quad \frac{dy}{dx} &= \frac{1}{x\sqrt{1-(\ln 5x)^2}}
 \end{aligned}$$

Chapter 9 Exercise 8

$$\begin{aligned}
 1 \quad f'(x) &= 2x - 5 & 2 \quad \frac{dy}{dx} &= 6(2x-7)^2 & 3 \quad f'(x) &= -8 \sin 8x - \frac{3}{2}x^{-\frac{1}{2}} & 4 \quad \frac{dy}{dx} &= \sec x \tan x - 5e^{5x} & 5 \quad f'(x) &= x^2e^{-4x}(3-4x) \\
 6 \quad \frac{dy}{dx} &= x(2 \ln x + 1) & 7 \quad f'(x) &= \frac{3 \cos 3x - \sin 3x}{e^x} & 8 \quad \frac{dy}{dx} &= \frac{\sin x - 4x \sin x + x \cos x}{e^{4x}} & 9 \quad f'(x) &= 3^x(\ln 3 \cdot \sin x + \cos x) \\
 10 \quad \frac{dy}{dx} &= \frac{\frac{x-4}{x \ln 2} - 3 \log_2 x}{(x-4)^4} & 11 \quad \frac{dy}{dx} &= \frac{x \ln x(x+18) + x(x+9)}{(x+9)^2} & 12 \quad \frac{dy}{dx} &= -6(\sin 2x \sin 4x - 2 \cos 2x \cos 4x) & 13 \quad \frac{dy}{dx} &= \frac{12}{\sqrt{1-4x^2}} \\
 14 \quad f'(x) &= \frac{-\left(\frac{x}{\sqrt{1-x^2}} + 2 \cos^{-1} x\right)}{3x^3} & 15 \quad \frac{dy}{dx} &= \sin x(\ln x + 1) + x \ln x \cos x & 16 \quad \frac{dy}{dx} &= \frac{-(\sec x \operatorname{cosec} x + \ln(\cot x))}{e^x} & 17 \quad f'(2) &= -\frac{20}{3} \\
 18 \quad f'(4) &= \frac{-\pi + 2}{64} & 19 \quad \frac{dy}{dx} &= \frac{-y(2x + e^xy)}{x^2 + 2e^xy} & 20 \quad \frac{dy}{dx} &= \frac{y(4x^3y^2 - \cos x)}{(\sin x - 3x^4y^2)}
 \end{aligned}$$

Chapter 9 Exercise 9

$$\begin{aligned}
 1 \quad \frac{3}{4} & & 2 \quad 1 & & 3 \quad \frac{4 \ln 4 - 3}{e^2} & 4 \quad y = -\frac{4}{5}x + \frac{14}{5}, y = -\frac{6}{5}x - \frac{9}{5} & 5 \quad \frac{4}{3} & 6 \quad \frac{4-4\pi}{e^\pi} & 7 \quad (0,0) \text{ and } \left(2, \frac{4}{e^2}\right) & 8 \quad \left(e^{-\frac{1}{2}}, \frac{-2}{e}\right) \\
 9 \quad (0,0) & \text{ rising point of inflexion and } \left(3, \frac{27}{e^3}\right) \text{ max TP}
 \end{aligned}$$

Chapter 9 Review Exercise

$$\begin{aligned}
 1 \quad a \quad 60(3x-2)^3 & \quad b \quad 14x(3-2x^2)^{-\frac{3}{2}} & c \quad 6-3 \tan 3t \sec 3t & d \quad 48e^{8x} & e \quad \frac{1}{x} - 3^x \ln 3 & 2 \quad a \quad 4e^{4x} \sin 3x + 3e^{4x} \cos 3x & b \quad \frac{1}{x} + \cot x \\
 2 \quad c \quad \frac{e^{5x}}{\sqrt{x+4}} \left(5 - \frac{1}{2(x+4)}\right) & d \quad \frac{3}{3x+4} - \frac{2}{2x-1} & e \quad \frac{1}{\ln 10} \left(2 - 3 \tan 3x - \frac{2}{x+4}\right) & 3 \quad a \quad \frac{6xy}{8y-3x^2} & b \quad \frac{3x^2}{\ln x} - \frac{y}{x \ln x}
 \end{aligned}$$

- 4 $\frac{(2 \sin x + 4x(\cos x - \sin x) - 2x^{2\cos x-7})}{e^x} - \frac{2x \sin x - x^2 \cos x}{e^{2x}} + y$ 5 $\frac{-2(1 + \csc x \cot x + \cot^2 x)}{1 + \left(\frac{1 + \cos x}{\sin x}\right)^2}$, which reduces to -1
- 6 $-\frac{16\sqrt{x} - 4\pi\sqrt{x}}{\pi^2}$ 7 $-\frac{3}{4}$ 8 $-\frac{1}{3}$ 9 $y = \frac{4}{3}x - \frac{5}{3}$ 10 (0, 0) 11 2.533 12 $y = x - 4$ 13 $\frac{-4}{(2x-1)^2}$ 14 a $6 \sec 2t \tan 2t + 5$
- b i $3 + 5\pi$ ii 5 15 a -1 b $\frac{4}{5}$

Chapter 10 Exercise 1

- 1 $v = \sqrt{500}ms^{-1}$ 2 All three sides are $\sqrt{50}cm$ 3 14.65cm 4 5.62cm, 4.22cm, 16.9cm 5 7cm, 3.5cm 6 3.414 cm² 7 78.125 8 b $\frac{4r}{3}$
- 9 $x = y = 75cm$. It is a maximum value. 10 b $V = 60\left(\frac{450x - 60x^3}{13}\right)$ 10 c $x = 1.58cm$. It is a maximum value.
- 11 $t = 6.29$ seconds, $t = 12.6$ seconds 12 11100 13 50 Yen, 14.14 Km h^{-1} 14 20 15 a $\frac{7-x}{7} = \frac{y}{24}$ b $A = \frac{168x - 24x^2}{7}$ c $42cm^2$

Chapter 10 Exercise 2

- 1 $128\pi cm^2 s^{-1}$ 2 $\frac{15}{32\pi}$ 3 $\frac{2}{h}$ 4 611N₀ 5 $216cm^3 s^{-1}$ 6 $0.954ms^{-1}$ 7 $2.988cm^2 s^{-1}$ 8 $0.011cms^{-1}$ 9 $-\frac{5}{3}$
- 10 a $(r\theta - r \sin \theta, r - r \cos \theta)$ 11 $100cm^3 s^{-1}$ 13 a $\frac{2}{9}cms^{-1}$ b $\frac{4\pi}{3}cm^2 s^{-1}$

Chapter 10 Exercise 3

- 1 $v = 3\frac{1}{4}ms^{-1}$ $a = -3ms^{-2}$ $t = \frac{2\sqrt{3}}{3}$ seconds 2 a $8ms^{-1}$ b $16 - 12t$ c $-20ms^{-2}$ 3 a $-4(1 - 2t)$ b $t = \frac{1}{2}$ second c $0ms^{-2}$
- 4 a $v = \frac{t^2 \cos t - t \cos t - \sin t}{(t-1)^2}$ b $-1.74ms^{-1}$ c $a = \frac{t^3 \sin t + 2t^2 \sin t - 2t \cos t + 2 \cos t - t \sin t + 2 \sin t}{(t-1)^3}$ 7 Period = π
- 8 a $s = \frac{e^{2t}(t^2 - 2t - 1)}{(t^2 - 1)^2}$ b $v = \frac{-e^4}{9}$ c $a = \frac{4e^{2t}}{t^2 - 1} - \frac{(8t + 2)e^{2t}}{(t^2 - 1)^2} + \frac{4t^2 e^{2t}}{(t^2 - 1)^3}$ d $a = \frac{-2}{27e^4}$ 10 a $v = 3k \cos(kt + c)$
- 10 b $t = \frac{\pi - c}{k}$ c $a = 0.0213ms^{-2}$ 11 a $k = \frac{1}{100} \ln 300$ b $v = e^{\frac{\ln 300}{100} t^2} \left(1 + \frac{\ln 300}{50} t^2\right)$ c $a = \frac{\ln 300}{50} e^{\frac{\ln 300}{100} t^2} \left(3t + \frac{\ln 300}{50} t^3\right)$ d 1.927s
- 12 a Min is (2, 1.39) b $v = \frac{2}{t} - \frac{1}{t-1}$ $t \geq 2$ c $a = -\frac{2}{t^2} - \frac{1}{(t-1)^2}$ $t \geq 2$ d $v = \frac{4}{45}ms^{-1}$ $a = -\frac{31}{4050}ms^{-2}$
- 13 a $v = \frac{2t - s}{t + s}$ b $a = \frac{3(s^2 + 2st - 2t^2)}{(t + s)^3}$ c $s = t(-1 \mp \sqrt{3})$

Chapter 10 Review Exercise

- 1 120 km h^{-1} 2 a 13 ms⁻² b $t = 4.70$ seconds and $t = 1.05$ seconds
- 2 c Maximum velocity is $0.541 ms^{-1}$ Minimum velocity is $-1.35 ms^{-1}$ 3 $\frac{1}{2\pi}cms^{-1}$ 4 a = b = 24.42 cm 5 -1.6
- 6 a $A = 2\pi rh + \pi r^2$ b 4.30 cm c 1120 cm² 7 a $6t \sin 5t + 15t^2 \cos 5t$ b 0.457 hours c 0.304 hours 8 a $(\pi - 2x) \sin x$
- 8 b 1.12 units² 9 $\frac{\pi}{3}cm^2 s^{-1}$ 10 $-\frac{56}{27}ms^{-2}$ 11 a 6.28 hours. b 0.524 hours. 12 $256 cm^3 s^{-1}$ 13 a $BC = 2(x - h \csc \theta)$
- 13 b $2xh + h^2(\cot \theta - 2 \csc \theta)$ c $2h(x + h\left(2 - \frac{1}{\sqrt{3}}\right))$ 14 a $t = 2$ minutes b $\frac{112t^3}{(8 + t^4)^2}cm \text{ min}^{-1}$ c $19.55 cm^2 \text{ min}^{-1}$ d 1.48 minutes

Chapter 11 Exercise 1

- 1 a 1×3 b 2×3 c 3×3 d 4×1 2 Week 1 $\begin{pmatrix} 3 & 1 \\ 2 & 2 \\ 4 & 4 \end{pmatrix}$ Week 2 $\begin{pmatrix} 1 & 2 \\ 4 & 1 \\ 0 & 1 \end{pmatrix}$ Week 3 $\begin{pmatrix} 4 & 2 \\ 1 & 0 \\ 1 & 1 \end{pmatrix}$

The operation is addition.

	Magazines	Newspapers
Alan	8	5
Bill	7	3
Colin	5	6

3 a $\begin{pmatrix} 8 & 4 & 12 \\ 20 & -8 & 12 \\ 28 & -16 & 4 \end{pmatrix}$ b $\begin{pmatrix} -18 & -24 \\ 6 & -12 \\ 18 & 24 \end{pmatrix}$ c $\begin{pmatrix} 3k & 6k \\ -4k & -k \\ 12k & 4k \end{pmatrix}$ d $\begin{pmatrix} 3(k-1) & 2(k-1) \\ 1-k & 0 \end{pmatrix}$ 4 a $k=6$ b $k=0, 1$ c $k=1$ d $k=0, 3$

4 e $k=\frac{1}{2}$ f $k=5$ g $x=0, y=11$ 5 a not possible b $\begin{pmatrix} 10 & -2 \\ 0 & 4 \end{pmatrix}$ c not possible d $\begin{pmatrix} -11 & 5 \\ 6 & 0 \\ 8 & 1 \end{pmatrix}$ e $\begin{pmatrix} 7 & 1 \\ -1 & 3 \end{pmatrix}$ f $\begin{pmatrix} 9 & -2 \\ 0 & 3 \end{pmatrix}$

5 g $\begin{pmatrix} 18 & 5 \\ -8 & -15 \\ -4 & 37 \end{pmatrix}$ h $\begin{pmatrix} -15 & 1 \\ 1 & -5 \end{pmatrix}$ 6 a $\begin{pmatrix} -24 & 11 \\ -6 & 29 \end{pmatrix}$ b (-26) c $\begin{pmatrix} 11 & 29 \\ 6 & 22 \\ 12 & -7 \end{pmatrix}$ d $\begin{pmatrix} 29 & 39 & -11 \\ 11 & 41 & -9 \\ 2 & -29 & 2 \end{pmatrix}$ e $\begin{pmatrix} 6+k^2 & 2+2k \\ k^2-3 & 2k-1 \end{pmatrix}$

6 f $\begin{pmatrix} 7+3k^2-4k \\ -5 \\ 4-k \\ 1+2k-2k^2 \end{pmatrix}$ 7 a $\begin{pmatrix} 45 & 4 \\ 39 & -18 \end{pmatrix}$ b $\begin{pmatrix} 45 & 45k+4 \\ 39 & 39k-18 \end{pmatrix}$ c $\begin{pmatrix} 45 & 45k+4 \\ 39 & 39k-18 \end{pmatrix}$ d $\begin{pmatrix} 45+39k & 4-18k \\ 39 & -18 \end{pmatrix}$ e $\begin{pmatrix} 9 & 9k+12 \\ 27 & 27k-6 \end{pmatrix}$

7 f $\begin{pmatrix} 0 & 0 \\ -11 & 7-11k \end{pmatrix}$ g $\begin{pmatrix} -6 & 84-9k \\ -6 & 52-5k \end{pmatrix}$ h $\begin{pmatrix} -264 & 168 \\ -99 & 63 \end{pmatrix}$ 8 a $x=2, y=1$ b $x=0, y=1$ c $x=10, y=1$ d $x=4, y=-3$

9 $A^2 = \begin{pmatrix} 13 & -4 \\ 12 & -3 \end{pmatrix}$ $A^3 = \begin{pmatrix} 40 & -13 \\ 39 & -12 \end{pmatrix}$ 10 a $A = \begin{pmatrix} 3 & 2 & 4 \\ 5 & 7 & 2 \end{pmatrix}$ b $B = \begin{pmatrix} 1900 \\ 1300 \\ 1100 \end{pmatrix}$ c $AB = \begin{pmatrix} 12700 \\ 20800 \end{pmatrix}$

Minimum total number of calories consumed on day 1 and day 2. d i (33500). Minimum total calories consumed.

ii $\begin{pmatrix} 9 \\ 14 \end{pmatrix}$ Total number of people dieting on each day.

iii (4300) Total number of calories consumed by one man, one woman and one child. 11 a $P = \begin{pmatrix} 3 & 4 & 7 \\ 6 & 2 & 6 \\ 10 & 1 & 3 \\ 3 & 9 & 2 \\ 8 & 3 & 3 \end{pmatrix}$ b $Q = \begin{pmatrix} 3 \\ 1 \\ 0 \end{pmatrix}$ c $\begin{pmatrix} 13 \\ 20 \\ 31 \\ 18 \\ 27 \end{pmatrix}$

12 a $\begin{pmatrix} -1 & 6 \\ -4 & 1 \end{pmatrix}$ b $\begin{pmatrix} -7 & 9 \\ -6 & -4 \end{pmatrix}$ c $\begin{pmatrix} -6 & 0 \\ 0 & -6 \end{pmatrix}$ 13 $m=1, n=-6$ 14 $k=10$ 16 $c=5$ 17 $c=-2$

18 $PQ = \begin{pmatrix} 4 & 1-3c \\ 5c+4 & c \end{pmatrix}$ $QP = \begin{pmatrix} 5+c & 22 & -15 \\ 2 & 8 & -6 \\ 3+c^2 & 12+2c & -9 \end{pmatrix}$ 19 a $x=-\frac{8}{5}, y=10$ b $x=-5, y=0$ c $x=\frac{13}{3}, y=0$ 20 $\begin{pmatrix} a & b \\ 0 & a \end{pmatrix}$

Chapter 11 Exercise 2

1 a $\frac{1}{11} \begin{pmatrix} 5 & 2 \\ -3 & 1 \end{pmatrix}$ b $\frac{1}{41} \begin{pmatrix} 10 & -7 \\ 3 & 2 \end{pmatrix}$ c $\frac{1}{76} \begin{pmatrix} 1 & -8 \\ 9 & 4 \end{pmatrix}$ d $\begin{pmatrix} \frac{11}{137} & -\frac{6}{137} & \frac{29}{274} \\ \frac{10}{137} & \frac{7}{137} & -\frac{11}{274} \\ -\frac{24}{137} & \frac{38}{137} & -\frac{1}{274} \end{pmatrix}$ e $\begin{pmatrix} \frac{2}{37} & -\frac{25}{333} & -\frac{8}{333} \\ \frac{3}{74} & \frac{1}{37} & \frac{11}{74} \\ \frac{5}{74} & \frac{5}{111} & -\frac{19}{222} \end{pmatrix}$ f $\begin{pmatrix} \frac{37}{304} & -\frac{33}{152} & \frac{9}{76} \\ -\frac{1}{38} & \frac{5}{19} & -\frac{1}{19} \\ -\frac{17}{152} & \frac{9}{76} & \frac{1}{38} \end{pmatrix}$

1 g $-\frac{1}{14k} \begin{pmatrix} 1 & -5 \\ -3k & k \end{pmatrix}$ h $\frac{1}{k^2+7k} \begin{pmatrix} k+2 & -k \\ 1-2k & 3k \end{pmatrix}$ 2 $X = \begin{pmatrix} 1 & -\frac{3}{14} \\ -1 & \frac{5}{14} \end{pmatrix}$ $Y = \begin{pmatrix} 5 & 1 \\ 2 & 2 \\ 7 & 5 \end{pmatrix}$ $Z = \begin{pmatrix} \frac{43}{18} & \frac{31}{18} \\ \frac{19}{18} & -\frac{11}{18} \end{pmatrix}$ 3 a -30 b 44 c 78 d 190

4 a $\cos^2 \theta + \sin^2 \theta = 1$ b $-\sin 2\theta$ c -2 d $2abc$ e $\cos^3 \theta + \sin^3 \theta - 3 \sin^2 \theta + \tan^3 \theta$ f $-y^2 + y - 2$ g $a^3 - a^2b - ab^2 + b^3$

5 a 4 units² 5 b 4 units² c 20 units² 6 a Collinear b Not collinear c Collinear 8 $k = -1.22, 1.08$ 10 $c = -5, 4.5$

11 $y = -3.36, 3.86$ 12 $x = y = 1$ or $x = y = -1$ 13 a $\frac{1}{3}B^{-1}(2A - B)$ b $X = I$ 14 b $\frac{1}{8} \begin{pmatrix} -x-3 & x-1 \\ x+1 & 3-x \end{pmatrix}$

Chapter 11 Exercise 3

1 a $x = \frac{15}{7}, y = -\frac{17}{7}$ b $p = -21, q = -14$ c $x = \frac{5}{6}, y = \frac{2}{9}$ d $x = 7, y = 17$ 2 a $x = \frac{17}{4}, y = -\frac{11}{20}$ b $a = -\frac{61}{11}, b = -\frac{9}{11}$

2 c $x = -\frac{5}{7}, y = \frac{22}{7}$ d $x = -\frac{16}{5}, y = -\frac{69}{5}$ 3 a $x = -\frac{1}{3k+1}, y = -\frac{(5k+2)}{3k+1}, k \neq -\frac{1}{3}$ b $x = \frac{3(3-k)}{3-k^2}, y = \frac{3(k-1)}{3-k^2}, k \neq \pm\sqrt{3}$

3 c $x = \frac{12}{11k-5}, y = \frac{-13k+7}{11k-5}, k \neq \frac{5}{11}$ d $x = \frac{4k+14}{k^2+k+3}, y = \frac{10k-12}{k^2+k+3}, k \in \mathbb{R}$ 4 a Unique solution b Unique solution

4 c No unique solution d $k = -\frac{5}{3}, 1$ 5 a $c = 1, 0$. Lines are parallel. b $c = -2$. Lines are parallel.

- 6 a Consistent. Lines intersect giving unique solution. b Consistent. Same line giving infinite solutions. c Consistent. Same line giving infinite solutions.
7 $p = 3$ 8 $\lambda = -6, x = 1, y = -1$

Chapter 11 Exercise 4

- 1 a $x = -1, y = 9, z = -13$ b $x = 10, y = 10, z = -36$ c $x = 2, y = -4, z = -3$ d $x = 2, y = -1, z = 2$ 2 a $x = -3, y = 2, z = 4$
 2 b $x = -2, y = 1, z = 4$ c $x = -1, y = 1, z = 2$ d $x = 4, y = -5, z = 2$ 3 a $x = 4, y = \frac{1}{3}, z = -\frac{2}{3}$ b $x = \frac{55}{47}, y = \frac{40}{47}, z = -\frac{64}{47}$
 3 c $x = \frac{1}{2}, y = 1, z = -2$ d $x = 2, y = 3, z = -2$ 4 a Determinant = 6. Unique solution. b Determinant = 0. No unique solution.
 4 c Determinant = 0. No unique solution. d Determinant = 0. No unique solution. 5 a $x = -1, y = -1, z = 1$ b $x = -\frac{3}{19}, y = -\frac{59}{19}, z = \frac{28}{19}$
 5 c $x = -1, y = -2, z = 4$ d $x = \frac{1}{4}, y = \frac{1}{2}, z = 2$ 6 a $x = \frac{74}{19}, y = -\frac{3}{19}, z = -\frac{9}{19}$ b $x = 2, y = -1, z = -1$
 6 c $x = \frac{35}{66}, y = -\frac{43}{66}, z = -\frac{13}{33}$ d $x = 0, y = 2, z = 3$ 7 a $x = \frac{5-4\lambda}{2}, y = \lambda, z = \frac{-2\lambda-3}{4}$ b $x = -\frac{2}{5} + \lambda, y = \lambda, z = \frac{8}{5} - \lambda$
 7 c $x = \frac{19-5\lambda}{13}, y = \lambda, z = \frac{7\lambda-11}{13}$ d $x = \lambda, y = \mu, z = \frac{4-2\lambda-\mu}{3}$ e $x = \frac{7}{5}, y = 0, z = \frac{2}{5}$ f No solution. g No solution.
 7 h $x = 4, y = 4, z = 6$ 8 a $x = 2\lambda - 3, y = \lambda, z = \frac{5\lambda-10}{2}$ b $x = -\frac{5}{44}, y = \frac{15}{44}, z = -\frac{7}{22}$ c No solution.
 8 d No solution. e $x = \frac{44-4\lambda}{11}, y = \lambda, z = \frac{3\lambda}{11}$ f $x = 1, y = 2, z = -3$ 9 a $\begin{pmatrix} \frac{1}{5} & \frac{3}{5} & -\frac{2}{15} \\ -\frac{1}{10} & \frac{1}{5} & -\frac{1}{10} \\ -\frac{1}{6} & 0 & \frac{1}{18} \end{pmatrix}$ b $x = \frac{7}{15}, y = -\frac{2}{5}, z = -\frac{1}{9}$
 10 a 0 b $c = 3$ c $x = \lambda, y = \lambda, z = -2\lambda$
 12 a $\frac{4b-38}{b-20}$ 13 a $-2k^2 - 11k + 37$ b $k = -7.86, 2.36$ 14 a = 36

Chapter 11 Review Exercise

- 1 R is an $n \times p$ matrix S is an $m \times p$ matrix 2 $\lambda = 1$ or 6 3 a $\frac{1}{k^2+1} \begin{pmatrix} k & 1 \\ -1 & k \end{pmatrix}$ b $x = 1, y = -k$ 4 $x = 1, y = 8$
 5 a $\begin{pmatrix} 1 & k+3 & 5 \\ 1 & 3 & k+1 \\ 1 & 1 & k \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 0 \\ k+2 \\ 2k-1 \end{pmatrix}$ b $k = \frac{8}{3}$ c $z = \frac{k^2-5k-4}{8-3k}$ d If $k = \frac{8}{3}$ there is no solution.
 5 d Otherwise $x = \frac{-k^3-2k^2+29k-22}{8-3k}, y = \frac{k^2-6k+14}{8-3k}, z = \frac{k^2-5k-4}{8-3k}$ 6 a = -1, b = 3 7 a $3p - 3q - r = 0$
 7 b Solution is not unique. $x = \frac{17+3\lambda}{51}, y = \lambda, z = -\frac{5\lambda+11}{17}$ 8 b $k = -3$ 9 $p = 3, q = -5$ 10 a $c = -2.5, 0.5, 2$
 10 b $\begin{pmatrix} 36 & 39 & 50 \\ 14 & 16 & 20 \\ 15 & 18 & 22 \end{pmatrix}$ c Since M is singular, A must be singular. 11 $k = 5$ 12 b $c = -3$ c $x = -\frac{1+7\lambda}{2}, y = \lambda, z = \frac{11\lambda+7}{2}$
 13 a $a = 7, b = 2$ b $x = -1, y = 2, z = -1$ 15 a = 1 16 a = 4, b = -1 17 $y_1 = 16z_1 + 36z_2 - 58z_3$
 17 $y_2 = -18z_1 + 11z_2 - 3z_3$ $y_3 = 13z_1 + 12z_2 - 17z_3$

Chapter 12 Exercise 1

- 1 a $a = 1$ b $\frac{1}{2}$ c = 4 b $a = \frac{1}{3}$ b = 0, $\frac{1}{2}$ c = -8 c $a = \frac{8}{7}$ b = -3 2 a $PQ = i - 4j$ b $|PQ| = \sqrt{17}$
 3 a $AB = \begin{pmatrix} -3 \\ 2 \end{pmatrix}$ b $|AB| = \sqrt{13}$ 4 $\begin{pmatrix} 1 \\ 3 \end{pmatrix}$ 5 a $\sqrt{34}$ b $\sqrt{53}$ c $\sqrt{90}$ d $\sqrt{29}$ e $\sqrt{21}$ f $\sqrt{57}$ 6 a Parallel b Parallel
 6 c Not parallel d Not parallel 7 a $c = 6$ b $c = -7$ c $c = 6$ 8 $\begin{pmatrix} \frac{13}{2} \\ \frac{13\sqrt{3}}{2} \end{pmatrix}$ 9 $\begin{pmatrix} -5 \\ \sqrt{62} \\ -6 \\ \sqrt{62} \\ 1 \\ \sqrt{62} \end{pmatrix}$ 10 a Not parallel b Not parallel c Parallel

11 $PQ = \begin{pmatrix} 2 \\ 3 \end{pmatrix}$ $QR = \begin{pmatrix} -4 \\ -6 \end{pmatrix}$ $PR = \begin{pmatrix} -2 \\ -3 \end{pmatrix}$ $|PQ| = \sqrt{13}$ $|QR| = \sqrt{52}$ $|PR| = \sqrt{13}$ 12 a $R = \begin{pmatrix} 3 \\ 3 \\ 5 \end{pmatrix}$

12 b $PQ = \begin{pmatrix} 4 \\ -2 \\ -1 \end{pmatrix}$ $QR = \begin{pmatrix} -1 \\ 4 \\ 2 \end{pmatrix}$ $SR = \begin{pmatrix} 4 \\ -2 \\ -1 \end{pmatrix}$ $RP = \begin{pmatrix} -3 \\ -2 \\ -1 \end{pmatrix}$ c $|PQ| = \sqrt{21}$ $|QR| = \sqrt{21}$ $|SR| = \sqrt{21}$ $|RP| = \sqrt{14}$

12 d $PQ = \begin{pmatrix} \frac{4}{\sqrt{21}} \\ \frac{2}{\sqrt{21}} \\ \frac{-1}{\sqrt{21}} \end{pmatrix}$ $QR = \begin{pmatrix} \frac{-1}{\sqrt{21}} \\ \frac{4}{\sqrt{21}} \\ \frac{2}{\sqrt{21}} \end{pmatrix}$ $SR = \begin{pmatrix} \frac{4}{\sqrt{21}} \\ \frac{2}{\sqrt{21}} \\ \frac{-1}{\sqrt{21}} \end{pmatrix}$ $RP = \begin{pmatrix} \frac{-3}{\sqrt{14}} \\ \frac{-2}{\sqrt{14}} \\ \frac{-1}{\sqrt{14}} \end{pmatrix}$

14 $SU = -a - b$ 15 $a = -1, b = 1$ 16 $p = -\frac{4}{7}, q = \frac{4}{7}, r = -\frac{6}{7}$ 17 $x = -\frac{69}{53}, y = \frac{75}{53}$

Chapter 12 Exercise 2

1 a $3i + 4j - k$ b $6i - 2j - 9k$ c $-2i + 11j + 2k$ d $17i - 21j - 28k$ e $-3i - 6j + 49k$ f $20i - 25j - 84k$

1 g $13mi + 117mj - 91mk$ 2 a $17i + 16j$ b $\sqrt{421}$ c 74.7° 3 $q = 1$ Ratio is 1:2 4 a $AB = b - a$ b $AC = \frac{1}{2}(b - a)$

4 c $CB = \frac{1}{2}(b - a)$ d $OC = \frac{1}{2}(a + b)$ 5 a $\begin{pmatrix} -5 \\ 20 \end{pmatrix}$ b $\sqrt{425}$ c $\begin{pmatrix} 3 \\ 2 \end{pmatrix}$ d $\begin{pmatrix} 2 \\ -8 \end{pmatrix}$ 6 a $\begin{pmatrix} 6 \\ 10 \end{pmatrix}$ b $\sqrt{136}$ c $\begin{pmatrix} -4 \\ -8 \end{pmatrix}$ d $\begin{pmatrix} -25 \\ 4 \\ -47 \\ 4 \end{pmatrix}$

7 a $\frac{1}{1+k}(b-a)$ b $\frac{k}{1+k}(a-b)$ c $(a-b)$ d $\frac{ka+b}{1+k}$

8 a i $CD = -a$ ii $CA = -b - a$ iii $BD = b - a$ iv $AX = \frac{1}{3}b$ v $XD = \frac{2}{3}b$ b $AC = \begin{pmatrix} 6k \\ 4c \end{pmatrix}$

9 a $BE = \frac{mb}{m+n+3}$ 7 b $EF = \frac{nb}{m+n+3}$ c $CF = \frac{-3b}{m+n+3}$ d $AF = a + \frac{(m+n)b}{m+n+3}$ e $ED = -a + \frac{(2m+3n+9)b}{m+n+3}$

10 a $BC = b$ b $FH = b - a$ c $AH = b + c$ d $AG = a + b + c$ e $BH = b + c - a$ 12 a $DG = d - a - b$ b $AH = d$

12 c $FA = -b - c - d$ 14 a $AB = c, BC = -a, AC = c - a, OB = a + c$ b They are perpendicular.

Chapter 12 Exercise 3

1 a 11 b -1 c 29 d 2 e 7 f 54 g 40 h 25 2 a -5 b 6 c 30 d -9 e 3 f 55 g -26 h 1 3 a 58.7° b 86.6°

3 c 24.8° d 129° e 54.0° f 50.0° 4 p. q = 14, $\cos \theta = \sqrt{\frac{7}{19}}$ 5 a and d, a and f, b and c, b and e. 6 a $-\frac{3}{2}$ b -11 c $\frac{15}{2}$ d -3, 2

8 $-\frac{5}{\sqrt{35}}i + \frac{3}{\sqrt{35}}j + \frac{1}{\sqrt{35}}k$ 9 $x = 17.9$ or $x = 6.5$ 10 70.5° 12 It is not a rhombus

16 It is a rectangle since $\hat{A}BC$ is 90° but we do not know if $AB = BC$

Chapter 12 Exercise 4

1 a $-14i - 5j - 8k$ b $-14i - 5j - 8k$ c $14i + 5j + 8k$ d $28i + 10j + 16k$ e $14i + 5j + 8k$ f $42i + 15j + 24k$ g 0

2 a $\frac{21\sqrt{3}}{2}$ b $\frac{9\sqrt{39}}{2}$ c 6 7 a $-\frac{18}{\sqrt{817}}i + \frac{3}{\sqrt{817}}j + \frac{22}{\sqrt{817}}k$ b $\sqrt{\frac{817}{986}}$ 8 a $-\frac{2}{\sqrt{6}}i - \frac{1}{\sqrt{6}}j + \frac{1}{\sqrt{6}}k$ b $\sqrt{\frac{54}{55}}$

9 $\frac{-3}{\sqrt{19}}i + \frac{3}{\sqrt{19}}j - \frac{1}{\sqrt{19}}k$ 10 $\frac{\sqrt{74}}{2}$ units² 11 $\frac{\sqrt{341}}{2}$ units² 12 $\sqrt{6}$ units² 13 $4\sqrt{189}$ or $\sqrt{3024}$ units² 14 $\sqrt{850}$ units²

15 $\sqrt{234}$ units² 16 $PQ = 25i - 5j + 10k$ and $PS = -6i - 14j + 2k$ Area = $10\sqrt{1734}$ units²

Chapter 12 Review Exercise

1 b $\frac{3}{2}\sqrt{146}$ or $\frac{1}{2}\sqrt{1314}$ units² c $-10.8i + 9.6j - 1.2k$ d $\frac{137}{\sqrt{24817}}$ 2 a $6i - 12j + (2p + 1)k$ b $p = 4$ 4 $\sqrt{2 - 2\cos \theta}$ 5 $\begin{pmatrix} 5\cos \theta + 3 \\ 5\sin \theta + 2 \end{pmatrix}$

6 0 8 0.70210 $\alpha = \frac{\pi}{2} - 2\theta$ 11 a A has coordinates (2, 4, 6) B has coordinates (6, -3, 0) C has coordinates (4, -7, -6)

11 b 50.2 units² 11 c $\begin{pmatrix} 3 \\ -\frac{3}{2} \\ 0 \end{pmatrix}$ d 96.3° e 22.6 units² 12 $m = \frac{10}{3}$

Chapter 13 Exercise 1

1 a $r = \begin{pmatrix} 0 \\ 2 \\ -3 \end{pmatrix} + \lambda \begin{pmatrix} 1 \\ -2 \\ -1 \end{pmatrix}$ b $r = i - 2j + \lambda(i - 4j - 2k)$ c $r = \begin{pmatrix} 4 \\ 4 \\ 3 \end{pmatrix} + \lambda \begin{pmatrix} 0 \\ -5 \\ 12 \end{pmatrix}$ d $r = 5i + 2j + k + \lambda(3i + 6j - k)$ e $r = -3i - j + \lambda(2i - j)$

1 f $r = \begin{pmatrix} -5 \\ 1 \end{pmatrix} + \lambda \begin{pmatrix} 4 \\ -7 \end{pmatrix}$ 2 a $r = \begin{pmatrix} 2 \\ 1 \\ 2 \end{pmatrix} + \lambda \begin{pmatrix} 4 \\ -3 \\ -1 \end{pmatrix}$ b $r = \begin{pmatrix} -3 \\ 1 \\ 0 \end{pmatrix} + \lambda \begin{pmatrix} 7 \\ -2 \\ 2 \end{pmatrix}$ c $r = \begin{pmatrix} 2 \\ -2 \\ 3 \end{pmatrix} + \lambda \begin{pmatrix} -2 \\ 9 \\ -6 \end{pmatrix}$ d $r = \begin{pmatrix} 3 \\ 4 \\ -2 \end{pmatrix} + \lambda \begin{pmatrix} -1 \\ -9 \\ 1 \end{pmatrix}$

2 e $r = \begin{pmatrix} 4 \\ -3 \end{pmatrix} + \lambda \begin{pmatrix} -3 \\ 0 \end{pmatrix}$ 3 a $r = i - 2j - 4k + \lambda(3i + j - 5k)$ $x = 1 + 3\lambda, y = -2 + \lambda, z = -4 - 5\lambda$ $\frac{x-1}{3} = y+2 = \frac{z+4}{-5}$

3 b $r = \begin{pmatrix} -3 \\ -2 \\ 3 \end{pmatrix} + \lambda \begin{pmatrix} 4 \\ -7 \\ 3 \end{pmatrix}$ $x = -3 + 4\lambda, y = -2 - 7\lambda, z = 3 + 3\lambda$ $\frac{x+3}{4} = \frac{y+2}{-7} = \frac{z-3}{3}$

3 c $r = j + k + \lambda(i - 3k)$ $x = \lambda, y = 1, z = 1 - 3\lambda$ $y = 1, x = \frac{1-z}{3}$

3 d $r = \begin{pmatrix} 4 \\ 1 \\ 0 \end{pmatrix} + \lambda \begin{pmatrix} -1 \\ 2 \\ 2 \end{pmatrix}$ $x = 4 - \lambda, y = 1 + 2\lambda, z = 2\lambda$ $4 - x = \frac{y-1}{2} = \frac{z}{2}$

4 a $x = 1 - 2\lambda, y = -1 + 3\lambda, z = 2 - 2\lambda$ $\frac{1-x}{2} = \frac{y+1}{3} = \frac{2-z}{2}$ b $x = 2 + 3\mu, y = -5 - \mu, z = -1 + 4\mu$ $\frac{x-2}{3} = \frac{y+5}{-1} = \frac{z+1}{4}$

4 c $x = 2 + 4m, y = 8 - 7m, z = -1 + 6m$ $\frac{x-2}{4} = \frac{8-y}{7} = \frac{z+1}{6}$ d $x = 1 + 2n, y = -1 - 3n, z = 7 - n$ $\frac{x-1}{2} = \frac{y+1}{-3} = 7 - z$

4 e $x = 4 + 3s, y = 6 - 5s$ $\frac{x-4}{3} = \frac{6-y}{5}$ f $x = 1 + 2t, y = -6 - 5t$ $\frac{x-1}{2} = \frac{y+6}{-5}$

5 a $r = \begin{pmatrix} -7 \\ 6 \\ 4 \end{pmatrix} + \lambda \begin{pmatrix} 3 \\ 1 \\ 2 \end{pmatrix}$ b $r = \begin{pmatrix} -4 \\ -5 \\ 1 \end{pmatrix} + \mu \begin{pmatrix} -1 \\ 3 \\ 5 \end{pmatrix}$ c $r = \begin{pmatrix} 4 \\ 0 \\ -3 \end{pmatrix} + m \begin{pmatrix} 5 \\ 3 \\ 4 \end{pmatrix}$ d $r = \begin{pmatrix} -4 \\ -1 \\ 5 \end{pmatrix} + n \begin{pmatrix} 0 \\ 1 \\ -1 \end{pmatrix}$ 6 a $r = \begin{pmatrix} 3 \\ -5 \\ -1 \end{pmatrix} + \lambda \begin{pmatrix} 4 \\ 3 \\ -3 \end{pmatrix}$

6 b $r = \begin{pmatrix} 5 \\ 2 \\ -1 \\ -1 \end{pmatrix} + \lambda \begin{pmatrix} 2 \\ -4 \\ -3 \\ 2 \end{pmatrix}$ c $r = \begin{pmatrix} 2 \\ 5 \\ -5 \\ -7 \\ -2 \end{pmatrix} + \lambda \begin{pmatrix} 4 \\ 5 \\ -2 \\ 3 \\ 2 \end{pmatrix}$ d $r = \begin{pmatrix} -1 \\ 4 \\ 3 \\ 4 \end{pmatrix} + \lambda \begin{pmatrix} 1 \\ 1 \\ -9 \end{pmatrix}$ e $r = \begin{pmatrix} 5 \\ 3 \\ -2 \\ 1 \end{pmatrix} + \lambda \begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix}$ f $r = \begin{pmatrix} 5 \\ 3 \\ 7 \\ 2 \end{pmatrix} + \lambda \begin{pmatrix} 49 \\ -4 \\ 0 \end{pmatrix}$

7 a No b Yes c No d Yes e No f Yes 8 $r = \begin{pmatrix} 3 \\ 7 \\ -1 \end{pmatrix} + \lambda \begin{pmatrix} 6 \\ -9 \\ 2 \end{pmatrix}$ Position vector is $\begin{pmatrix} 6 \\ 5 \\ 2 \\ 0 \end{pmatrix}$

9 Crosses the xy plane at $(-9, -7, 0)$ Crosses the yz plane at $(0, 11, -\frac{9}{2})$ Crosses the xz plane at $(-\frac{11}{2}, 0, -\frac{7}{4})$

10 a $r = 2i - j + 5k + \lambda(3i - j + k)$ Crosses the xy plane at $(-13, 4, 0)$ Crosses the yz plane at $(0, -\frac{1}{3}, \frac{13}{3})$ Crosses the xz plane at $(-1, 0, 4)$

10 b $r = \begin{pmatrix} 2 \\ 6 \\ 7 \end{pmatrix} + \lambda \begin{pmatrix} 1 \\ -1 \\ -1 \end{pmatrix}$ Crosses the xy plane at $(9, -1, 0)$ Crosses the yz plane at $(0, 8, 9)$ Crosses the xz plane at $(8, 0, 1)$

11 Crosses the xy plane at $(-\frac{29}{15}, \frac{14}{5}, 0)$ Crosses the yz plane at $(0, \frac{17}{4}, -\frac{29}{12})$ Crosses the xz plane at $(-\frac{17}{3}, 0, \frac{14}{3})$

Chapter 13 Exercise 2

1 a Skew b Intersect at the point $(2, 1, 6)$ c Parallel d Skew e Skew f Parallel g Skew

2 a $\frac{\sqrt{210}}{6}$ b $\sqrt{17}$ c 1 d $\frac{5}{\sqrt{2}}$ e Lies on line. f $\frac{2\sqrt{3}}{\sqrt{7}}$

3 AB: $r = \begin{pmatrix} 0 \\ 1 \\ -2 \end{pmatrix} + \lambda \begin{pmatrix} 3 \\ 4 \\ 7 \end{pmatrix}$ $\frac{x}{3} = \frac{y-1}{4} = \frac{z+2}{7}$ AD: $r = \begin{pmatrix} 0 \\ 1 \\ -2 \end{pmatrix} + \lambda \begin{pmatrix} 1 \\ 2 \\ -1 \end{pmatrix}$ $x = \frac{y-1}{2} = -z - 2$ Coordinates of C are $(4, 7, 4)$

4 a 60.5° b 36.3° c 71.2° d 88.4° e 62.8° 5 $a = -2$ Point of intersection is $(1, 5, -3)$ 6 $r = \begin{pmatrix} -3 \\ 8 \end{pmatrix} + t \begin{pmatrix} -3 \\ 2 \end{pmatrix}$

7 a $r = 2i - 3j + k + \lambda(i + 8j - 3k)$ b $p = 34$

Chapter 13

Exercise 3

$$1 \text{ a } r. \begin{pmatrix} 1 \\ \sqrt{18} \\ 4 \\ \sqrt{18} \\ -1 \\ \sqrt{18} \end{pmatrix} = 3 \quad \text{b } r. \left(\frac{1}{\sqrt{35}}i - \frac{3}{\sqrt{35}}j + \frac{5}{\sqrt{35}}k \right) = \frac{-8}{\sqrt{35}} \quad \text{c } r. \begin{pmatrix} 2 \\ \sqrt{5} \\ 0 \\ 1 \\ \sqrt{5} \end{pmatrix} = 6 \quad \text{d } r. \left(\frac{-1}{\sqrt{18}}i - \frac{4}{\sqrt{18}}j + \frac{1}{\sqrt{18}}k \right) = \frac{-15}{\sqrt{18}}$$

$$1 \text{ e } r. \left(\frac{1}{\sqrt{74}}i - \frac{8}{\sqrt{74}}j + \frac{3}{\sqrt{74}}k \right) = \frac{-19}{\sqrt{74}} \quad \text{f } r. \left(\frac{-3}{\sqrt{19}}i + \frac{3}{\sqrt{19}}j + \frac{1}{\sqrt{19}}k \right) = \frac{3}{\sqrt{19}} \quad \text{g } r. \left(\frac{10}{\sqrt{1133}}i - \frac{3}{\sqrt{1133}}j + \frac{32}{\sqrt{1133}}k \right) = \frac{-63}{\sqrt{1133}}$$

$$1 \text{ h } r. \begin{pmatrix} 7 \\ \sqrt{354} \\ 17 \\ \sqrt{354} \\ 4 \\ \sqrt{354} \end{pmatrix} = \frac{32}{\sqrt{354}} \quad \text{i } r. \begin{pmatrix} 20 \\ \sqrt{557} \\ 6 \\ \sqrt{557} \\ 11 \\ \sqrt{557} \end{pmatrix} = \frac{86}{\sqrt{557}} \quad \text{j } r. \left(\frac{-3}{\sqrt{26}}i - \frac{4}{\sqrt{26}}j + \frac{1}{\sqrt{26}}k \right) = 0 \quad \text{k } r. \left(\frac{3}{\sqrt{13}}i - \frac{2}{\sqrt{13}}j \right) = \frac{15}{\sqrt{13}}$$

$$1 \text{ l } r. \left(\frac{-7}{\sqrt{65}}j + \frac{4}{\sqrt{65}}k \right) = 0 \quad \text{2 a } r. (5j + 2k) = -2 \quad \text{b } r. (5i - 4j + 15k) = 42 \quad \text{c } r. \begin{pmatrix} -15 \\ 3 \\ 11 \end{pmatrix} = -3 \quad \text{d } r. (i + 11j - 9k) = 16$$

$$3 \text{ a } x - 2y + 7z = 9 \quad \text{b } 4x - y = -6 \quad \text{c } 15x + 13y - 8z = -38 \quad \text{d } -4x + 3y + 8z = 21 \quad \text{4 } r. \begin{pmatrix} 1 \\ -3 \\ 7 \end{pmatrix} = 4$$

$$5 \text{ a } \frac{1}{\sqrt{30}}i + \frac{2}{\sqrt{30}}j - \frac{5}{\sqrt{30}}k \quad \text{b } \frac{4}{\sqrt{42}}i - \frac{1}{\sqrt{42}}j + \frac{5}{\sqrt{42}}k \quad \text{c } \frac{-3}{7}i - \frac{6}{7}j + \frac{2}{7}k \quad \text{d } \frac{5}{\sqrt{45}}i - \frac{2}{\sqrt{45}}j + \frac{4}{\sqrt{45}}k \quad \text{7 } r. (13i - 4j - 11k) = 31$$

8 The direction normals are equal. Distance $\frac{8}{\sqrt{19}}$ units.

$$9 \text{ b } r. (i + 5j + k) = 1 \quad \text{c } \text{Distance of } \pi_1 \text{ to origin is } \frac{8}{\sqrt{27}} \text{ units. Distance of } \pi_2 \text{ to origin is } \frac{1}{\sqrt{27}} \text{ units. Distance between } \pi_1 \text{ and } \pi_2 \text{ is } \frac{7}{\sqrt{27}} \text{ units}$$

$$10 P_1 = r.(2i + 5j - 6k) = -41. \text{ Distance of } P_1 \text{ to origin is } \frac{41}{\sqrt{65}} \text{ units. Distance of } P_2 \text{ to origin is } \frac{14}{\sqrt{65}} \text{ units. Distance between } P_1 \text{ and } P_2 \text{ is } \frac{55}{\sqrt{65}} \text{ units}$$

11 $r. (i - k) = 1$ r_1 is not contained in the plane. r_2 is contained in the plane.

$$12 r. \left(\frac{8}{\sqrt{89}}i - \frac{5}{\sqrt{89}}k \right) = \frac{-17}{\sqrt{89}} \quad \text{Distance of plane from the origin is } \frac{17}{\sqrt{89}} \text{ units.}$$

$$13 r. \begin{pmatrix} 2 \\ -3 \\ -2 \end{pmatrix} = -13 \quad \text{Distance of plane from the origin is } \frac{13}{\sqrt{17}} \text{ units.} \quad \text{14 } r = (4i + 3j + 7k) + \lambda(2i + 2j - 5k)$$

$$15 \text{ b } r. (i + j - k) = -9 \quad \text{c } \text{Distance of } P_1 \text{ to origin is } \frac{8}{\sqrt{3}} \text{ units. Distance of } P_2 \text{ to origin is } \frac{9}{\sqrt{3}} \text{ units. Distance between } P_1 \text{ and } P_2 \text{ is } \frac{17}{\sqrt{3}} \text{ units}$$

16 a The line and the plane intersect. b The line and the plane are parallel. c The line and the plane intersect. d The line and the plane intersect.

Chapter 13

Exercise 4

$$1 \text{ a } \left(9, \frac{1}{2}, -\frac{2}{3} \right) \quad \text{b } \left(4, \frac{1}{2}, -2 \right) \quad \text{c } (3, -2, -9) \quad \text{d } \left(\frac{51}{7}, \frac{1}{7}, 1 \right) \quad \text{e } \left(\frac{20}{3}, -\frac{13}{9}, \frac{4}{3} \right) \quad \text{f } (16, -10, -7)$$

$$2 \text{ a } 45.0^\circ \quad \text{b } 23.2^\circ \quad \text{c } 11.0^\circ \quad \text{d } 64.5^\circ \quad \text{e } 90^\circ \quad \text{f } 55.9^\circ \quad \text{3 a } 11.7^\circ \quad \text{b } 57.8^\circ \quad \text{c } 17.6^\circ \quad \text{d } 32.5^\circ \quad \text{e } 34.1^\circ \quad \text{f } 5.51^\circ$$

$$4 \text{ a } r = (4i + j) + \lambda(14i + 17j + 13k) \quad \text{b } r = \begin{pmatrix} 2 \\ -2 \\ 0 \end{pmatrix} + \lambda \begin{pmatrix} 7 \\ -1 \\ 4 \end{pmatrix} \quad \text{c } r = (7i + 3j) + \lambda(2i - k) \quad \text{d } r = (i - 6j) + \lambda(-3i - 2j + k)$$

$$4 \text{ e } r = (-4i - 22j) + \lambda(7i + 31j + 2k) \quad \text{f } r = \left(\frac{56}{25}i + \frac{29}{25}j \right) + \lambda(36i - 26j - 25k) \quad \text{6 } 48.5^\circ \quad \text{7 a } r = \begin{pmatrix} 1 \\ 2 \\ -3 \end{pmatrix} + \lambda \begin{pmatrix} 3 \\ 1 \\ -3 \end{pmatrix} \quad \text{b } (-2, 1, 0)$$

$$8 \text{ a } a = -3 \quad \text{b } 74.2^\circ \quad \text{c } 13.9 \text{ units.}$$

Chapter 13

Review Exercise

$$1 \text{ i } \frac{3}{\sqrt{178}}i - \frac{12}{\sqrt{178}}j + \frac{5}{\sqrt{178}}k \quad \text{ii } r. \left(\frac{3}{\sqrt{178}}i - \frac{12}{\sqrt{178}}j + \frac{5}{\sqrt{178}}k \right) = \frac{7}{\sqrt{178}} \quad \text{iii } 73.5^\circ \quad \text{2 b } \frac{\sqrt{30}}{2} \text{ units}^2 \quad \text{c } \frac{1}{\sqrt{30}}i - \frac{2}{\sqrt{30}}j - \frac{5}{\sqrt{30}}k$$

- 2 d AD has equation $x - 1 = \frac{1 - y}{3} = \frac{1 - z}{4}$ BD has equation $2x - 4 = \frac{4 + 2y}{-9} = \frac{6 + 2z}{-7}$ e 16.4° 3 a ii $r = \begin{pmatrix} 2 \\ 1 \\ 1 \end{pmatrix} - \lambda \begin{pmatrix} 1 \\ 2 \\ 1 \end{pmatrix}$ b $3x - 2y + z = 5$
- 3 c $r = \begin{pmatrix} 2 \\ 1 \\ 1 \end{pmatrix} + \lambda \begin{pmatrix} -1 \\ -2 \\ -1 \end{pmatrix}$ 4 b $\left(\frac{18}{5}, \frac{-36}{5}, 4\right)$ c $r \cdot \begin{pmatrix} -2 \\ 4 \\ 9 \end{pmatrix} = 0$ d $\left(-33, \frac{-51}{2}, 4\right)$ 5 a $\left(1, \frac{-13}{5}, \frac{12}{5}\right)$ b $(6, -1, 4)$ c $r = \begin{pmatrix} 6 \\ -1 \\ 4 \end{pmatrix} + \lambda \begin{pmatrix} 25 \\ 8 \\ 8 \end{pmatrix}$
- 5 d 62.7° 6 a $\frac{x-2}{1} = \frac{y-5}{1} = \frac{z+1}{1}$ b $\left(\frac{1}{3}, \frac{10}{3}, \frac{-8}{3}\right)$ c $\left(\frac{-4}{3}, \frac{5}{3}, \frac{-13}{3}\right)$ d 8.52 7 $r = \begin{pmatrix} -2 \\ 3 \\ 0 \end{pmatrix} + \lambda \begin{pmatrix} -1 \\ 1 \\ 1 \end{pmatrix}$ 8 a $AB = \begin{pmatrix} -1 \\ -3 \\ 1 \end{pmatrix}$ $BC = \begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix}$
- 8 b $-i + j + 2k$ c $\frac{\sqrt{6}}{2}$ d $r \cdot \begin{pmatrix} -1 \\ 1 \\ 2 \end{pmatrix} = 3$ e $x = 2 - \lambda$ $y = -1 + \lambda$ $z = -6 + 2\lambda$ f $3\sqrt{6}$ g $\frac{-j}{\sqrt{6}} + \frac{j}{\sqrt{6}} + \frac{2k}{\sqrt{6}}$ h $(-4, 5, 6)$
- 9 a A lies in the plane. B does not lie in the plane b $\frac{2-x}{2} = \frac{y+3}{4} = z - 8$ c 43.6° d 3.16 units. e $r \cdot (i + 3j - 10k) = -87$
- 10 a $-2i + 2j - k$ b i $n_1 = 6i + 3j - 2k$ and $n_2 = -2i + 2j - k$ ii 79.0° d i $(8, -20, -12)$
- 11 a $r = (2i + j + 4k) + \lambda(3i + j)$ b $(-4, -1, 4)$ c 0.716 d $(0, -13, 18)$ e $\left(-\frac{13}{3}, 0, \frac{28}{3}\right)$ f $r = \begin{pmatrix} 0 \\ -13 \\ 18 \end{pmatrix} + \lambda \begin{pmatrix} -\frac{13}{3} \\ 13 \\ -\frac{26}{3} \end{pmatrix}$
- 12 a ii $r = (-j - k) + \lambda(3i + 11j + k)$ b $c = -2$. Line of intersection. c ii $\frac{7\sqrt{2}}{6}$ 13 $r = \begin{pmatrix} 7 \\ 0 \\ -4 \end{pmatrix} + \lambda \begin{pmatrix} -7 \\ 1 \\ 5 \end{pmatrix}$
- 14 a $r = (2i + 3j + 7k) + t(3i + j + 3k)$ b $(8, 5, 13)$ c $2x + 3y - 4z + 4 = 0$ e i $i + j - k$ ii $PO = i - 2j - 4k$ iii $\frac{12}{\sqrt{14}}$
- 15 b $\frac{4}{\sqrt{21}}$ c $r \cdot (i + 4j + 2k) = -9$ d $\frac{13}{\sqrt{21}}$ 16 a $\left(4, \frac{5}{2}, \frac{13}{2}\right)$ b $x + 2y = 9$ c $\left(\frac{37}{5}, \frac{4}{5}, \frac{9}{5}\right)$ d $(6.63, 3.50, 4.65)$
- 16 $(6.87, 3.99, 4.15)$ or $(4.53, -0.694, 4.15)$

Chapter 14 Exercise 1

- 1 $5x$ 2 $10x$ 3 $-2x$ 4 $2x^2$ 5 $6x^2$ 6 x^3 7 x^4 8 x^5 9 $3x^3$ 10 $4x^{-1}$

Chapter 14 Exercise 2

- 1 $x^2 - x + c$ 2 $\frac{1}{3}x^3 + c$ 3 $\frac{1}{4}x^4 + c$ 4 $\frac{1}{5}x^5 + c$ 5 $2x^3 - 5x + c$ 6 $2x^4 + 2x^2 - 3x + c$ 7 $\frac{5}{3}x^3 - 4x + c$ 8 $-x^{-1} + c$
- 9 $\frac{2}{3}x^3 + c$ 10 $3x^3 + c$ 11 $7x + 2x^{-2} + c$ 12 $2x^3 + c$ 13 $\frac{2}{7}x^7 - x^5 + c$ 14 $2x^3 + 2x^{-2} + c$ 15 $x^4 + 2x^2 - 9x + c$
- 16 $x - x^2 + 2x^3 - \frac{1}{4}x^4 + c$ 17 $-3x^{-2} + c$ 18 $y = -\frac{1}{2}x^{-4} + c$ 19 $y = \frac{2}{3}x^3 - 2x^{\frac{3}{2}} + c$ 20 $y = 8x - \frac{9}{2}x^{\frac{3}{2}} + c$ 21 $y = 4x^4 - 12x^2 + c$
- 22 $y = \frac{2}{3}x^3 - \frac{21}{2}x^2 + 27x + c$ 23 $y = 3x^3 - 12x^2 + 16x + c$ 24 $y = -\frac{1}{2}x^{-2} + \frac{5}{4}x^{-4} + c$ 25 $y = \frac{8}{7}x^{\frac{7}{2}} - \frac{14}{3}x^{\frac{3}{2}} + c$ 26 $y = \frac{14}{19}x^{\frac{19}{2}} - 2x^{\frac{3}{2}} + c$
- 27 $y = -6\rho^{-2} + c$ 28 $y = \frac{32}{9}k^{\frac{3}{2}} + c$ 29 $y = \frac{1}{6}z^6 - \frac{1}{2}z^2 + c$ 30 $y = -t^{-1} - 3t^{-2} - 3t^{-3} + c$ 31 $y = \frac{2}{3}t^{\frac{1}{2}} - \frac{4}{9}t^3 + c$

Chapter 14 Exercise 3

- 1 $y = 6x - 4$ 2 $y = 2x^2 + 3$ 3 $y = 4x^2 - 3x - 18$ 4 $y = -x^2 + 5x$ 5 $y = x^4 - 2x^3 + 7x + 3$ 6 $y = \frac{4}{3}x^3 - 6x^{-1} - \frac{509}{6}$
- 7 $y = 16x^{\frac{1}{2}} - 46$ 8 $y = \frac{1}{7}t^7 - \frac{3}{5}t^5 - \frac{4}{3}t^3 + \frac{818}{105}$ 9 $Q = \frac{2}{21}p^{\frac{2}{3}} - \frac{8}{33}p^{\frac{1}{3}} + 2$

Chapter 14 Exercise 4

- 1 $\frac{1}{4}x^4 - 2 \ln|x| + c$ 2 $4e^x - \cos x + c$ 3 $5 \ln|x| - \sin x + c$ 4 $-6 \cos x - \frac{6}{5}x^5 + c$ 5 $8 \cos x + 7e^x + c$
- 6 $5e^x + 2 \cos x + 3 \ln|x| + c$ 7 $\frac{1}{3}e^x - \frac{5}{2} \ln|x| - 7 \cos x + c$ 8 $\frac{e^x}{15} - 10x^{\frac{3}{2}} + \sin x + c$

Chapter 14 Exercise 5

- 1 $-\frac{1}{5}\cos 5x + c$ 2 $\frac{1}{6}\sin 6x + c$ 3 $-\frac{1}{2}\cos 2x + c$ 4 $-2\cos\frac{1}{2}x + c$ 5 $2\sin 4x + c$ 6 $2\cos 3x + c$ 7 $-\frac{5}{2}\sin 2x + c$ 8 $\frac{1}{6}e^{6x} + c$
 9 $\frac{1}{5}e^{5x} + c$ 10 $e^{4x} + c$ 11 $\frac{4}{3}e^{6t} + c$ 12 $-\frac{5}{6}e^{6p} + c$ 13 $4x^2 - \frac{1}{2}e^{2x} + c$ 14 $-2e^{-2x} + c$ 15 $y = \frac{1}{2}\ln|2x - 3| + c$
 16 $y = \frac{1}{8}\ln|8x + 7| + c$ 17 $y = 2\ln|2x - 5| + c$ 18 $y = \frac{1}{18}(3x - 1)^6 + c$ 19 $y = \frac{1}{28}(4x - 7)^7 + c$ 20 $y = -\frac{1}{8}(4x + 3)^{-2} + c$
 21 $y = -\frac{1}{10}(3 - 2x)^5 + c$ 22 $y = -\frac{2}{3}(3x - 2)^{-2} + c$ 23 $y = -\frac{3}{2}(2t - 1)^{-1} + c$ 24 $y = \frac{4}{3}\ln|3x - 1| + c$ 25 $y = 2\ln|3x - 5| + c$
 26 $y = -8\ln|4 - p| + c$ 27 $y = -3\ln|6 - t| + c$ 28 $\frac{3}{2}e^{4x} + c$ 29 $-\frac{1}{3}\cos 3x - 2x^2 + c$ 30 $-\frac{1}{2}e^{-8x} - 2\sin 2x + c$
 31 $\frac{1}{2}\ln|2x - 1| + \frac{1}{18}(3x + 4)^6 + c$ 32 $2x^3 - \frac{2}{3}\ln|3x + 2| + c$

Chapter 14 Exercise 6

- 1 3 2 38 3 20 4 0 5 $\frac{2}{3}$ 6 $-\frac{8}{3}$ 7 201 8 216468 9 1490 10 $\frac{2}{3}$ 11 0 12 $\frac{1 - 3\pi}{3}$ 13 21 14 -200 15 312.6
 16 0.490 17 0.0429 18 0.549 19 1.85 20 -3.47 21 8.56 22 0, because both functions are odd 23 $2\ln|2k + 1|$

Chapter 14 Exercise 7

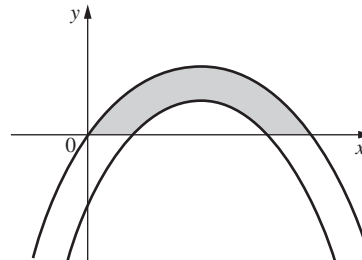
- 1 32 2 $\frac{343}{6}$ 3 50 4 70.4 5 2 6 6.39 7 5.55 8 0.619 9 22 10 1.69 11 0.825 12 2.19 13 27 14 10.4 15 2 16 2.27
 17 $\frac{4}{3}$ 18 9 19 $\frac{4}{3}$ 20 1.48 21 $\frac{2}{3}\ln\left|\frac{3p + 5}{8}\right|$ 22 $\frac{1}{2}(1 - e^{-2p}) + \frac{1}{3}p^3$ 23 $k = 4$ 24 $a = 1$

Chapter 14 Exercise 8

- 1 $\frac{64}{3}$ 2 61 3 16 4 $\frac{85}{4}$ 5 $\frac{253}{12}$ 6 $\frac{2401}{16}$ 7 $\frac{863}{6}$ 8 22.1 9 23 10 408 11 $\frac{21}{4}$ 12 2 13 6 14 15.3

Chapter 14 Exercise 9

- 1 $\frac{1}{6}$ 2 $\frac{1}{8}$ 3 $\frac{1}{2}$ 4 $\frac{1}{3}$ 5 $\frac{125}{6}$ 6 $\frac{407}{4}$ 7 36 8 6.43 9 $\frac{160}{3}$
 10 1.60 11 1.85 12 3.08 13 $\frac{5}{2}$ 14 3.92 15 $\frac{8}{3}$ 16 $\frac{32}{3}$
 17 $\frac{256}{3}$ 18 18 19 $\frac{10\sqrt{5}}{3}$ 20 3.62 21 4.53 22 3.21



Chapter 14 Review Exercise

- 1 a $\frac{4}{3}x^3 - 7x + c$ b $3x^3 + 2x^2 - 5x + c$ c $-4x^{-2} + c$ d $-\frac{1}{6}(3 - 2x)^3 + c$ 2 a $y = -\frac{1}{x} + \frac{3}{2}x^{-4} + c$ b $y = p^3 - \frac{1}{8}p^8 + c$
 2 c $y = \frac{3}{8}t^2 - \frac{1}{2}t^3 + c$ 3 $y = -\frac{3}{2}x^2 + 8x - 2$ 4 a $4e^x + \cos x + c$ b $7\sin x - 4\ln|x| + c$ c $\frac{1}{3}e^{6x} - 5\ln|x| - 4\cos x + c$
 5 a $3\sin 2x + c$ b $2e^{2x} + c$ c $\frac{1}{2}\ln|4x - 3| + c$ d $\frac{1}{21}(3x - 2)^7 + c$ e $\frac{7}{3}e^{3x} + \frac{1}{3}(3x - 4)^{-4} + c$ 6 $\frac{4x^{\frac{3}{2}}}{5} + \frac{3}{x} + c$
 7 a $\frac{382}{25}$ b $\frac{1}{2} + \frac{1}{4}\pi$ c $3\sin 2k$ 8 a $e^5 - e^2$ b 36 c $\frac{2}{3}$ 9 $\frac{3}{2}\ln(2p - 5)$
 10 $\frac{407}{4}$ 11 a 0.753 b 2.45 c 1.78 12 a $\frac{9}{2}$ b 24.3 13 a 13.3 b 1.93 14 30.2

Chapter 15 Exercise 1

- 1 $-\cos\left(\theta - \frac{3\pi}{4}\right) + c$ 2 $\frac{1}{3}\sin\left(3x + \frac{\pi}{4}\right) + c$ 3 $\frac{1}{32}e^{32x-7} + c$ 4 $2e^{\sin^2} - 2$ 5 $\frac{1}{4}\ln|8x - 9| + c$ 6 $\frac{1}{54}(x^6 - 9)^9 + c$
 7 $\frac{1}{16}[(2p^4 + 1)^2 - 1]$ 8 $\frac{1}{3}(1 + x^2)^{\frac{3}{2}} + c$ 9 $\frac{1}{12}(4x^2 - 3)^{\frac{3}{2}} + c$ 10 $\frac{1}{12}(3\tan x + 4)^4 + c$ 11 $(x^2 - 1)^{\frac{1}{2}} + c$ 12 $\frac{1}{10}[1 - (2\cos 0.5 - 1)^5]$
 13 $\frac{1}{24}[(6e^{2a} - 7)^2 + 1]$ 14 $-\frac{1}{3}(\cos 2x - 1)^{\frac{3}{2}} + c$ 15 $\frac{1}{12}(x^2 + 2x - 4)^6 + c$ 16 $\ln|x^2 - 3x + 5| + c$ 17 $\frac{3}{2(\cos x + 8)^2} + c$

18 $\frac{1}{2} \ln|2e^x - 4| + c$ 19 $\frac{1}{3} \ln|3 \sin x - 12| + c$ 20 $\frac{2}{15}(3x^3 + 6x - 19)^{\frac{5}{2}} + c$ 21 $\frac{1}{21}(1 - 3 \cos 2x)^{\frac{3}{2}} + c$ 22 $\frac{1}{6} \ln|3 \tan 2x - 7| + c$
 23 $\frac{15}{128}$ 24 $\frac{1}{3} \ln|3x^2 - 3x + 4| + c$ 25 $-\frac{1}{9(3x^2 - 3x + 4)^3} + c$ 26 $(\ln|p|)^2$ 27 $\ln|e^{2x} + 1| + c$ 28 $\frac{1}{6} \ln|2p^2 + 2p - 5|$

Chapter 15 Exercise 2

1 $\frac{1}{3} \tan^{-1} \frac{x}{3} + c$ 2 $\sin^{-1} \frac{x}{5} + c$ 3 $\cos^{-1} \frac{x}{6} + c$ 4 $3 \tan^{-1} \frac{x}{3} + c$ 5 $2 \sin^{-1} \frac{x}{2\sqrt{2}} + c$ 6 $\frac{\sqrt{3}}{3} \tan^{-1} \frac{p\sqrt{3}}{3} - \frac{\pi\sqrt{3}}{18}$ 7 0.0203
 8 $\frac{\sqrt{3}}{3} \sin^{-1} x\sqrt{3} + c$ 9 $\sin^{-1}(x - 1) + c$ 10 $\frac{1}{8} \tan^{-1} \left(\frac{x+1}{2}\right) + c$ 11 $\frac{1}{3} \tan^{-1} \left(\frac{x+3}{3}\right) + c$ 12 $5 \cos^{-1} \left(\frac{x+2}{3}\right) + c$ 13 $\frac{1}{6} \tan^{-1} \left(\frac{3x+1}{2}\right) + c$
 14 $\frac{2}{\sqrt{7}} \tan^{-1} \left(\frac{2x+3}{\sqrt{7}}\right) + c$ 15 $4 \sin^{-1} \left(\frac{2x-3}{7}\right) + c$ 16 $\frac{1}{3} \sin^{-1} \left(\frac{x-1}{2\sqrt{3}}\right) + c$ 17 0.0623 18 $\sin^{-1} \left(\frac{p+3}{\sqrt{3}}\right) - \sin^{-1} \left(\frac{\sqrt{3}}{3}\right)$

Chapter 15 Exercise 3

1 $\sin x - \frac{1}{3} \sin^3 x + c$ 2 $-\frac{1}{2} \cos 2x + \frac{1}{6} \cos^3 2x + c$ 3 $-\cos x + \frac{2}{3} \cos^3 x - \frac{1}{5} \cos^5 x + c$ 4 $\frac{1}{2} \tan 2p - p$ 5 $\frac{x}{2} + \frac{\sin 4x}{8} + c$
 6 $\frac{x}{2} - \frac{\sin 4x}{8} + c$ 7 $\frac{1}{32}(12x - 8 \sin 2x + \sin 4x) + c$ 8 $-\cos x + \frac{4}{3} \cos^3 x - \frac{6}{5} \cos^5 x + \frac{4}{7} \cos^7 x - \frac{1}{9} \cos^9 x + c$ 9 $\frac{1}{6} \tan^2 3x + \frac{1}{3} \ln|\cos 3x| + c$
 10 $\frac{1}{32}(4x - \sin 4x) + c$ 11 $\frac{1}{4} \tan^4 x + \frac{1}{6} \tan^6 x + c$ 12 $-\frac{1}{6} \cos^3 2x + \frac{1}{10} \cos^5 2x + c$ 13 $\frac{1}{3} \sin^3 p - \frac{1}{5} \sin^5 p$

Chapter 15 Exercise 4

1 $\frac{(x+2)^5}{5} + c$ 2 $\frac{(2+7x)^4}{28} + c$ 3 $-\sqrt{1-2x} + c$ 4 $\frac{-3}{4(2x+1)^2} + \frac{(1+2x)^{\frac{3}{2}}}{3} + c$ 5 $\frac{(3+5x)^{\frac{3}{2}}}{30} + c$
 6 $\frac{-2}{3}(1-x)^{\frac{3}{2}} - 2(1-x)^{\frac{1}{2}} - \frac{1}{1-x} + c$ 7 $\frac{3}{4} \sin \left(4x - \frac{\pi}{2}\right) + c$ 8 $\tan^{-1} 2x + c$ 9 $\frac{1}{4} \ln|3 - 4 \cos x| + c$ 10 $-\frac{1}{2} \tan \left(\frac{\pi}{3} - 2x\right) + c$
 11 $-\frac{2}{3} \cos(3x + \alpha) + c$ 12 $\frac{1}{4} e^{4x+1} + c$ 13 $\frac{2^x}{\ln 2} + c$ 14 $\frac{1}{3} \ln|3x + 1| + c$ 15 $\ln|x^2 + 4| + c$ 16 $\frac{1}{2} \ln|x^2 + 2x + 3| + c$
 17 $\frac{1}{4} \ln|x^4 + 3| + c$ 18 $\sin^{-1} 3x + c$ 19 $\frac{3}{4} \tan^{-1} 2x + c$ 20 $\frac{1}{14}(x^2 + 6x - 8)^7 + c$ 21 $\frac{1}{10}(\sin 2x + 3)^5 + c$ 22 $2e^{1-\cot^2 x} + c$
 23 $\frac{1}{12}(1+x^2)^8 + c$ 24 $-\frac{1}{4} \cos^4 x + c$ 25 $\frac{1}{2(\cot x - 3)^2} + c$ 26 $\ln|e^x + 2| + c$ 27 $2(e^x + 2)^{\frac{1}{2}} + c$ 28 $\frac{1}{64}(24x + 8 \sin 4x + \sin 8x) + c$
 29 $\frac{1}{2} \ln|x^2 + 2x + 3| + c$ 30 $\sqrt{2} \tan^{-1} \left(\frac{x+1}{\sqrt{2}}\right) + c$ 31 $2 \sin^{-1} \left(\frac{x-2}{3}\right) + c$ 32 $2(-x^2 + 4x + 5)^{\frac{1}{2}} + c$ 33 $\frac{1}{5}(\sin^2 x + 3)^5 + c$

Chapter 15 Exercise 5

1 $\frac{(x^2+3)^6}{12} + c$ 2 $\frac{1}{4} \ln|6x^2 + 4x - 13| + c$ 3 $-\sqrt{1 - \sin 2x} + c$ 4 $\frac{2}{15}(x-2)^{\frac{3}{2}}(3x+4) + c$ 5 $\frac{(2p-1)^{\frac{1}{2}}(p+1) - 2}{3}$
 6 $\frac{(2x+1)^{\frac{1}{2}}(x+8)}{3} + c$ 7 $\tan^{-1} x^2 + c$ 8 $\frac{2(3x-4)^{\frac{3}{2}}(9x+38)}{135} + c$ 9 $\frac{(p-2)^4(8p-1) - 7}{20}$ 10 $\frac{1-6x}{24(2x-1)^3} + c$ 11 $\frac{1-5x}{10(x-3)^5} + c$
 12 $\frac{2(p-2)^{\frac{3}{2}}}{3} + 4(p-2)^{\frac{1}{2}} - \frac{26\sqrt{7}}{3}$ 13 $\frac{(x+5)^2}{2} - 15(x+5) + 75 \ln|x+5| + \frac{125}{x+5} + c$ 14 $\frac{2(5p+2)^{\frac{3}{2}}(15p-4)}{375} - \frac{416\sqrt{3}}{125}$
 15 $\frac{x^2 - 4x + 8}{x-2} + c$ 16 $\frac{1}{2} \tan^{-1}(2 \tan x) + c$ 17 $\frac{3}{2}(\sin^{-1} x + 4x\sqrt{1-x^2}) + c$ 18 $\frac{1}{2} \tan^{-1} \left(2 \tan \frac{x}{2}\right) + c$
 19 $2 \sin^{-1} \frac{p}{2} + p \cos \left(\sin^{-1} \frac{p}{2}\right) - 2 \sin^{-1} \frac{1}{4} + \frac{1}{2} \cos \left(\sin^{-1} \frac{1}{4}\right)$ 20 $\frac{1}{\sqrt{5}} \tan^{-1}(\sqrt{5} \tan x) + c$ 21 $3 \tan^{-1} \left(\frac{5 \tan \frac{1}{2} p + 3}{4}\right) - 3 \tan^{-1} \frac{3}{4}$
 22 $\frac{1}{32} \tan 2x + c$ 23 $\frac{8}{3n} \tan^{-1} \sqrt{x^n - 1} + c$

Chapter 15 Exercise 6

1 $x \sin x + \cos x + c$ 2 $\frac{e^{2x}}{4}(2x-1) + c$ 3 $\frac{x^5}{25}(5 \ln x - 1) + c$ 4 $\frac{-x \cos 2x}{2} + \frac{\sin 2x}{4} + c$ 5 $\frac{(p+1)^{10}}{110} - (10p-1) - \frac{4608}{55}$
 6 $-x^2 \cos x + 2x \sin x + 2 \cos x + c$ 7 $\frac{e^{2x}}{4}(2x^2 - 2x + 1) + c$ 8 $\frac{x^3}{9}(3 \ln 3x - 1) + c$ 9 $x^3 \ln 8x - \frac{x^3}{3} + c$ 10 $\frac{-e^{-3x}}{27}(9x^2 + 6x + 2) + c$

- 11 $\frac{e^x}{2}(\cos x + \sin x) + c$ 12 $x \sin^{-1} x + (1 - x^2)^{\frac{3}{2}} + c$ 13 $x \tan^{-1} x - \frac{1}{2} \ln|1 + x^2| + c$ 14 $e^{2x}(x - 1) + c$ 15 $\frac{e^{3x}}{10}(\sin x + 3 \cos x) + c$
 16 $\frac{e^{2x}}{13}(2 \sin 3x - 3 \cos 3x) + c$ 17 $\frac{e^x}{5}(\sin 2x - 2 \cos 2x) + c$ 18 $\frac{x^{n+1}}{(n+1)^2}[(n+1) \ln x - 1] + c$ 19 $\frac{e^{ax}}{a^2 + b^2}(a \sin bx - b \cos bx) + c$
 20 $\frac{(2p+1)^{n+1}(np-1)+1}{2(n+1)(n+2)}$

Chapter 15 Exercise 7

- 1 $-(1 - x^2)^{\frac{1}{2}} + \sin^{-1} x + c$ 2 $\frac{3}{2} \ln|x^2 + 4| + 2 \tan^{-1} \frac{x}{2} + c$ 3 $\frac{1}{2} \ln|x^2 + 3| + \frac{5\sqrt{3}}{3} \tan^{-1} \frac{x\sqrt{3}}{3} + c$ 4 $2 \ln|x^2 + 4x + 8| - \frac{1}{2} \tan^{-1} \left(\frac{x+2}{2} \right) + c$
 5 $\ln|x^2 + 4x + 6| - \frac{\sqrt{2}}{2} \tan^{-1} \left(\frac{x+2}{\sqrt{2}} \right) + c$ 6 $2(-x^2 - 6x - 4)^{\frac{3}{2}} + \sin^{-1} \left(\frac{x+3}{\sqrt{5}} \right) + c$ 7 $x - 7 \ln|x + 4| + c$ 8 $\frac{x^2}{2} - 3x + 10 \ln|x + 3| + c$

Chapter 15 Exercise 8

- 1 $\frac{\sin 3x}{3} - \frac{\cos 2x}{2} + c$ 2 $\frac{1}{3}(8x^{\frac{3}{2}} + 8(x+1)^{\frac{3}{2}} + (1-3x)^4) + c$ 3 $\frac{1}{3} \ln|3x^2 + 1| + c$ 4 $2 \tan^{-1} 2x + c$ 5 $\frac{1}{2} \tan \left(2x - \frac{\pi}{3} \right) + c$
 6 $2\sqrt{1 + \sin x} + c$ 7 $2e^{x^2+x-5} + c$ 8 $\frac{1}{(n-1) \cos^{n-1} x} + c$ $n \neq 1, \ln|\cos x| + c$ for $n = 1$ 9 $\tan^{-1} 2x + c$ 10 $2 \sin^{-1} \left(\frac{x+4}{5} \right) + c$
 11 $\frac{(1-x)^8}{36}(7-8x) + c$ 12 $x + 5 - 10 \ln|x + 5| - \frac{25}{x+5} + c$ 13 $\frac{4(3x-4)^{\frac{3}{2}}}{135}(9x+8) + c$ 14 $\frac{1-5p}{10(p-3)^5} - \frac{1}{80}$ 15 $\tan^{-1} e^x + c$
 16 $x(1-x^2)^{\frac{1}{2}} + \sin^{-1} x + c$ 17 $\frac{2\sqrt{3}}{3} \tan^{-1} \left(\frac{\tan \frac{x}{2}}{\sqrt{3}} \right) + c$ 18 $-\frac{1}{4} \cot \left(\sin^{-1} \frac{x}{2} \right) + c$ 19 $\frac{3}{2} \tan^{-1} x^2 + c$
 20 $\sqrt{x-2} + \frac{\sqrt{2}}{2} \tan^{-1} \sqrt{\frac{x-2}{2}} + c$ 21 $\frac{-1}{x}(\ln|x| + 1) + c$ 22 $\frac{e^{3x}}{9}(3x-1) + c$ 23 $x \sin \left(x + \frac{\pi}{6} \right) + \cos \left(x + \frac{\pi}{6} \right) + c$
 24 $\frac{e^{-2x}}{4}(\sin 2x - \cos 2x) + c$ 25 $-2x^2 \cos \frac{x}{2} + 8x \sin \frac{x}{2} + 16 \cos \frac{x}{2} + c$ 26 $x \ln|2x + 1| - x + \frac{1}{2} \ln|2x + 1| + c$ 27 $x \tan^{-1} \frac{1}{x} + \frac{1}{2} \ln|x^2 + 1| + c$
 28 $\frac{e^{ax}}{a^2 + 4}(a \sin 2x - 2 \cos 2x) + c$ 29 $\frac{1}{3} \sin^3 x + c$ 30 $-\frac{1}{3} \cos^3 x + c$ 31 $\frac{1}{4} \tan^4 x + c$ 32 $\frac{\theta}{2} + \frac{\sin 2\theta}{4} + c$ 33 $\frac{x}{2} - \frac{\sin 6x}{12} + c$
 34 $\frac{\sin 2x}{2} - \frac{1}{6} \sin^3 2x + c$ 35 $-4 \cos \frac{x}{4} + \frac{8}{3} \cos^3 \frac{x}{4} - \frac{4}{5} \cos^5 \frac{x}{4} + c$ 36 $\frac{2}{3} \tan^3 \frac{x}{2} - 2 \tan \frac{x}{2} + x + c$ 37 $\frac{1}{4} \left(x - \frac{\sin 4ax}{4a} \right) + c$
 38 $\frac{1}{3} \tan^3 x + \frac{1}{5} \tan^5 x + c$ 39 $\frac{1}{4} \left(\frac{3}{2} x + 6 \sin \frac{x}{3} + \frac{3}{4} \sin \frac{2x}{3} \right) + c$ 40 $-2(1-x^2)^{\frac{1}{2}} - \sin^{-1} x + c$
 41 $\ln \left| \frac{3x^2}{2} - 2x + 3 \right| - \frac{2\sqrt{14}}{7} \tan^{-1} \left(\frac{\sqrt{14}}{14}(3x-2) \right) + c$ 42 $\frac{x^3}{3} + \frac{x^2}{2} + x + 2 \ln|x-1| + c$ 43 $\frac{x^2}{4} + \frac{x}{4} + \frac{13 \ln|2x-1|}{8} + c$

Chapter 15 Exercise 9

- 1 $\frac{(x-3)^4}{4} + c$ 2 $\frac{2}{9}(3x-5)^{\frac{3}{2}} + c$ 3 $\frac{1}{4} e^{4x-5} + c$ 4 $\frac{12x^{\frac{2}{3}}}{7} - \frac{192x^{\frac{23}{12}}}{23} + \frac{32x^{\frac{3}{2}}}{3} + c$ 5 $-\frac{1}{4} \operatorname{cosec} 4x + c$ 6 0.0791
 7 $\frac{-e^{-2x}}{4}(2x^2 + 2x + 1) + c$ 8 0.169 9 $\ln|x^2 + 1| - 3 \tan^{-1} x + c$ 10 $\frac{1}{2} \sin^{-1} \frac{2x}{5} + c$ 11 $\frac{-1}{4}(2e^x + 1)^{-2} + c$ 12 $-\frac{1}{b} \ln \left| \frac{a + b \cos p}{a + b} \right|$
 13 $\frac{-(1+5x)}{25(2+5x)^2} + c$ 14 $\frac{3}{4} \tan^{-1} \left(\frac{x-3}{4} \right) + c$ 15 $\frac{1}{32}(12 + 8 \sin 2x + \sin 4x) + c$ 16 -0.142 17 16.5
 18 $\frac{-3x^2}{4} \cos 2x + \frac{3x}{4} \sin 2x + \frac{3}{8} \cos 2x + c$ 19 $\sin^{-1} \left(\frac{x+2}{\sqrt{33}} \right) + c$ 20 $\frac{x}{\ln 4}(\ln x - 1) + c$ 21 $\sin^{-1}(x-1) + c$ 22 $\frac{x^5}{25}(5 \ln 2x - x) + c$
 23 2.44 24 3.16 25 $\frac{e^{-3x}}{10}(\sin x - 3 \cos x) + c$ 26 $\frac{\sqrt{x}}{25}(2x^2 + 70) + c$ 27 $\frac{1}{5} \tan^5 x + \frac{1}{7} \tan^7 x + c$ 28 $\frac{1}{2} \sin^{-1} 2x + 2\sqrt{1-4x^2} + c$
 29 $\frac{2}{\sqrt{5}} \tan^{-1} \left(\sqrt{5} \tan \frac{x}{2} \right) + c$ 30 1.44 31 $\frac{-(1+3a)}{3(a+1)^3} + \frac{1}{3}$ 32 $x \cos^{-1} 2x - \frac{\sqrt{1-4x^2}}{2} + c$ 33 1 34 $\frac{\pi a^4}{16}$ 35 -0.0280 36 1.50
 37 $-\frac{1}{4} \ln|\cos 2x| + c$ 38 0

Chapter 15 Exercise 10

- 1 0.215 2 4.48 3 0.148 5 9.42 6 $2(4-x^2)^{\frac{1}{2}}$ 7 $0.227a^2$ 10 $\frac{4-e^3}{2}$ 11 $\frac{2(2a-1)^3(3a+1)}{15}$ 12 5.66 13 11.7 14 3.03

Chapter 15 Review Exercise

- 1 $e - e^k + 1$ 2 $\frac{4}{15}\left(\frac{x+2}{2}\right)^{\frac{3}{2}}(3x-4) + c$ 3 $\frac{(k^2-4)^{\frac{3}{2}}}{3\sqrt{5}}$ 4 $x \arctan x - \frac{1}{2} \ln|1+x^2| + k$ 5 0.307 6 $a = 25, b = 2, \sin^{-1}\left(\frac{x-2}{5}\right) + c$
 7 $a = 1.07$ 8 $-\frac{e^{-2x}}{4}(2x^2 + 2x + 1) + k$ 9 a $y = \frac{ex}{2}$ b $\frac{1}{10}$ 10 $\frac{1}{2} \arctan\left(\frac{x+3}{2}\right) + k$ 11 $-\frac{a}{b} \ln(3 - b \sin x) + k$ 12 0.690
 13 a (0, 1) is a maximum b $y = 0$ d $\frac{\pi}{2} - 1$ 14 1 15 b i $\frac{2\pi}{9}$ ii $\frac{4\pi}{9}$ iii $\frac{6\pi}{9}$ c $\frac{n\pi}{9}(n+1)$

Chapter 16 Exercise 1

- 1 $y = \frac{x^3}{3} - \cos x + k$ 2 $y = \frac{(3x-7)^5}{15} + k$ 3 $y = -\frac{2}{3}(1-x^2)^{\frac{3}{2}} + k$ 4 $y = -x \cos x + \sin x + k$
 5 $y = -\ln|1 - \sin x| + k$ 6 $y = \frac{3}{2k} e^{\frac{2x}{k}} \left[1 - \frac{3}{2k}\right] + c$ 7 $y = -\frac{1}{3}(1-15x^2)^{\frac{1}{2}} + k$ 8 $y = \frac{1}{8}(4x - \sin 4x) + k$ 9 $y = \frac{4}{135}(3x+2)^{\frac{5}{2}}$
 10 $y = -\ln|\cos x| + kx + c$ 11 $y = \frac{x^4}{24} \ln x - \frac{13x^4}{288} + \frac{kx^2}{2} + cx + d$
 12 $y = x \cos x - 4 \sin x + \frac{kx^3}{6} + \frac{cx^2}{2} + dx + e$ 13 $y = \frac{1}{2} \ln|4x^2 + 3| - \frac{1}{2} \ln 19$ 14 $y = \frac{1}{2} \ln\left(\frac{4x^2+3}{19}\right)$
 15 $y = \frac{(2x-1)^6}{120} + 2x + \frac{239}{240}$ 16 $y = 2x \tan^{-1} x - \ln|1+x^2| - 2x \tan^{-1}\left(\frac{\pi}{4}\right) + 3x + 5$

Chapter 16 Exercise 2

- 1 $\frac{y^2}{2} = -\ln|\cos x| + k$ 2 $\tan^{-1} y = \frac{1}{2} \ln|x| + k$ 3 $\frac{1}{2} \ln|3+2y| = -\frac{1}{3} \ln|4-3x| + k$ 4 $y = \ln|\cos x + \sin x| + k$
 5 $y^4 = 2x^2 \ln x - x^2 + k$ 6 $y = \ln\left(\frac{5}{c-6\ln|x|}\right)$ 7 $\ln y = 4 \sin^{-1} \frac{x}{2} + k$ 8 $s^3 = 3(t \sin^{-1} t + (1-t^2)^{\frac{1}{2}}) + k$
 9 $y = \frac{(3x-1)^{10}(30x+1)}{110} + c$ 10 $v^2 = \frac{\sin 2at}{2a} + t + k$ 11 $y = \ln\left(\frac{-e^{-2x}}{2} + k\right)$ 12 $\ln|y| = \frac{3}{2} \ln|x^2 + 2x| + k$
 13 $\ln y = \frac{-(3-x)^5}{5} + \ln 4 + \frac{1}{5}$ 14 $\frac{3}{2} y^{\frac{3}{2}} = \frac{-e^{-2x}}{2} + \frac{3}{2} + \frac{1}{2e^2}$ 15 $-\cot y = \ln x - 1 - \ln 4$
 16 $\frac{1}{2} \ln|2y^2 + 3| = \frac{3}{8} \ln|4x^2 - 1| + \frac{1}{2} \ln 131 - \frac{3}{8} \ln 3$ 17 $\frac{\theta^3}{3} = \frac{e^{2t}}{5} (2 \sin t - \cos t) + \frac{\pi^3}{24} + \frac{1}{5}$ 18 $2 \sin^{-1} 3s = 3(t^2 - 1) + \pi$

Chapter 16 Exercise 3

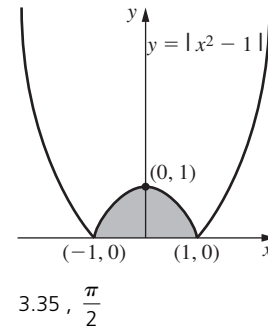
- 1 $y = -\ln|\cos x| + k$ 2 $x = \frac{\omega^2 t^3}{6} + kt + c$ 3 $x = \frac{-\omega \sin nt}{n^2} + kt + c$ 4 $\frac{y^3}{3} = \ln|1+x^3| + 9$ 5 $\tan y = \tan x + k$
 6 a $\frac{dz}{dx} = 1 + \frac{dy}{dx} \tan^{-1} z = x + k$ c $y = \tan(x+k) - x$ 7 $y = \frac{Bx^4}{24A} - \frac{Bx^3}{12A} + \frac{Bx}{24A}$ 8 $V = -4 \cos\left(t + \frac{\pi}{4}\right) + 6$
 9 $r = 4t \ln t - 4t + 24 - 20 \ln 5$

Chapter 16 Exercise 5

- 1 $v = \frac{4t^3}{3} + t$ $s = \frac{t^4}{3} + \frac{t^2}{2}$ 2 a $v = \frac{-3t^4}{2} + 10$ 2 b -6134 ms^{-1} 2 c $s = \frac{-3t^5}{10} + 10t$ 2 d -29900 m 3 26.6m
 4 a $v = \frac{\sin 3t}{3}, s = -\frac{\cos 3t}{9} + \frac{11}{18}$ 4 b $\frac{\pi}{3}$ seconds 5 $s = -\frac{t^2}{2} - t - 2 \ln|t-1| + 14$ 6 $v = \sqrt{4 - 2 \cos\left(s + \frac{\pi}{4}\right)}$
 7 $v = \pm \sqrt{\frac{2se^{2s} - e^{2s} + 9}{2}}$ 8 $v = \pm \sqrt{\frac{(2s-1)^5 + 223}{5}}$ 9 a $7\frac{3}{4} \text{ ms}^{-1}$ b $\frac{1}{t} + 7\frac{1}{2} \rightarrow 7\frac{1}{2} \text{ ms}^{-1}$ as $t \rightarrow \infty$ 10 b $\frac{e^8 - 137}{4}$
 11 a 2.60 11 b $v = 220e^{-2.60t}$ c 108m 12 a $v = \frac{2}{\omega}$ 12 b $\frac{2\pi}{\omega}$ 13 $v = \frac{g}{k} - \frac{g}{ke^{kt}}$ Yes $v \rightarrow \frac{g}{k}$

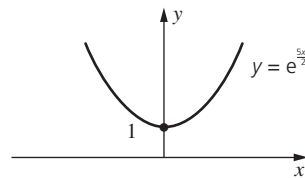
Chapter 16 Exercise 6

- 1 a 176 1 b 107 1 c 57.4 1 d 8.90 1 e 104 1 f 2060 1 g 327 1 h 1.23 1 i 1.08 1 j 274 2 a 8π 2 b 5.98 2 c 0.592
 2 d 0.622 2 e 113 2 f 0.965 2 g 12.8 3 $\frac{\pi a^5}{5}$ 4 145 5 1940 6 84.2 7 5cm, 196 cm² 8
 9 $\frac{49\pi}{16}$ 10 $\pi^2 b^2 a$ 11 $\pi^3(n^2 + (n-1)^2)$
 12 a $\frac{1}{4}(2 \sin^{-1} x + 2x\sqrt{1-x^2}) + k$ b. $\frac{\pi}{4}(\pi - 2 \sin^{-1} a + 2a\sqrt{1-a^2})$



Chapter 16 Review Exercise

- 1 $\frac{\pi}{12}$ 2 $y = \sqrt{\frac{x}{2}} - 1$ 3 $4m$ 4 $\frac{\pi(e^{8a} - 1)}{4e^{4a}}$ 5 $y = Ce^{\frac{3x}{2}}$
 6 $v = \sqrt{3 \ln\left(\frac{s^2 + 1}{2}\right)} + 4$. At $t = 5$, $v = \sqrt{3 \ln 13} + 4$
 7 a Correct b i $A = 78$, $k = \frac{1}{15} \ln\left(\frac{8}{13}\right)$ ii 45.3 mins
 8 $\cos^{-1}\left(\frac{1}{\sqrt{T}}\right) + \frac{\sqrt{T-1}}{T} - \frac{\pi}{4} - \frac{1}{2}$ 9 Correct 10 169.8 years 11a $v = \frac{3}{2\pi}\left(1 - \cos \frac{2\pi t}{3}\right)$, $s = \frac{3}{2\pi}\left(t - \frac{3}{2\pi} \sin \frac{2\pi t}{3}\right)$
 b $t = 3$ seconds 12 a Correct b 0, 3, 6 seconds c i distance = $\int_0^3 t \sin \frac{\pi t}{3} dt - \int_3^6 t \sin \frac{\pi t}{3} dt$ ii $\frac{36}{\pi}$ metres 13 a $v = v_0 e^{-kt}$ b $t = \frac{1}{k} \ln 2$
 14 $\frac{\pi}{4}(\pi + 2)$ 15 a b $V_x = 72\pi a^3$ c $\frac{V_y}{V_x} = \frac{32}{45}$



Chapter 17 Exercise 1

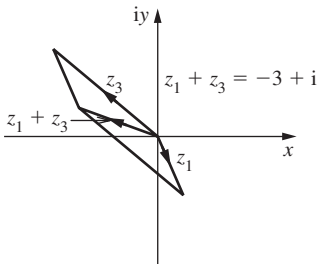
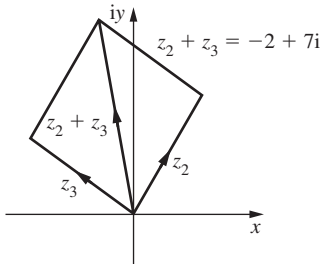
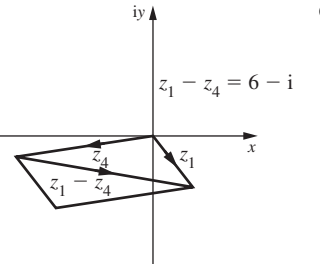
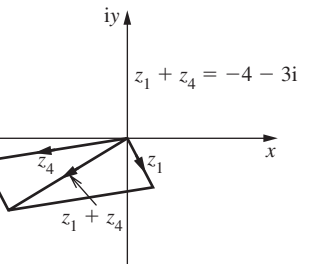
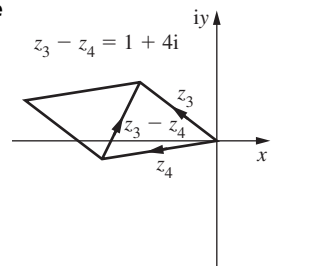
- 1 a 18i b 38i c 112i d 60i 2 a 12i b 15i c -24i d -52i 3 a 240i b -32 c 45i d 96i e -72i f 35 g -90i
 4 a $-\frac{15}{2}$ b 2 c $\frac{5}{2}i$ d -16i 5 a 9 b -1 6 a 9i b $-\frac{5}{3} + \frac{7i}{3}$ c $-\frac{1}{2}i$ d 1 e $1 - \frac{3}{4}i$

Chapter 17 Exercise 2

- 1 a $8 + 16i$ b $18 + 28i$ c $7 + i$ d $14 - 21i$ e $-7 + 11i$ 2 a $3 - 5i$ b $13 + 22i$ c $-20 + 10i$ d $7 + 13i$
 3 a $-4 + 19i$ b $47 + 35i$ c $7 + 2i$ d $115 - 111i$ e 306 f $a^2 + b^2$ g $1 + 70i$ h $117 + 44i$ i $x^2 - y^2 + 2ixy$
 3 j $m(m^2 - 3n^2) + in(3m^2 - n^2)$ k $(m^3 - 18m^2 - 12m + 24) + i(3m^3 + 6m^2 - 36m - 8)$ 4 a $\frac{3+i}{5}$ b $\frac{-15+10i}{13}$ c $\frac{7+26i}{29}$
 4 d $\frac{-10-33i}{29}$ e $6 - 2i$ f $\frac{2x^2 - y^2 + 3ixy}{4x^2 + y^2}$ g $\frac{3+4i}{5}$ h $-\frac{3}{2} + \frac{i}{2}$ i $\frac{(2x-5y) + i(5x+2y)}{x^2 + y^2}$ j $\frac{x(y^2 + 3x^2 + 2ixy)}{x^2 + y^2}$
 5 a -4 b $-11 - 2i$ c $-237 - 3116i$ d $-8432 - 5376i$ 6 a $x = 15, y = -7$ b $x = 8, y = 0$ c $x = 0, y = -3$
 6 d $x = 5, y = 12$ e $x = -6, y = -3$ f $x = -\frac{5}{17}, y = -\frac{14}{17}$ g $x = -21, y = 20$ h $x = y = \pm\sqrt{\frac{15}{2}}$ i $x = -\frac{72}{25}, y = \frac{29}{25}$

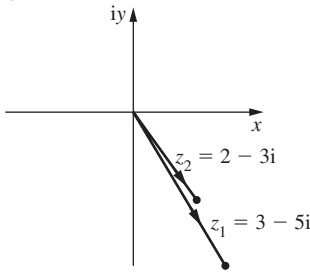
- 6 j $x = -3, y = 1$ k $x = -\frac{33}{169}, y = \frac{2591}{169}$ 7 a $\operatorname{Re}(z) = 27, \operatorname{Im}(z) = -8$ b $\operatorname{Re}(z) = -\frac{53}{185}, \operatorname{Im}(z) = -\frac{89}{185}$ c $\operatorname{Re}(z) = \frac{117}{145}, \operatorname{Im}(z) = \frac{41}{145}$
- 7 d $\operatorname{Re}(z) = \frac{72}{65}, \operatorname{Im}(z) = -\frac{61}{65}$ e $\operatorname{Re}(z) = \frac{2a}{4+b^2} - \frac{12}{16+a^2}, \operatorname{Im}(z) = -\frac{ab}{4+b^2} - \frac{3a}{16+a^2}$ f $\operatorname{Re}(z) = 0, \operatorname{Im}(z) = -\frac{2xy}{x^2+y^2}$
- 7 g $\operatorname{Re}(z) = -597, \operatorname{Im}(z) = 122$ h $\operatorname{Re}(z) = \cos\frac{2\pi}{3}, \operatorname{Im}(z) = \sin\frac{2\pi}{3}$ i $\operatorname{Re}(z) = -128, \operatorname{Im}(z) = -128\sqrt{3}$
- 7 j $\operatorname{Re}(z) = \frac{x}{1+y^2} + \frac{12}{16+9x^2}, \operatorname{Im}(z) = -\frac{xy}{1+y^2} + \frac{9x}{16+9x^2}$ 8 a $1+4i, -1-4i$ b $1.10+0.455i, -1.10-0.455i$
- c $2.12-0.707i, -2.12+0.707i$ 8 d $3.85+1.69i, -3.85-1.69i$ e $1.92+1.30i, -1.92-1.30i$ f $0.734-0.454i, -0.734+0.454i$
- 8 g $0.704-0.369i, -0.704+0.369i$ h $1.59+1.42i, -1.59-1.42i$ i $0.541+0.0416i, -0.541-0.0416i$ 9 a $x = -3 \pm i$
- 9 b $x = \frac{-1 \pm i\sqrt{3}}{2}$ c $x = \frac{-3 \pm i\sqrt{51}}{2}$ d $x = \frac{-3 \pm i\sqrt{6}}{3}$ e $x = \frac{-3 \pm i\sqrt{95}}{4}$ 10 a $x^2 - 4x + 13 = 0$ b $x^2 - 6x + 10 = 0$
- 10 c $x^2 - 8x + 25 = 0$ d $x^3 - 3x^2 + 7x - 5 = 0$ e $x^3 - 8x^2 + 25x - 26 = 0$ f $x^4 - 10x^3 + 20x^2 + 90x - 261 = 0$
- 11 a $x^2 - 4x + 53 = 0$ b $x^2 - 8x + 25 = 0$ c $x^2 - 14x + 85 = 0$ d $x^2 - 2ax + a^2 + b^2 = 0$ 12 $x^4 - 10x^3 + 42x^2 - 82x + 65 = 0$
- 13 $3, 1-i$ 14 a $3, -1+2i, -1-2i$ b $2, -1+3i, -1-3i$ 15 $\frac{-214+735i}{53}$ 16 $-8+2i, -8-i$ 17 $\frac{348-115i}{13}$
- 18 $z_1 = \frac{26-2i}{17}, z_2 = \frac{21+i}{17}$ 19 $\frac{3-i\sqrt{3}}{2}$ 20 $p = -\frac{3}{5}, q = \frac{9}{5}$ 21 $\frac{88-966i}{25}$

Chapter 17 Exercise 3

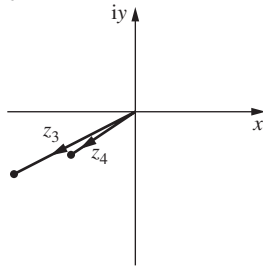
- 1 a  b  c  d 
- e 
- 2 a $2\left(\cos\frac{\pi}{3} + i\sin\frac{\pi}{3}\right)$ b $\sqrt{8}\left[\cos\left(-\frac{3\pi}{4}\right) + i\sin\left(-\frac{3\pi}{4}\right)\right]$ c $\sqrt{26}[\cos(2.94) + i\sin(2.94)]$
- 2 d $\sqrt{41}[\cos(-0.896) + i\sin(-0.896)]$ e $10(\cos 0 + i\sin 0)$ f $6\left(\cos\frac{\pi}{2} + i\sin\frac{\pi}{2}\right)$
- 3 a $4\sqrt{2}e^{i\frac{\pi}{4}}$ b $5e^{-2.21i}$ c $\sqrt{53}e^{1.85i}$ d $\sqrt{82}e^{-1.46i}$ e $8e^{0i}$ f $2e^{i\frac{\pi}{3}}$

- 4 a $1+i\sqrt{3}$ b $-\frac{\sqrt{15}}{2} + i\frac{\sqrt{5}}{2}$ c $5\sqrt{2} - 5i\sqrt{2}$ d $3.74 - 1.00i$ e $-\frac{3\sqrt{2}}{2} + \frac{3\sqrt{2}}{2}i$ f $-\frac{\sqrt{5}}{2} + i\frac{\sqrt{15}}{2}$ g $\frac{15\sqrt{3}}{2} - \frac{15}{2}i$
- 4 h $1.67 - 4.03i$ 5 a $r = \sqrt{313}, \theta = 0.825$ b $r = \sqrt{701}, \theta = 1.38$ c $r = 2\sqrt{370}, \theta = 0.487$ d $r = 4\frac{\sqrt{370}}{5}, \theta = 1.41$
- 6 a Root 1 $r = 2.65, \theta = 2.17$ Root 2 $r = 2.65, \theta = -2.17$ b Root 1 $r = \sqrt{5}, \theta = 1.11$ Root 2 $r = \sqrt{5}, \theta = -1.11$
- 6 c Root 1 $r = \sqrt{7}, \theta = 0.714$ Root 2 $r = \sqrt{7}, \theta = -0.714$ 7 a i $z_1 = 13e^{-1.18i}$ ii $z_2 = 5e^{2.21i}$ iii $z_3 = 25e^{-0.284i}$ iv $z_4 = 2e^{i\frac{\pi}{3}}$
- 7 b i $r = 65, \theta = 1.04$ ii $r = 325, \theta = -1.46$ iii $r = 26, \theta = -0.129$ iv $r = 2.5, \theta = 1.17$ v $r = 5, \theta = -2.50$ vi $r = 6.5, \theta = -2.22$
- 7 vii $r = 25, \theta = -1.33$ viii $r = 150, \theta = 0.763$

8 a



and b

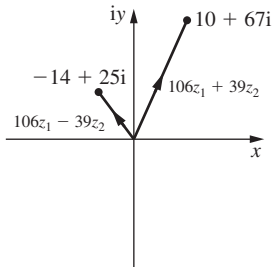


c Rotation of $\frac{\pi}{2}$ radians clockwise.

9 a $z_1 = \sqrt{7}[\cos(-0.714) + i \sin(-0.714)]$, $z_2 = \sqrt{2}\left[\cos\left(-\frac{3\pi}{4}\right) + i \sin\left(-\frac{3\pi}{4}\right)\right]$

9 b $|z_1 z_2| = \sqrt{14}$, $\arg(z_1 z_2) = -3.07$, $\left|\frac{z_1}{z_2}\right| = \sqrt{\frac{7}{2}}$, $\arg\left(\frac{z_1}{z_2}\right) = 1.64$

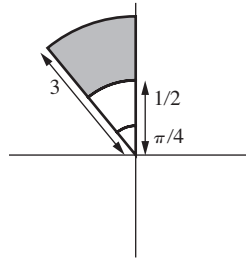
10 $z_1 = -\frac{1}{53} + \frac{23}{53}i$, $z_2 = \frac{4}{13} + \frac{7}{13}i$



11 b $z = 1 + 0i$, $\frac{-1 + i\sqrt{3}}{2}$, $\frac{-1 - i\sqrt{3}}{2}$ 12 b i 16 ii 10

14 a $1[\cos(0.841) + i \sin(0.841)]$, $1[\cos(-0.841) + i \sin(-0.841)]$ b 1.68 radians

15 a $r = \frac{3}{2}$, $\theta = 1.23$ 15 b



c No.

Chapter 17 Exercise 4

1 a $1024(\cos 10\theta + i \sin 10\theta)$ b $\cos 25\theta + i \sin 25\theta$ c $\frac{1}{243}[\cos(-5\theta) + i \sin(-5\theta)]$ d $\cos(-9\theta) + i \sin(-9\theta)$ e $\cos\frac{1}{2}\theta + i \sin\frac{1}{2}\theta$

1 f $\frac{1}{\sqrt[3]{4}}\left[\cos\left(-\frac{1}{3}\theta\right) + i \sin\left(-\frac{1}{3}\theta\right)\right]$ g $\cos 0 + i \sin 0$ h $\cos\left(-\frac{\pi}{2}\right) + i \sin\left(-\frac{\pi}{2}\right)$ i $\cos\left(\frac{3\pi}{4}\right) + i \sin\left(\frac{3\pi}{4}\right)$ j $\cos\left(\frac{\pi}{10}\right) + i \sin\left(\frac{\pi}{10}\right)$

2 a $(\cos \theta + i \sin \theta)^7$ b $4(\cos \theta + i \sin \theta)^{\frac{1}{2}}$ c $6(\cos \theta + i \sin \theta)^{-3}$ d $(\cos \theta + i \sin \theta)^{-\frac{1}{2}}$ e $(\cos \theta + i \sin \theta)^{-2}$ f $(\cos \theta + i \sin \theta)^{-\frac{1}{2}}$

3 a $\cos 8\theta + i \sin 8\theta$ b $\cos\frac{5}{2}\theta + i \sin\frac{5}{2}\theta$ c $\cos 3\theta + i \sin 3\theta$ d $\cos \theta - i \sin \theta$ e $\cos 11\theta + i \sin 11\theta$ f $\cos 3\theta - i \sin 3\theta$

3 g $\cos\frac{1}{6}\theta - i \sin\frac{1}{6}\theta$ h $\cos\frac{3}{4}\pi - i \sin\frac{3}{4}\pi$ i $\cos\frac{3}{4}\pi + i \sin\frac{3}{4}\pi$ j $\cos\frac{\pi}{12} + i \sin\frac{\pi}{12}$ 4 a $2 + 3i, -2 - 3i$ b $0.644 - 1.55i, -0.644 + 1.55i$

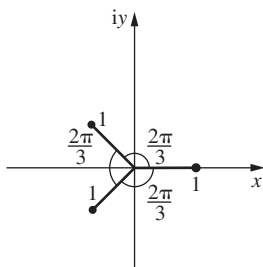
4 c $2^{\frac{1}{2}}\left[\cos\left(-\frac{3\pi}{4}\right) + i \sin\left(-\frac{3\pi}{4}\right)\right]$, $2^{\frac{1}{2}}\left[\cos\left(-\frac{\pi}{12}\right) + i \sin\left(-\frac{\pi}{12}\right)\right]$, $2^{\frac{1}{2}}\left[\cos\left(\frac{7\pi}{12}\right) + i \sin\left(\frac{7\pi}{12}\right)\right]$ d $1.69 - 0.606i, -0.322 + 1.77i, -1.37 - 1.16i$

4 e $1.456 + 0.347i, -0.347 + 1.456i, 0.347 - 1.456i, -1.456 - 0.347i$ f $1.54 - 0.640i, 1.09 + 1.27i, -0.872 + 1.42i$

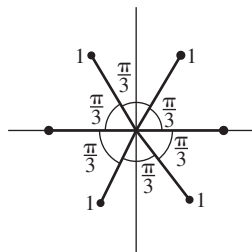
4 f $-0.132 - 1.67i, -1.62 - 0.389i$ g $2^{\frac{1}{8}}\left[\cos\left(-\frac{35\pi}{36}\right) + i \sin\left(-\frac{35\pi}{36}\right)\right]$, $2^{\frac{1}{8}}\left[\cos\left(-\frac{23\pi}{36}\right) + i \sin\left(-\frac{23\pi}{36}\right)\right]$, $2^{\frac{1}{8}}\left[\cos\left(-\frac{11\pi}{36}\right) + i \sin\left(-\frac{11\pi}{36}\right)\right]$

4 g $2^{\frac{1}{2}}\left[\cos\left(\frac{\pi}{36}\right) + i \sin\left(\frac{\pi}{36}\right)\right]$, $2^{\frac{1}{2}}\left[\cos\left(\frac{13\pi}{36}\right) + i \sin\left(\frac{13\pi}{36}\right)\right]$, $2^{\frac{1}{2}}\left[\cos\left(\frac{25\pi}{36}\right) + i \sin\left(\frac{25\pi}{36}\right)\right]$

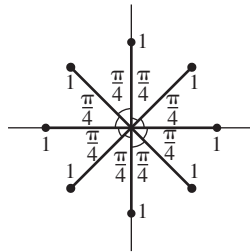
5 a



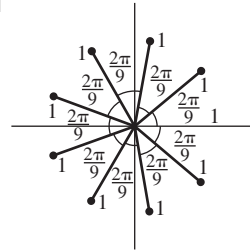
b



c



d



6 a $16 \left[\cos\left(\frac{\pi}{2}\right) + i \sin\left(\frac{\pi}{2}\right) \right]$ b $1.85 + 0.765i, -0.765 + 1.85i, 0.765 - 1.85i, -1.85 - 0.765i$ 7 a $2 \left[\cos\left(\frac{\pi}{3}\right) + i \sin\left(\frac{\pi}{3}\right) \right]$

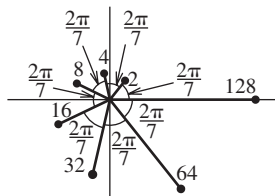
7 b Real part is -2^{15} Imaginary part is $-2^{15}\sqrt{3}$ 9 b $\tan\left(-\frac{15\pi}{16}\right), \tan\left(-\frac{7\pi}{16}\right), \tan\left(\frac{\pi}{16}\right), \tan\left(\frac{9\pi}{16}\right)$ 10 $-\frac{1}{2} - i\frac{\sqrt{3}}{2}$

11 a $z_2 = 5[\cos(-0.927) + i \sin(-0.927)]$ b $\frac{4}{25}$ 12 Product = 4, Sum = -2

15 a $z_1 = 2 \left(\cos\frac{2\pi}{7} + i \sin\frac{2\pi}{7} \right)$ b $z_1^2 = 4 \left(\cos\frac{4\pi}{7} + i \sin\frac{4\pi}{7} \right), z_1^3 = 8 \left(\cos\frac{6\pi}{7} + i \sin\frac{6\pi}{7} \right)$

$z_1^4 = 16 \left[\cos\left(-\frac{6\pi}{7}\right) + i \sin\left(-\frac{6\pi}{7}\right) \right], z_1^5 = 32 \left[\cos\left(-\frac{4\pi}{7}\right) + i \sin\left(-\frac{4\pi}{7}\right) \right], z_1^6 = 64 \left[\cos\left(-\frac{2\pi}{7}\right) + i \sin\left(-\frac{2\pi}{7}\right) \right], z_1^7 = 128(\cos 0 + i \sin 0)$

15 c



15 d Rotate $\frac{2\pi}{7}$ anticlockwise. Enlargement scale factor 2.

16 b $\cos\left(\frac{\pi}{3}\right) + i \sin\left(\frac{\pi}{3}\right), \cos\left(-\frac{\pi}{3}\right) + i \sin\left(-\frac{\pi}{3}\right)$ c $\cos\left(-\frac{2\pi}{3}\right) + i \sin\left(-\frac{2\pi}{3}\right)$

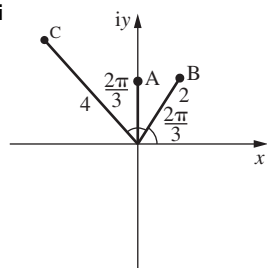
17 c $z^6 + 6z^4 + 15z^2 + 20 + \frac{15}{z^2} + \frac{6}{z^4} + \frac{1}{z^6}$ d $a = \frac{1}{32}, b = \frac{3}{16}, c = \frac{15}{32}, d = \frac{5}{16}$

Chapter 17 Review Exercise

1 $r = \sqrt{14.8}, \theta = -2.06$ 2 $k = -2$ 3 $a = -2, b = 5$ 4 4 5 b 4^{16} 6 $x = -\frac{47}{65}, y = -\frac{1}{65}$ 7 $x^3 - 5x^2 + 10x - 12 = 0$

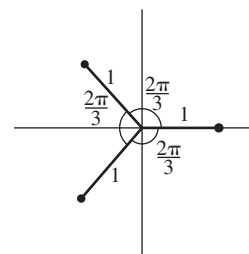
8 Real part = $\frac{x^3 + xy^2 + x}{x^2 + y^2}$, Imaginary part = $\frac{x^2y + y^3 - y}{x^2 + y^2}$ 9 $\sqrt{3}$ 10 a $|z| = 2, \arg(z) = \frac{\pi}{3}$ b $|z^2| = 4, \arg(z^2) = \frac{2\pi}{3}$

10 c i



ii $2\sqrt{3}$ iii $2\sqrt{3} - \frac{3}{2}$ 11 b $1, \frac{-1 + i\sqrt{3}}{2}, \frac{-1 - i\sqrt{3}}{2}$

11 c $\cos 0 + i \sin 0, \cos\frac{2\pi}{3} + i \sin\frac{2\pi}{3}, \cos\left(-\frac{2\pi}{3}\right) + i \sin\left(-\frac{2\pi}{3}\right)$



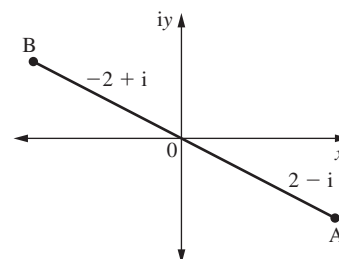
11 d Each side has length $\sqrt{3}$. Area of triangle = $\frac{3\sqrt{3}}{4}$ 12 a $a = -\frac{5}{3}, b = \frac{16}{9}$ b $a = -\frac{17}{4} - \frac{31i}{4}, b = -\frac{17}{4} + \frac{31i}{4}$

13 d i $a = 32, b = -32, c = 6$ ii 6 14 $z = 5 + i, \omega = 6 - i$ 15 a i $\cos^3 \theta - 3 \cos \theta \sin^2 \theta + i(3 \cos^2 \theta \sin \theta - \sin^3 \theta)$ c $\frac{23\sqrt{2}}{20}$

16 a i 1 ii $\frac{2\pi}{3}$ c $\frac{3}{2} + \frac{3\sqrt{3}}{2}i$ 17 $|z| \leq 5, \frac{\pi}{3} \leq \arg(z) \leq \pi, -2 \leq \operatorname{Re}(z) \leq \frac{5}{2}$ 18 a $\frac{10k + i(k^2 - 21)}{k^2 + 49}$ b $k = \pm\sqrt{21}$

19 a $1, \frac{-1 + i\sqrt{3}}{2}, \frac{-1 - i\sqrt{3}}{2}$ c $\begin{pmatrix} 3 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 3 \end{pmatrix}$ d $x = -1, y = z = 2$ 21 a $2 - i, -2 + i$ b

21 c $(\sqrt{3}, 2\sqrt{3}), (-\sqrt{3}, -2\sqrt{3})$



Chapter 18 Exercise 3

Answers are given when asked to form a conjecture

1 $D^n = \binom{1}{0} \frac{2^n - 1}{2^n}$ 2 $\sum_{r=1}^n 3r + 2 = \frac{1}{2}n(3n + 7)$ 3 $\sum_{r=1}^n 4r - 7 = n(2n - 5)$ 4 Any value $\geq 18p$

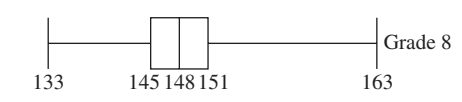
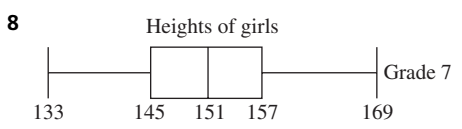
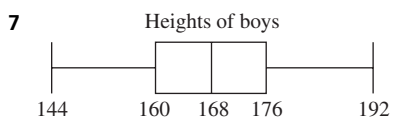
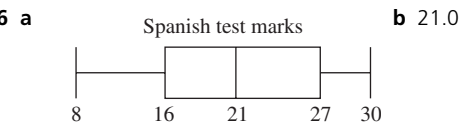
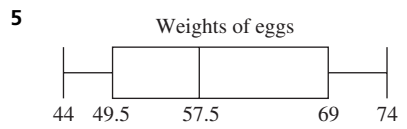
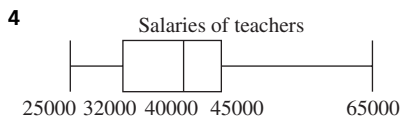
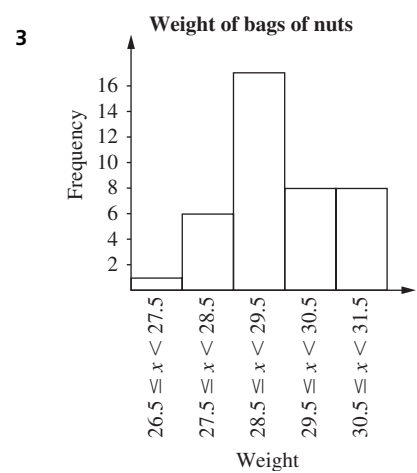
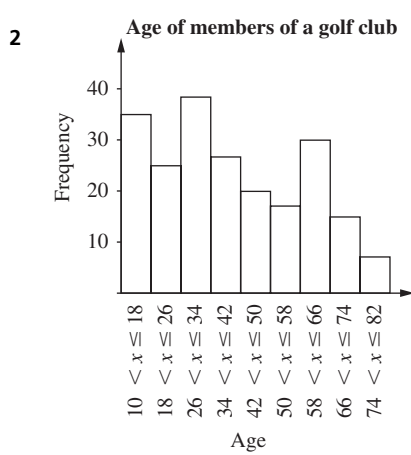
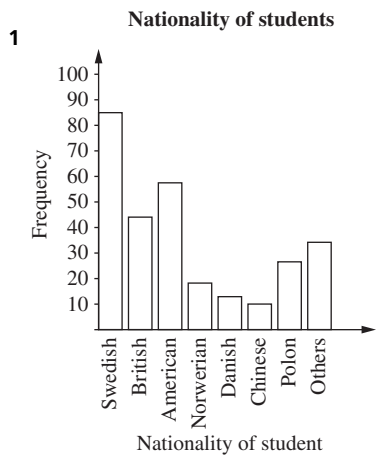
Chapter 18 Review Exercise

5 sum of the first n odd numbers $= n^2$ 6 $n^2 + 2n + 2$ 7 $n^2 + 4$

Chapter 19 Exercise 1

- 8 $(n + 1)! - 1$ 16 $M^n = \binom{n+1}{n} \frac{-n}{1-n}$ 1 a Continuous b Discrete c Continuous d Continuous 2 mode = 4., median = 4, mean = 4.15 3 mode = Blue 4 b 81-90 c 78.2 5 16.7 6 a 1.58m. b There is no information about the ages or gender of the students. 7 0.927 8 a People below this height are not allowed on the ride. b Mean = 1.79m

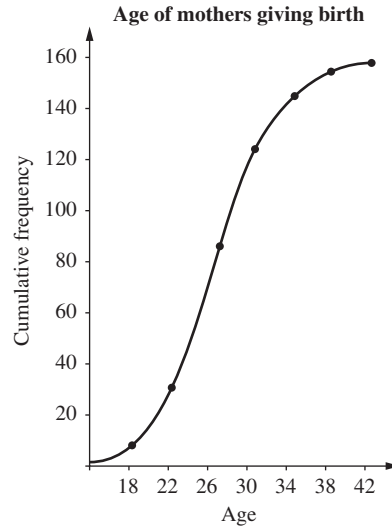
Chapter 19 Exercise 2



9 median = 13,



10 estimate median = 25



11 estimate $Q_1 = 12, Q_2 = 21, Q_3 = 24$

12 estimate $Q_1 = 20, Q_2 = 20.5, Q_3 = 21.25, 10^{\text{th}}$ percentile = 19

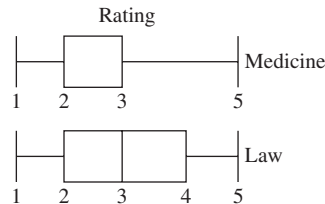
13 estimate $Q_1 = 35m, Q_2 = 42m, Q_3 = 48m, 35^{\text{th}}$ percentile = $38m, 95^{\text{th}}$ percentile = $54m$

Chapter 19 Exercise 3

1 a $Q_2 = 10, IQ = 8$ b $Q_2 = 59.5, IQ = 6.5$ c $Q_2 = 67, IQ = 39$ d $Q_2 = 176, IQ = 89$ e $Q_2 = 40, IQ = 3$

2 The two sets have a similar spread as $IQ = 3$ for both sets. The average age for set B is less as the median is 18 and the median for set A is 19.

3 Box and whisker plots. Medicine $IQ = 1, \text{median} = 2$. Law $IQ = 2, \text{median} = 3$. Law students rated the lecturing higher but there was a greater spread of opinion among this group.



4 a 2.28 b 3.74 c 33.4 d 5.50 e 9.17

5 Mean = 19.01, standard deviation = 6.28, estimated standard deviation = 6.31

6 $\bar{x} = 501, \text{variance} = 2.61$

7 a $Q_2 = 105, IQ = 16$ b $\bar{x} = 110, s = 16.2$

Chapter 19 Exercise 4

1 a i $Q_1 = 8.3, Q_2 = 9.9, Q_3 = 11.9$ ii $\bar{x} = 9.8, s = 1.79$ b i $Q_1 = 183, Q_2 = 263, Q_3 = 298$ ii $\bar{x} = 238, s = 60.2$

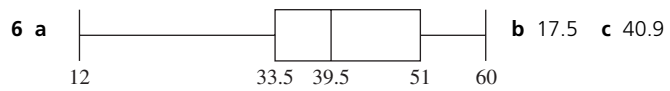
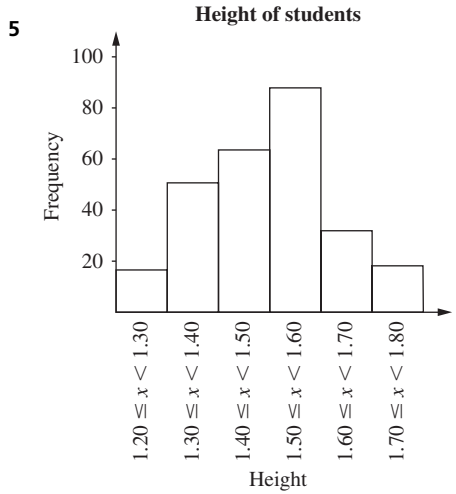
1 c i $Q_1 = 34000, Q_2 = 45500, Q_3 = 57250$ ii $\bar{x} = 44500, s = 14300$ d i $Q_1 = 0.62, Q_2 = 0.755, Q_3 = 0.845$ ii $\bar{x} = 0.724, s = 0.189$

2 Graph $IQ = 3$ 3 Daniel Graph, median = 185.5, range = 167 Paul Graph, median = 198.5, range = 71

4 $\bar{x} = 40.2, s = 29.1, \text{New mean} = 46.2, s = 33.5$ 5 $\bar{x} = 16.6, s = 1.44$

Chapter 19 Review Exercise

1 a Continuous b Discrete c Discrete d Continuous 2 Red 3 $\bar{x} = 76.0, s = 16.4$ 4 1.49



7 estimate $Q_1 = 18, Q_2 = 24, Q_3 = 28$ 8 a $Q_2 = 1, IQ = 1$ b $\bar{x} = 1.63, s = 1.51$

9 $\bar{x} = \text{£}264, s = \text{£}41.70$. After bonus, $\bar{x} = \text{£}296, s = \text{£}46.70$

10 a 29.9 b 0.183 11 a median = 135 b IQ = 11 12 a 31.3 b 9.84

13 a 156 b $x = 44$ minutes

$\bar{x} = \text{£}264, s = \text{£}41.70$. After bonus, $\bar{x} = \text{£}296, s = \text{£}46.70$

Chapter 20 Exercise 1

1 a $\frac{1}{4}$ b $\frac{1}{2}$ c $\frac{1}{2}$ 2 a $\frac{1}{10}$ b $\frac{1}{2}$ c $\frac{3}{10}$ d $\frac{2}{5}$ 3 a $\frac{1}{4}$ b $\frac{13}{20}$ c $\frac{9}{10}$ d $\frac{13}{20}$ e 0 4 a 0.48

4 b Because the probability of either a novel or a mathematics book is 1. 5 No. $P(A \cup B) \neq 1$ 6 a $\frac{7}{11}$ b $\frac{922}{1155}$ 7 $\frac{1}{2}$ 8 a $\frac{1}{5}$ b $\frac{9}{15}$

8 c $\frac{13}{15}$ d $\frac{13}{15}$ e $\frac{2}{3}$ 9 a $\frac{1}{4}$ b $\frac{5}{8}$ c $\frac{1}{8}$ d 1 e $\frac{3}{4}$ f $\frac{1}{2}$ g 0 10 a $\frac{1}{9}$ b $\frac{5}{6}$ c $\frac{1}{6}$ d $\frac{1}{6}$ e $\frac{1}{9}$ f $\frac{1}{4}$ g $\frac{2}{3}$

11 a 0.1 b 1 c 0.5 12 $\frac{1}{10}$ 13 $\frac{1}{4}$ 14 0.72 15 a $\frac{1}{3}$ b $\frac{13}{18}$ c $\frac{5}{18}$ d $\frac{7}{9}$ e $\frac{7}{18}$

15 f Because it is not possible to have one die showing a 5 and for the sum to be less than 4. 16 $\frac{23}{32}$

17 a $\frac{1}{2}$ b $\frac{9}{16}$ c 1

18 a Events X and Y are not mutually exclusive because 2 fish of type A and 2 fish of type B fit both.

18 b Events X and Z are not mutually exclusive because 2 fish of type A, 1 fish of type B and 1 fish of type C fit both. c Events Y and Z are mutually exclusive because the event Y does not allow a fish of type C and event Z does.

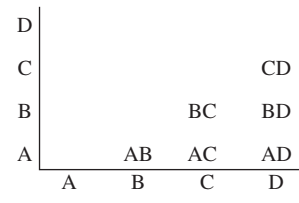
19 0.15 20 a $\frac{83}{500}$ b $\frac{1}{25}$

Chapter 20 Exercise 2

1 a $\frac{5}{42}$ b $\frac{3}{7}$ 2 a $\frac{9}{15}$ b $\frac{1}{6}$ c $\frac{1}{2}$ 3 a $\frac{7}{16}$ b $\frac{1}{4}$ c $\frac{2}{7}$ d $\frac{1}{2}$

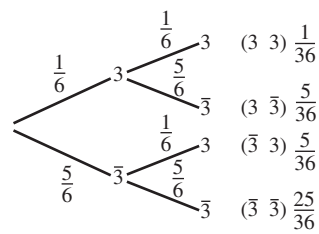
4 a $\frac{1}{14}$ b $\frac{1}{6}$ c $\frac{2}{7}$ 5 a $\frac{2}{5}$ b $\frac{1}{2}$ c $\frac{1}{2}$ 6 0.0768 7 a $\frac{181}{208}$

7 b No, because $P(A \cup B) \neq 1$ 8 $\frac{14}{17}$ 9 a b $\frac{2}{3}$ c $\frac{1}{2}$

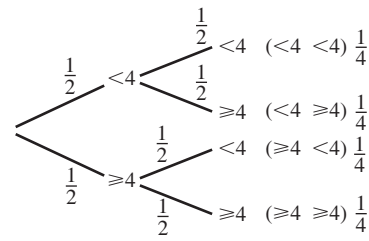


Chapter 20 Exercise 3

1 a 0.3 b 0.5 2 a

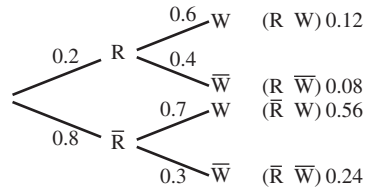


b $\frac{1}{36}$ c $\frac{25}{36}$ d



e $\frac{1}{2}$ f $\frac{3}{4}$

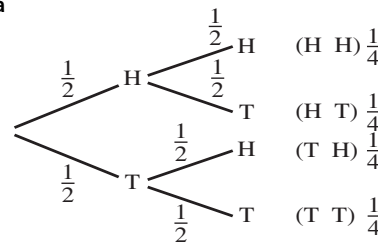
3 a



b 0.12 c 0.32 d 0.3 e 0.176

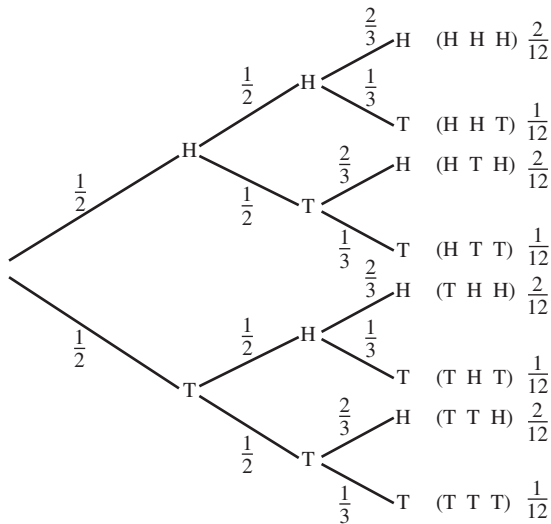
4 a $\frac{1}{8}$ b $\frac{3}{8}$ c $\frac{1}{4}$ d $\frac{7}{8}$

5 a

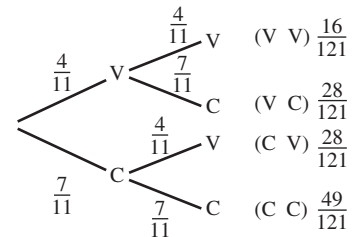


b $\frac{3}{4}$

5 c



5 d $\frac{5}{12}$ e $\frac{1}{2}$ 6 a



b $\frac{49}{121}$

6 c $\frac{56}{121}$ 7 a $\frac{1}{22}$ b $\frac{3}{11}$ c $\frac{41}{55}$ d 0 e $\frac{21}{55}$ f $\frac{7}{15}$

8 a $\frac{108}{455}$ b $\frac{128}{455}$ c 0.652 9 a $\frac{2}{15}$ b $\frac{8}{15}$

10 a $\frac{1}{5}$ b $\frac{2}{5}$ c $\frac{2}{5}$ 11 $\frac{5}{29}$ 12 a $\frac{2}{3}$ b $\frac{2}{9}$ c $\frac{3}{4}$

13 a 0.2 b 0.44 14 0.521 15 a $\frac{1}{6}$ b $\frac{1}{2}$

16 a 0.03 b 0.34 c 0.25 d 0.12 17 a 0.815 b 0.149

Chapter 20 Exercise 4

1 a 0.974 b 6 c 6 2 a 0.832 b 24 3 0.985 4 $\frac{3}{4}$ 5 $\frac{2}{3}$ 6 $\frac{45}{53}$ 7 $\frac{32}{45}$ 8 a i $\frac{11}{609}$ ii 0.0212 iii 0.0153 b 0.0839

9 0.84 10 a 0.222 b 0.074 c 0.144 d 6 11 a 0.00877 b 0.322 c 0.632 d 0.561 12 a 0.3 b 0.35 c 0.075 d 0.3

13 a $\frac{1}{16}$ b $\frac{1}{64}$ c 19 14 a 0.0191 b i 0.00459 ii 0.0255 15 a $\frac{1}{27000}$ b 90 c $\frac{1}{900}$

Chapter 20 Exercise 5

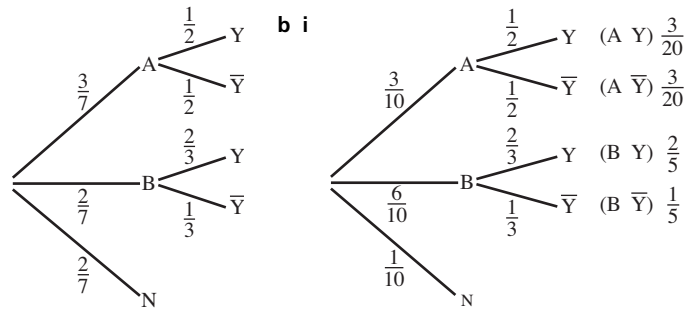
- 1 720 2 16065 3 24 4 60 5 4838400 6 604800 7 241920 8 2177280 9 a 36 b 6 c 12 d 24 10 70 11 a 90720
 b 5040 11 c 2520 12 a 40320 b 5040 c 20160, 2520 13 a 2494800 b 635040 14 a 5040 b 4320 c 720 15 a 36 b 10
 16 a 9000000 16 b Increases by 16000000 17 a 831600 b 176400 c 151200 18 119 19 38760 20 a 4 b 48 c 24 d 256
 21 a 60 b 30 22 a 28 b 28 c 35 23 a 120 b 90 24 756756 25 70 26 210 27 3185325 28 27

Chapter 20 Exercise 6

- 1 a 100 b $\frac{1}{2}$ c $\frac{1}{5}$ d $\frac{1}{5}$ 2 a 362880 b i $\frac{2}{9}$ ii $\frac{7}{9}$ c $\frac{1}{189}$ 3 a 15 b $\frac{2}{3}$ 4 a 360 b $\frac{2}{3}$ c $\frac{8}{15}$ 5 a 3838380
 5 b $\frac{3}{20}$ c $\frac{5}{39}$ 6 a 10440 b $\frac{12}{29}$ c $\frac{1}{15}$ 7 a 16 b i $\frac{1}{2}$ ii $\frac{3}{8}$ iii $\frac{3}{16}$ 8 a 3150 b $\frac{1}{30}$ c $\frac{1}{45}$ d $\frac{1}{6}$ 9 a 720 b $\frac{1}{15}$
 9 c $\frac{1}{30}$ 10 a 3628800 b $\frac{1}{30}$ c $\frac{7}{15}$ d $\frac{3}{28}$

Chapter 20 Review Exercise

- 1 a $\frac{1}{6}$ b Events are not independent since $P(\text{Black}) \times P(\text{Brown}) = \frac{1}{3}$ and $P(\text{Black} \cap \text{Brown}) = \frac{1}{6}$
 Events are not mutually exclusive because $P(\text{Black} \cap \text{Brown}) \neq 0$ Events are exhaustive since $P(\text{Black} \cup \text{Brown}) = 1$
 2 a 0.984 b 7 3 a 151200 b 10080 4 a $\frac{1}{6}$ b 0.0670 c $\frac{1}{6} \times \left(\frac{5}{6}\right)^{2n-2}$ 5 $\frac{10}{13}$ 6 62 7 a 453600
 7 b 90720 c 362880 8 $\frac{19}{30}$ 9 a 15 b $\frac{8}{15}$ c $\frac{4}{15}$ 10 0.888 11 a 252 b 250 c 126 d 32 12 $\frac{4}{5}$ 13 a 360
 13 b 216 14 0.048 15 a 20160 b $\frac{1}{4}$ c $\frac{1}{56}$ 16 a $\frac{17}{42}, \frac{9}{17}$
 16 b ii $\frac{5}{6}$ iii $\frac{7}{25}$ iv $\frac{28}{51}$ 17 a 252 b 196 c 186
 18 a $\frac{3n+1}{2}$ b $\frac{n+1}{3n+1}$ 20 a 0.549 b 0.368 c 0.439
 21 a 0.581 b 0.0918 c 0.0663



Chapter 21 Exercise 1

- 1 a $b = 0.2$ b 0.6 c 0.65 d 0.8 e 2 2 a $a = 0.33$ b 0.87 c 0.75 d 0.73 e 0.25 f 7
 3 a

X	0	1	2	3
$P(X=x)$	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{8}$

 b

X	0	1	2	3
$P(X=x)$	$\frac{27}{343}$	$\frac{108}{343}$	$\frac{144}{343}$	$\frac{64}{343}$

 c

X	0	1	2	3
$P(X=x)$	$\frac{125}{216}$	$\frac{75}{216}$	$\frac{15}{216}$	$\frac{1}{216}$

 3 d

X	2	3	4	5	6	7	8	9	10	11	12
$P(X=x)$	$\frac{1}{36}$	$\frac{2}{36}$	$\frac{3}{36}$	$\frac{4}{36}$	$\frac{5}{36}$	$\frac{6}{36}$	$\frac{5}{36}$	$\frac{4}{36}$	$\frac{3}{36}$	$\frac{2}{36}$	$\frac{1}{36}$

 e

X	0	1	2	3
$P(X=x)$	0.512	0.384	0.096	0.008

 4 a

X	0	1	2	3	4	5
$P(X=x)$	0	$\frac{1}{55}$	$\frac{4}{55}$	$\frac{9}{55}$	$\frac{16}{55}$	$\frac{25}{55}$

 b

X	1	2	3	4	5	6
$P(X=x)$	$\frac{1}{21}$	$\frac{2}{21}$	$\frac{3}{21}$	$\frac{4}{21}$	$\frac{5}{21}$	$\frac{6}{21}$

 c

X	7	8	9	10
$P(X=x)$	$\frac{6}{30}$	$\frac{7}{30}$	$\frac{8}{30}$	$\frac{9}{30}$

 4 d

X	12	13	14	15
$P(X=x)$	$\frac{9}{42}$	$\frac{10}{42}$	$\frac{11}{42}$	$\frac{12}{42}$

 5 a $k = \frac{1}{9}$

X	3	4	5
$P(X=x)$	$\frac{2}{9}$	$\frac{3}{9}$	$\frac{4}{9}$

 b $k = \frac{1}{74}$

X	4	5	6
$P(X=x)$	$\frac{15}{74}$	$\frac{24}{74}$	$\frac{35}{74}$

 5 c $k = \frac{1}{225}$

Y	1	2	3	4	5
$P(Y=y)$	$\frac{1}{225}$	$\frac{8}{225}$	$\frac{3}{225}$	$\frac{64}{225}$	$\frac{5}{9}$

 d $k = 35$

B	1	2	3	4	5
$P(B=b)$	$\frac{5}{35}$	$\frac{6}{35}$	$\frac{7}{35}$	$\frac{8}{35}$	$\frac{9}{35}$

6 a

X	0	1	2	3
$P(X = x)$	$\frac{6}{504}$	$\frac{108}{504}$	$\frac{270}{504}$	$\frac{120}{504}$

 b $\frac{249}{252}$ 7 a

X	0	1	2	3
$P(X = x)$	$\frac{27}{64}$	$\frac{27}{64}$	$\frac{9}{64}$	$\frac{1}{64}$

 b $\frac{5}{32}$

8 a

Y	0	1	2	3	4
$P(Y = y)$	$\frac{1}{126}$	$\frac{20}{126}$	$\frac{60}{126}$	$\frac{40}{126}$	$\frac{5}{126}$

 b $\frac{125}{126}$

Chapter 21 Exercise 2

1 a $b = 0.3$ $E(X) = 4.7$ b $b = 0.15$ $E(X) = 3.35$ c $b = 0.28$ $E(X) = 3.06$ d $b = 0.1$ $E(X) = 2.6$

2 $E(X) = \frac{1}{2}$ 3 a $c = \frac{12}{91}$ b $E(X) = \frac{441}{91}$ 4 a $E(X) = \frac{x-3}{4}$ b $x = 3$

5

X	-1	1
$P(X = x)$	0.3	0.7

 6

X	-1	1	3
$P(X = x)$	0.15	0.25	0.6

 7

Y	0	2	4	6
$P(Y = y)$	$\frac{4}{10}$	$\frac{1}{10}$	$\frac{1}{10}$	$\frac{4}{10}$

8 $E(X) = \frac{25}{9}$ 9 $E(X) = 1$ 10 a 2.05 b 5.45 c 3.10 d 8.15 11 a 3 b 14 c 7 d 8

12 a $\frac{691}{400}$ b 5.8 c 6 d 0.986 13 a 7 b $\frac{329}{6}$ c $\frac{35}{6}$ 14 a $\frac{9}{7}$ b $\frac{15}{7}$ c $\frac{24}{49}$ 15 a $\frac{1}{14}$ b 2.53 c 1.65

16 $E(Y) = \frac{28}{15}$, $Var(Y) = 0.782$

Y	0	1	2	3	4
$P(Y = y)$	$\frac{2}{39}$	$\frac{56}{195}$	$\frac{84}{195}$	$\frac{8}{39}$	$\frac{1}{39}$

 17 a $\frac{1}{2}$ b $\frac{26}{7}$ c 1.44

18 a can be a probability density function Mean = $\frac{110}{35}$ Standard deviation = 1.05

19 a 0, 1, 2, 4 b

X	0	1	2	3	4
$P(X = x)$	$\frac{15}{24}$	$\frac{4}{24}$	$\frac{4}{24}$	0	$\frac{1}{24}$

 c Mean = $\frac{2}{3}$ Variance = 1.06

20 a 10, 11, 12, 13, 14 b

X	10	11	12	13	14
$P(X = x)$	$\frac{6}{90}$	$\frac{24}{90}$	$\frac{30}{90}$	$\frac{24}{90}$	$\frac{6}{90}$

 c $E(X) = 12$, $Var(X) = \frac{16}{15}$ d $\frac{83}{225}$

21 a $\frac{1}{14}$ b $E(X) = \frac{4}{7}$, $Var(X) = 0.816$ c 0, 1, 2, 3, 4, 5, 6 d

X	0	1	2	3	4	5	6
$P(X = x)$	$\frac{81}{196}$	$\frac{54}{196}$	$\frac{27}{196}$	$\frac{24}{196}$	$\frac{7}{196}$	$\frac{2}{196}$	$\frac{1}{196}$

 e $E(Y) = \frac{8}{7}$, $Var(Y) = 1.63$

Chapter 21 Exercise 3

1 a 0.27 b 0.532 c 0.0556 2 a 0.201 b 0.833 c 0.834 3 a 0.208 b 0.0273 c 0.973 d 0.367 4 0.751 5 a 2.4 b 1.44 c 2

6 a 2.4 b 1.68 c 2 7 a $n = 7$, $p = \frac{1}{4}$, $q = \frac{3}{4}$ b 0.445 c 1 or 2 8 a 0.00345 b 0.982 c 0.939 9 a 0.0872 b 0.684

9 c 0.684 d 0.847 10 a 3.52×10^{-5} b 0.0284 c 0.683 d 0.163 11 a 0.238 b 0.0158 12 a 0.245 b 0.861 c 0.997

13 a 0.060 b 0.00257 c 0.00191 d 0.230 e 0.129 14 a 10 b 2.74 c 0.416 15 a $\frac{4}{7}$ b 17 16 a 0.0258 b 0 c $\frac{1}{3}$ d 4

16 e 0.00258 f 0.00858 17 a Mean = 2.1 Variance = 1.81 b 2 c 0.204 d 0.148 e 0.473 18 a $X \sim Bin\left(8, \frac{1}{3}\right)$ b 0.156

18 c $\frac{8}{3}$ d 0.961 19 a 8 b 0.822 c 8 d 0.0108

Chapter 21 Exercise 4

1 a 0.224 b 0.423 c 0.353 d 3 2 a 0.134 b 0.151 c 0.554 d 6 3 a 0.125 b 0.332 c 0.933 d 10

4 a 1.68 b 0.0618 c 0.910 5 a 2.48 b 0.213 c 0.763 d 0.0404 6 a 2.69 b 0.0799 c 0.136 d 0.505 e 0.944

7 a 2.10 b 0.0991 c 0.0204 d 0.350 8 a 7.62 b 0.996 9 a 1 b 0.981 10 a 0.905 b 0.00468 c 0.000151

11 a 0.874 b 0.191 c 0.223 d 0.0426 12 a 0.0804 b 0.751 c 2 d 0.182 e 0.454 13 a 0.0149 b 0.223

14 a 0.0183 b 0.215 c 0.927 d Mean = 80 Variance = 80 e 0.849 f 0.0262 15 a 0.0324 b 0.992 c 0.112 d 0.868 e 0.654

16 a i 0.839 ii 21.4, 21.4 iii 21 b 0.000241 17 a 0.195 b 0.785 c 0.152 d 0.166 e 8

18 a 0.0823 b 0.0499 c 0.00363 d 0.0000314

Chapter 21 Review Exercise

- 1 a $\frac{1}{10}$ b 3 c 1 2 a $\lambda = 2.99$ b 0.424 3 a 0.225 b 3 or 4 c 17.5 4 a 20 b 12.4 c 42.2 5 a 0.191 b 0.246
 6 a 0.176 b 0.905 c 7 d 6.5 e 0.0158 7 a $\frac{12}{25}$ b $\frac{48}{25}$ 8 a 0.175 b 0.141 9 a 0.160 b 4 c 0.271 d 0.0808
 10 a 0.0729 b 22 11 a i $\frac{1}{9}$ ii $\frac{1}{81}$ b i $\frac{73}{648}$ ii $\frac{575}{1296}$ c ii

X	1	2	3	4	5	6
$P(X = x)$	$\frac{1}{1296}$	$\frac{15}{1296}$	$\frac{65}{1296}$	$\frac{175}{1296}$	$\frac{369}{1296}$	$\frac{671}{1296}$

iii $\frac{6797}{1296}$

- 12 a 0.0105 b 0.0226 c 1 d 10 e 0.0232 13 30 14 a 0.222 b 0.939 c 0.104 d 0.00370 e 0.332 f 0.0145 g 0.995

15 a $P(A|B) = \frac{P(A \cap B)}{P(B)}$ b $P(A_1 \cup A_2) = P(A_1) + P(A_2)$ c $P(E_1 \cap E_2) = P(E_1) \times P(E_2)$

15 d This is a distribution that deals with events that either occur or do not occur, i.e. there are two complementary outcomes. We are usually told the number of times an event occurs and we are given the probability of the event happening or not happening.

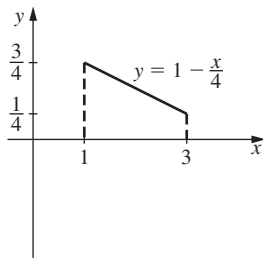
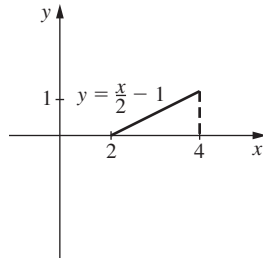
15 e i ${}^4C_k \theta^k (1 - \theta)^{4-k}$ ii $E(X) = 4\theta$, $Var(X) = 4\theta(1 - \theta)$ iii $6\theta^2(1 - \theta)^2 + 4\theta^4(1 - \theta) + \theta^4$ iv 0.688, 0.996 v $\frac{{}^4C_j \theta^j (1 - \theta)^{4-j}}{6\theta^2(1 - \theta)^2 + 4\theta^4(1 - \theta) + \theta^4}$

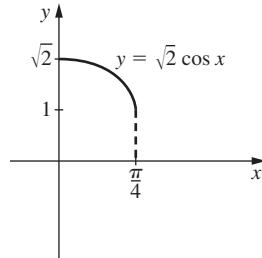
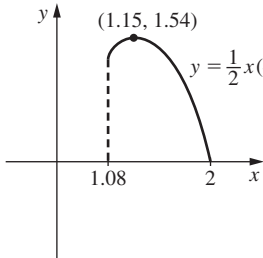
- 15 e vi 0.545, 0.0488 vii 0.969 16 a

No heads	0	1	2	3	4	5	6
Amount received in Euros X	30	25	15	12	18	25	40
$P(X = x)$	0.00137	0.0165	0.0823	0.219	0.329	0.263	0.0878

- 16 b Gain of 20.3 Euros c 59.5 d 305 17 $\alpha = \frac{1}{7}$, $E(X) = \frac{123}{49}$ 18 b i 0.0977 ii 0.885

Chapter 22 Exercise 1

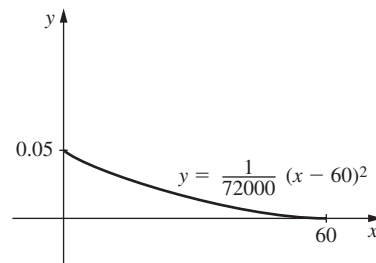
- 1 a $k = 1$ b  c $\frac{1}{2}$ d $\frac{27}{32}$ 2 a $c = 4$ b  c $\frac{3}{16}$ d 0

- 3 a $k = \sqrt{2}$ b  c 0.707 d 0.634 4 a $k = 1.08$ b  c 0.306 d 0.621

- 5 a $\frac{3}{269}$ b  c 0.494 d 0.375

Chapter 22 Exercise 2

- 1 a $k = \frac{1}{2}$ b $\frac{4}{3}$ c $\frac{2}{9}$ 2 a $\frac{1}{\ln 3}$ b $\frac{2}{\ln 3}$ c $\frac{4}{\ln 3} - \frac{4}{(\ln 3)^2}$ 3 a $c = 0.755$ b 0.530 4 a $k = \frac{1}{16}$ b $\frac{23}{6}$ c 1.97 d 4 e $\frac{15}{32}$
 5 a $k = \frac{1}{9}$ b 2.25 c $\frac{27}{80}$ d 2.38 6 a $c = \frac{1}{(e-1)}$ b $\frac{1}{(e-1)}$ 7 a $k = 1$ b 0.571 c 0.141 d $\frac{\pi}{6}$ e 0.169
 8 a $k = 1.56$ b 0.616 c 0.422 d 0.546 e 0.616 9 a $0 \leq x \leq \frac{1}{2}$ b $0 < x < 0.421$ c 0.115 d 0.0209 10 a 1 b 0
 11 c 0.273 12 a i 7.71 ii 0.947 b 0.318 13 a $k = \frac{e^2}{3(e^2 - 1)}$ b 0.148 c 0.00560 14 a
 14 b $\sqrt{135}$ c 12.4 15 a $c = 0, k = \frac{3}{8}$ b 0.15 c 1.587 d 0.305



Chapter 22 Exercise 3

- 1 a 0.775 b 0.589 c 0.633 d 0.0392 e 0.9234 f 0.0973 g 0.203 h 0.562 i 0.841 j 0.5392 2 a 0.121 b 1.53
 2 c -0.396 d -0.678 e 1.69 f -0.485 g 0.999 h 1.56 i 0.509 j 0.813 3 a 0.00332 b 0.901 c 0.00332 d 0.968
 4 a 0.0912 b 0.997 c 0.952 d 0.122 e 0 5 a 0.106 b 0.809 c 0.998 d 0.101 e 0 6 a 0.275 b 0.00139
 6 c 0.683 d 0.0279 7 a 0.840 b 0.0678 c 0.683 d 0.997 8 a 40.6 b 38.9 c 41.9 d 39.2 9 a 93.9 b 84.6 c 86.6
 9 d 82.2 10 a 5.89 b 13.7 c 18.1 d 4.18 11 Upper quartile $Z \geq 0.674$ Lower quartile $Z \leq -0.674$ 12 0.935 13 0.912 14 0.999
 15 0.939 16 0.134

Chapter 22 Exercise 4

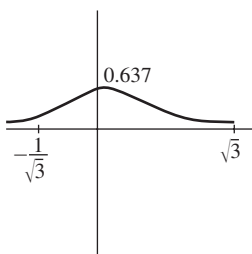
- 1 15.1 2 75.6 3 30.5 4 39.0 5 6.81 6 7.81 7 14.1 8 11.2 9 $\mu = 11.6, \sigma = 4.53$ 10 $\mu = 46.3, \sigma = 4.26$
 11 $\mu = 290, \sigma = 11.1$ 12 a $\mu = 23.6, \sigma = 6.13$ b 0.432 13 11.7

Chapter 22 Exercise 5

- 1 a 0.453 b 2.29 kg 2 a 10.6% b $m = 589g, n = 600g$ 3 a 0.309 b 0.227 c 0.440 4 a 0.106 b 0.734 c 0.599 d 0.159
 4 e 0.606 f 0.292 5 a 440 b 82.3 kg 6 $(\mu - \sigma, \frac{1}{\sigma\sqrt{2e\pi}}), (\mu + \sigma, \frac{1}{\sigma\sqrt{2e\pi}})$ 7 0.886 8 a 5 b 57.4 9 a 7.93 b 48.9
 9 c 7 10 $\mu = 64.56, \sigma = 11.36$ 11 a 0.235 b 564g c 114 12 a 19.0 b 117 c 98.2 13 a 90.9% b 94.7 14 0.338
 15 a $194 \leq X \leq 303$ b 0.423 16 a $\mu = 28.5, \sigma = \sqrt{1.49}$ b 0.587 17 a 126 b 280g 18 a 1.43 b 0.0146 19 4.14
 20 a 32.8 b 0.161 21 0.00123 22 $\mu = 59.3, \sigma = 18.6$ 23 a 4.82 b 0.0173

Chapter 22 Review Exercise

- 1 a $\mu = 34.5, \sigma = 3.93$ b 0.996 2 a 0.0668 b 142 cm c $q = 140 \text{ cm}, r = 180 \text{ cm}$ d 0.121 e 0.332 3 a 0.946 b 0.798
 3 c 0.000109 d 0.999851 4 $2\frac{1}{2}$ 5 a 99.9% b 11.4 c 3.96% d 0.00110 6 a 0.0327 b 8.00 c Day 1: 2620. Day 2: 2610. 7 b 0



- 7 c 0.268 d 0.350 e 0.348 8 a $\frac{1}{4}$ b $E(X) = \pi, \text{Var}(X) = 2.93$ c 0.323
 9 a 1.63 c 0.434 d \$6610 10 a $\mu = 28.6, \sigma = 14.3$ b 12.6% c $x = 0$ Model is not perfect. d i $\frac{8}{125}$
 10 d ii $\frac{36}{125}$ iii $\frac{98}{125}$ 10 e $< 0.4^3$ f Either the events are not independent or the distribution is not continuous

- 11 a i $E(X) = \frac{1}{12} \int_0^2 x(8x - x^3) dx$ ii 1.24 b ii 1.29 c 1.63 12 a i 1.355 ii 110.37 b $A = 108.63, B = 112.11$ 13 a $\frac{4}{81}$ b 0.6

- 13 c 0.24 d 9000 cents. 14 0.783 15 b $e^{\frac{1}{4}} - e^{\frac{1}{4}} + \frac{1}{4}e$ c $E(X) = \frac{e}{2} - 1, \text{Var}(X) = 1 + \frac{e}{3} - \frac{e^2}{4}$ d 0.290 e 0.0243 f 0.179