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 $x° = 30°, 150°$ **b** $x° = 70.5°, 289.5°$ **c** $x° = 41.8°, 138.2°$ **d** $x° = 80.4°, 279.6°$ **e** $x° = 22.0°, 158.0°$ **f** $x° = 55.2°, 304.8°$

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** $x = 5.82cm$ **b** $x = 6.37cm$ **c** $x = 7.64m$ **d** $n = 7.35m$ **e** $a = 14.2mm$

7 a $x° = 32.4°$ **b** $x° = 127.7°$ **8** 44.7° *or* 135.3° **9** 38.8° *or* 141.2°

10 a $x = 6.07cm$ **b** $x = 22.7m$ **c** $p = 381mm$ **d** $t = 10.7cm$ **11** $2.63m$ **12 a** 59.6° **b** 143.2° **13** 68.7°

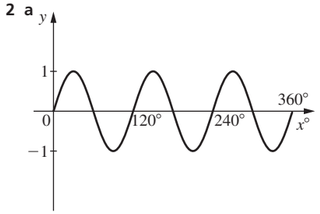
14 $A = 39.4°, B = 46.5°, C = 94.1°$ **15 a** $x = 7.64m$ **b** $x° = 50.9°$ **c** $x° = 83.8°$ **d** $x = 15.8cm$ **e** $x = 16.9m$

16 $312km$ **17** $21.6m$ **18** 57.9° **19** $56.25cm^2$

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°

2 a



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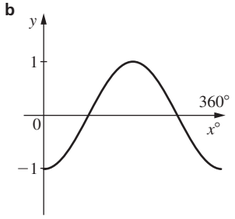

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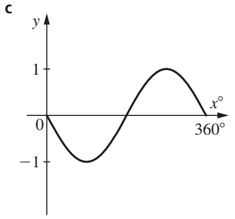

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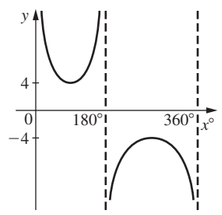

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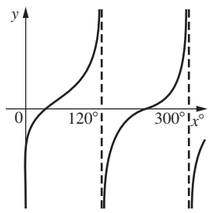

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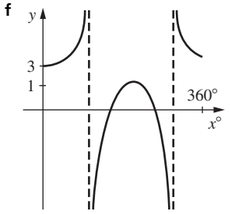

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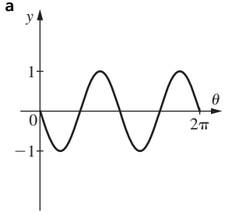

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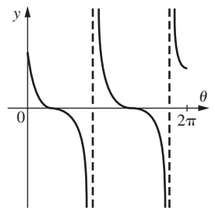

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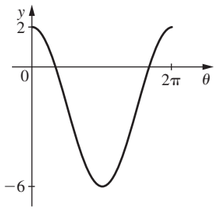

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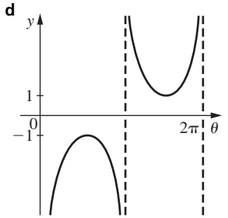

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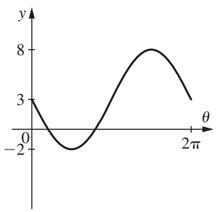

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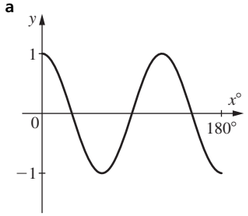

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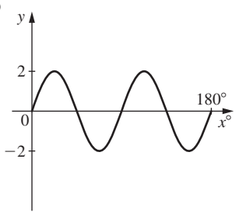

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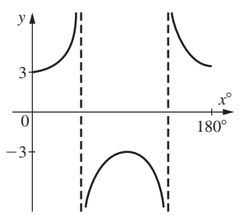

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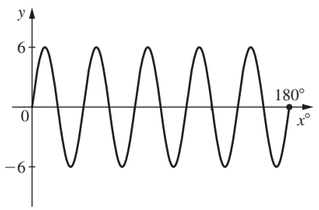

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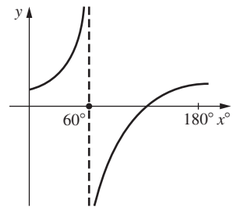

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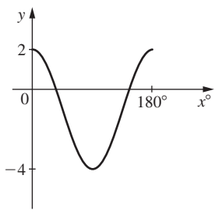

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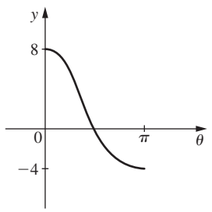

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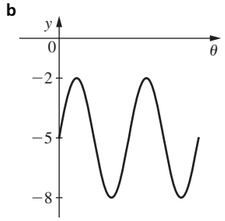

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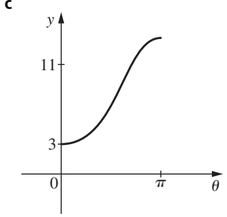

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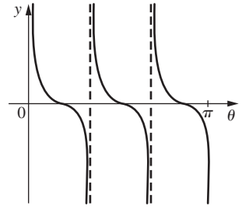

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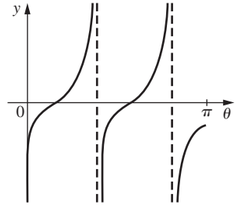

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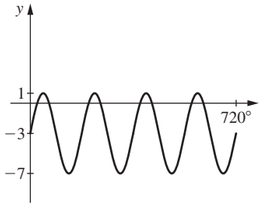

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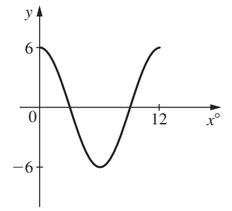

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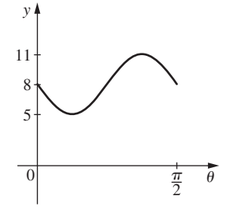


9 a $y = 4\cos 2\theta$ **b** $y = \sin x° + 1$ **c** $y = \tan 2\theta$ **d** $y = -4\cos x° + 2$ **e** $y = -4\sin 2\theta + 4$ **f** $y = -\frac{7}{2}\cos 4x° - \frac{7}{2}$

9 g $y = \tan 15x°$ **h** $y = 3\sin 24\theta + 8$ **i** $y = 2\csc 3x°$ **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 $\sin 43°$ **b** $\cos 50°$ **c** $\tan 20°$ **d** $-\sin 50°$ **e** $-\cos 23°$ **f** $-\tan 34°$ **g** $-\cos 15°$ **h** $-\sin 20°$ **i** $-\tan 46°$

4 a $x° = 30°, 150°$ **b** $x° = 30°, 330°$ **c** $x° = 60°, 240°$ **d** $x° = 135°, 315°$

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°, 240° **b** 60°, 300° **c** 60°, 120° **d** 210°, 330° **e** 150°, 210° **f** 180° **g** 90° **h** 30°, 150° **i** 45°, 225°

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°, 75°, 195°, 255° **b** 10°, 110°, 130°, 230°, 250°, 350° **c** 11.25°, 56.25°, 101.25°, 146.25°, 191.25°, 236.25°, 281.25°, 326.25°

3 d 60°, 120°, 240°, 300° **e** 25°, 45°, 145°, 165°, 265°, 285° **f** 40°, 80°, 160°, 200°, 280°, 320°

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°, 105° **6** $\frac{7\pi}{24}, \frac{11\pi}{24}, \frac{19\pi}{24}, \frac{23\pi}{24}$ **7** 1°, 5°, 13°, 17° **8** $-120°, 60°$ **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°, 160.5° **b** 41.4°, 318.6° **c** 58.0°, 238° **d** 48.2°, 311.8° **e** 48.6°, 131.4°

10 f 31.3°, 288.7° **g** 75.5°, 284.5° **h** 45°, 135° **i** 228.7°, 341.3° **j** 36.9°, 143.1°

10 k 20.9°, 159.1°, 200.9°, 339.1° **l** 25.2°, 94.8°, 145.2°, 214.8°, 265.2°, 334.8°

10 m 11.1^2, 47.1°, 83.1°, 119.1°, 155.1°, 191.1°, 227.1°, 263.1°, 299.1°, 335.1° **n** 70.5°, 289.5°

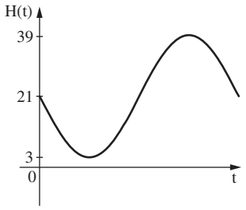
10 o 8.2°, 171.8° **p** 48.2°, 311.8° **q** 33.7°, 213.7° **r** 15°, 75°, 105°, 165°, 195°, 255°, 285°, 345° **s** 1.4°, 4.6°, 13.4°, 16.6°,…

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 0.08, 1.49, 3.22, 4.63 **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°, 289.5°, 430.5°, 649.5° **13** $-\frac{35\pi}{36}, -\frac{19\pi}{36}, -\frac{11\pi}{36}, \frac{5\pi}{36}, \frac{13\pi}{36}, \frac{29\pi}{36}$

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

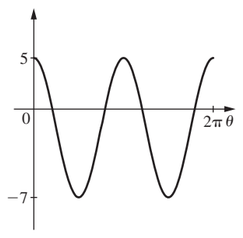
Chapter 1 Review Exercise

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



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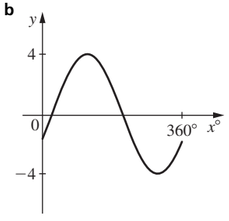

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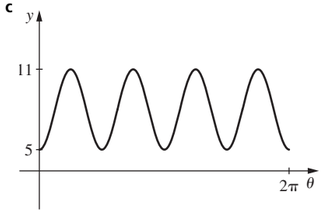
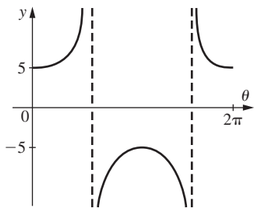
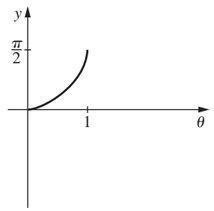


9 d



e



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

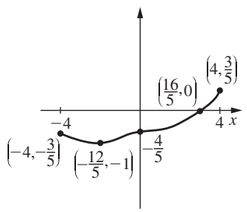
11 d $\theta = \frac{\pi}{12}, \frac{\pi}{6}, \frac{7\pi}{12}, \frac{2\pi}{3}, \frac{13\pi}{12}, \frac{7\pi}{6}, \frac{19\pi}{12}, \frac{5\pi}{3}$ **e** $\theta = \frac{5\pi}{12}, \frac{11\pi}{12}, \frac{17\pi}{12}, \frac{23\pi}{12}$ **12 a** $x° = 135°, 315°$ **b** $x° = 90°$ **c** $x° = 210°, 330°$

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

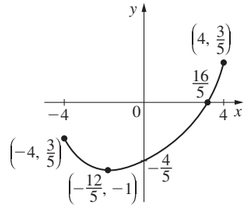
13 a $x° = 64.6°, 295.4°$ **b** $x° = 109.3°, 160.7°, 289.3°, 340.7°$ **c** $20.7°, 80.7°, 140.7°, 200.7°, 260.7°, 320.7°$ **d** $64.6°, 295.4°$

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

17 a



b



c $x = \sqrt{3}$

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** $5\left(x + \frac{7}{10}\right)^2 - \frac{109}{20}$

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 $3\left(x - \frac{5}{6}\right)^2 - \frac{1}{12}$ Minimum $\left(\frac{5}{6}, -\frac{1}{12}\right)$ y intercept: 2 x intercepts: $-1, -\frac{2}{3}$

2 i $-2\left(x - \frac{3}{4}\right)^2 + \frac{23}{8}$ Minimum $\left(\frac{3}{4}, \frac{23}{8}\right)$ y intercept: 4 x intercepts: $-0.851, 2.35$

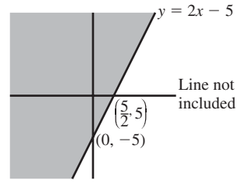
3 a Minimum $(-1.25, -10.125)$ y intercept: -7 x intercepts: $-3.5, 1$

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

1 a



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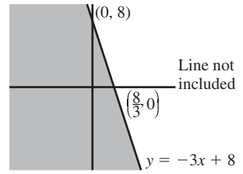

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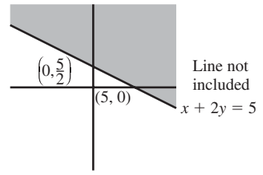
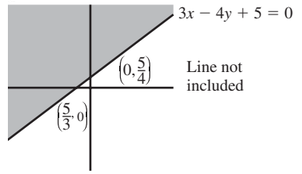


d



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 $p = \pm 14$ **3** $q = \frac{9}{8}$ **5** $a - b - 8ab^3 + 16a^2b = 0$ **7** $p = \frac{1}{2}$ **9** $m = \pm\sqrt{\frac{32}{9}}$ **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** $-2.46<k<0.458$

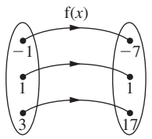
6 $m=\pm 2$ **8** $x=16, x=1$ **9** $k\leq 0, k\geq 8$ **10** $a=\frac{9}{4}, b=\frac{7}{2}$. Maximum point is $\left(\frac{7}{2}, \frac{9}{4}\right)$. Line of symmetry is $x=\frac{7}{2}$

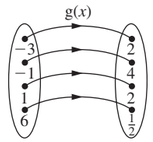
11 6 years old **12** $\cos C=\frac{c^2+3}{4c}$. True for all real values of c.

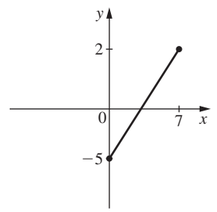
Chapter 3 Exercise 1

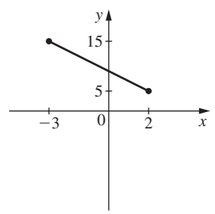
1 a 11 **b** 1 **c** 130 **d** 6 **2 a** -17 **b** 12 **c** -27 **d** $\frac{19}{4}$

3 $\{-7, 1, 17\}$ **4** $\left\{-2, \frac{1}{2}, 2, 4\right\}$ **5** $\{y: -5\leq y\leq 2\}$ **6** $\{y: 5\leq y\leq 15\}$

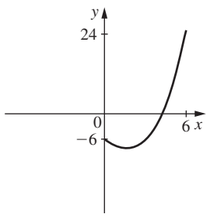


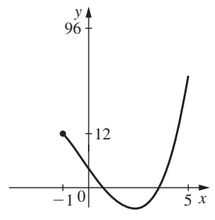






7 $\left\{y: -\frac{25}{4}\leq y\leq 24\right\}$ **8** $\{y: 0.959\leq y\leq 221\}$ **9** $\{y: 5\leq y<\infty\}$





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** $\sin\left(\theta+\frac{\pi}{3}\right)$

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** $\cos\left(x+\frac{\pi}{2}\right)$ **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** $f^{-1}(x)=x^{\frac{1}{3}}$ **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 $x\geq 0, x\in\mathbb{R}$ **e** $x\geq 0, x\in\mathbb{R}$ **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** $f^{-1}(x)=\frac{3-7x}{x}$

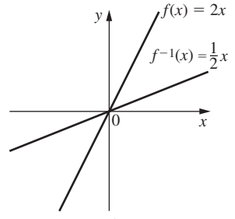
4 c i $x\neq\frac{2}{3}$ **ii** $f^{-1}(x)=\frac{2x+5}{3x}$ **d i** $x\neq 2$ **ii** $f^{-1}(x)=\frac{2x-7}{x}$ **e i** $x\neq\frac{9}{4}$ **ii** $f^{-1}(x)=\frac{9x+8}{4x}$ **f i** $x\neq -\frac{6}{5}$ **ii** $f^{-1}(x)=\frac{4-6x}{5x}$

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** $x\geq 0$ **ii** $f^{-1}(x)=\sqrt{\frac{16-x}{3}}$

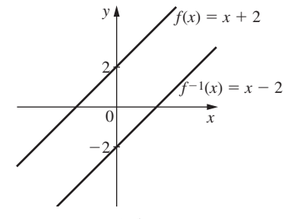
4 k i $x\geq 0$ **ii** $f^{-1}(x)=x^{\frac{1}{4}}$ **l i** $\mathbb{R}$ **ii** $f^{-1}(x)=\left(\frac{x+5}{2}\right)^{\frac{1}{3}}$ **5 a** $h(x)=3x-6$ **b** $h^{-1}(x)=\frac{(x+6)}{3}$

Chapter 3 Exercise 4

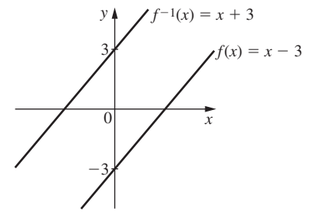
1 a $f^{-1}(x)=\frac{x}{2}$



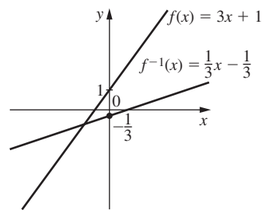
b $f^{-1}(x)=x-2$



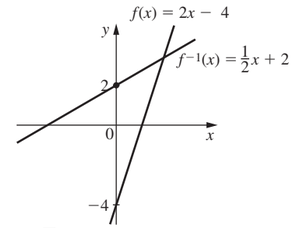
c $f^{-1}(x)=x+3$



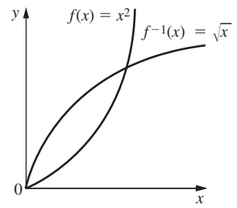
1 d $f^{-1}(x)=\frac{x-1}{3}$



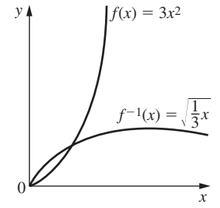
e $f^{-1}(x)=\frac{x+4}{2}$



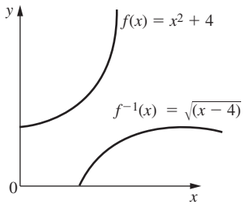
2 a $f^{-1}(x)=\sqrt{x}$



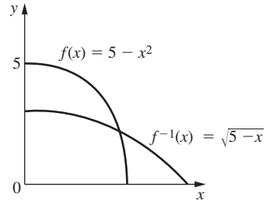
b $f^{-1}(x)=\sqrt{\frac{x}{3}}$



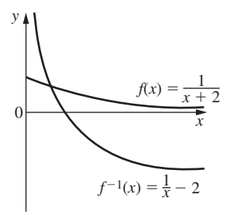
c $f^{-1}(x)=\sqrt{x-4}$



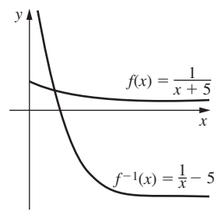
d $f^{-1}(x)=\sqrt{5-x}$



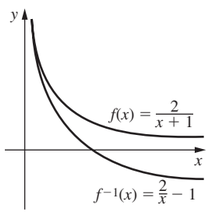
3 a $f^{-1}(x)=\frac{1-2x}{x}$



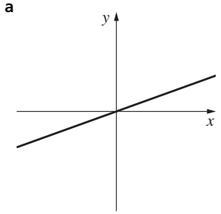
b $f^{-1}(x)=\frac{1-5x}{x}$



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



4 a



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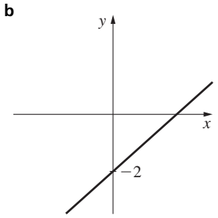

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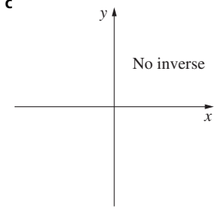

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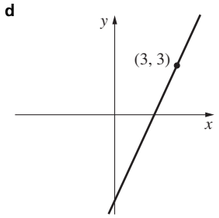

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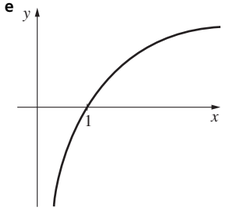

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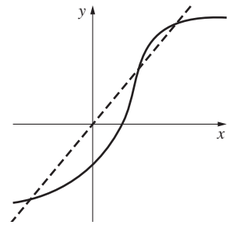

Chapter 3 Exercise 5

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

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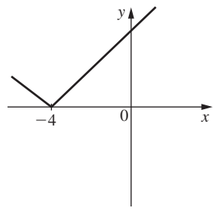

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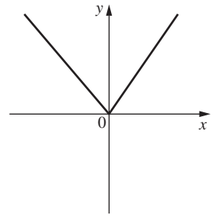

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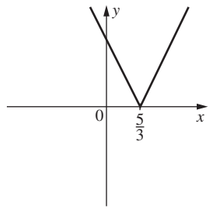

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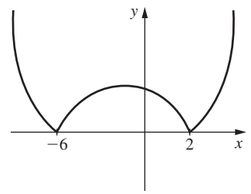

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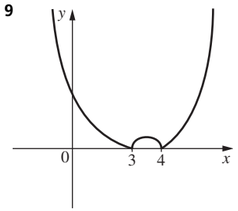

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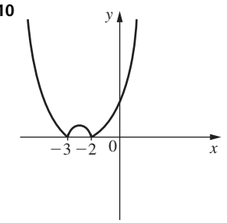

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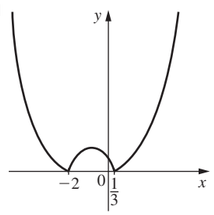

12 $x = -5, x = 1$ **13** $x = -4, x = 6$

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

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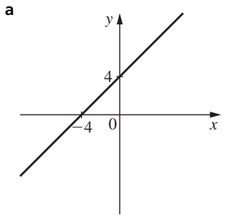

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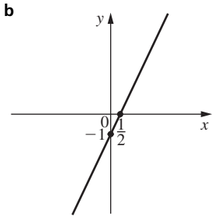

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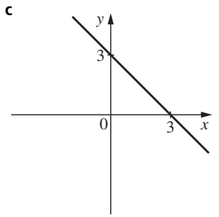

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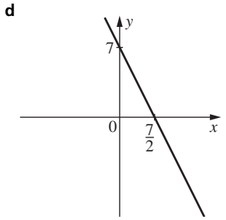

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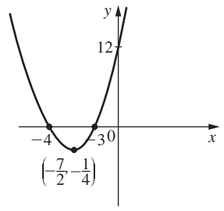

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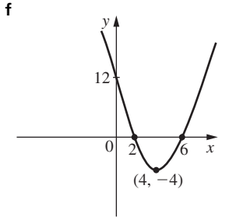

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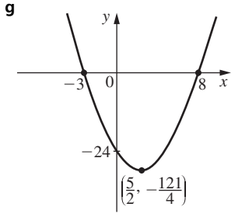

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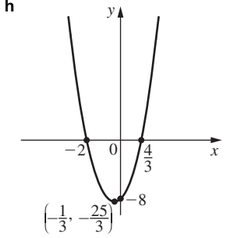

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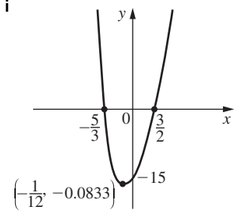

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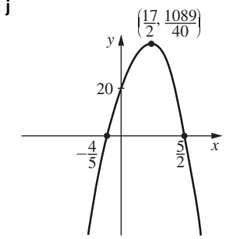

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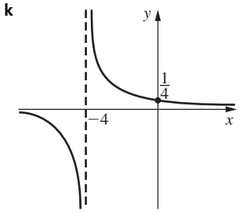

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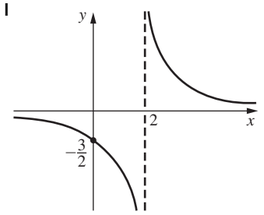

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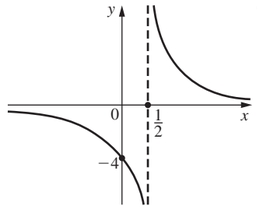

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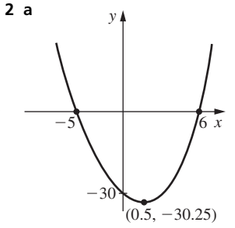

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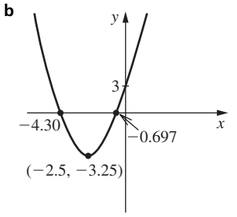

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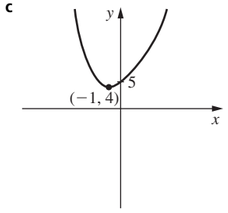

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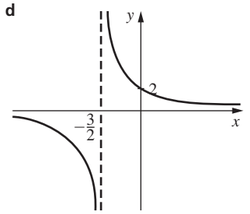

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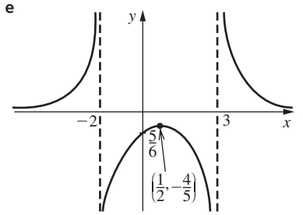

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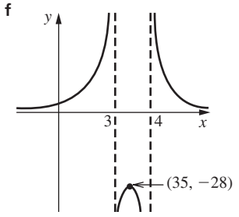

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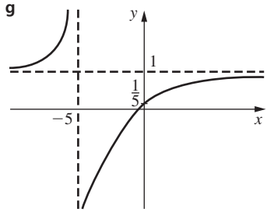

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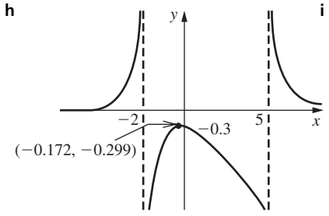

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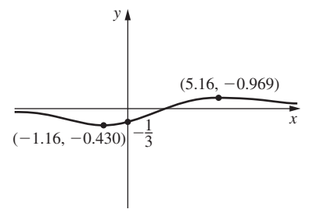

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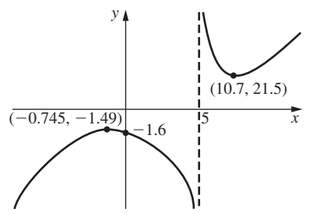

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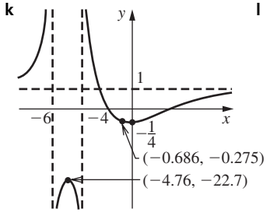

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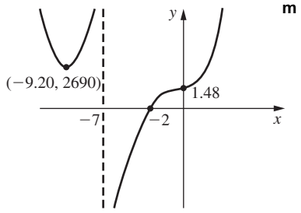

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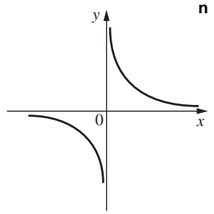

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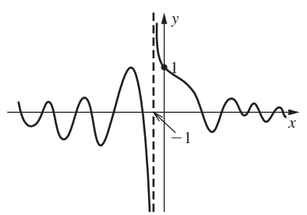

Chapter 3 Exercise 7

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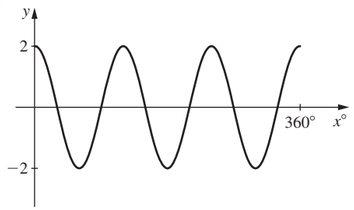

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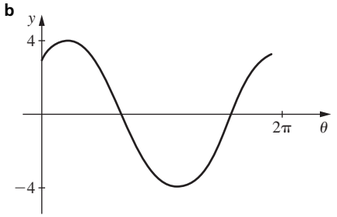

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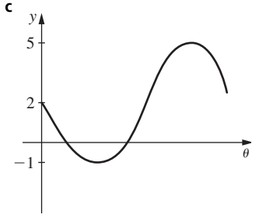

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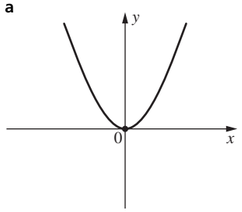

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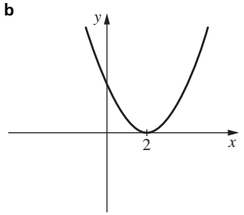

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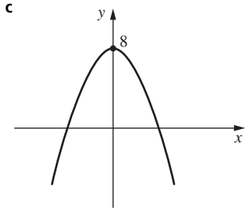

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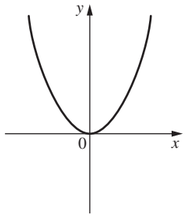

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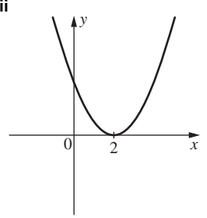

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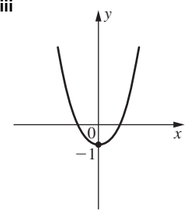

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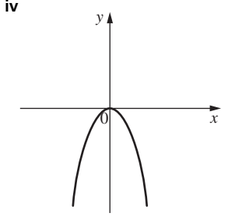

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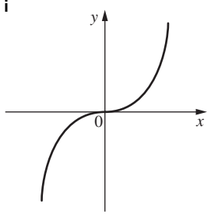

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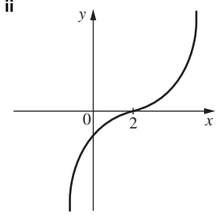

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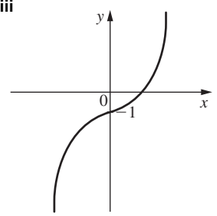

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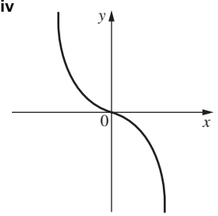

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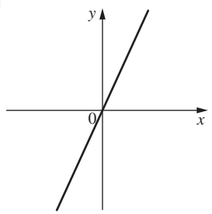

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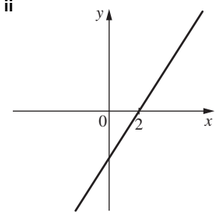

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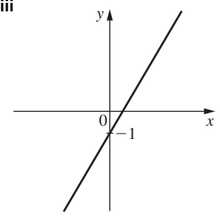

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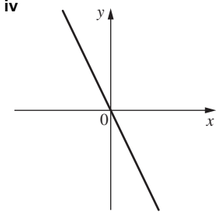

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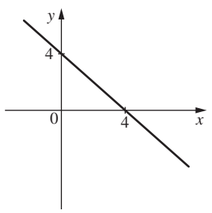

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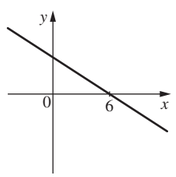

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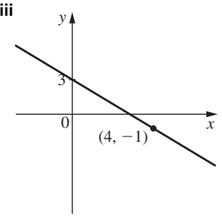

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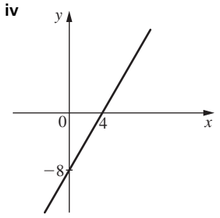

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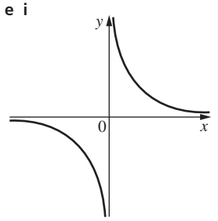

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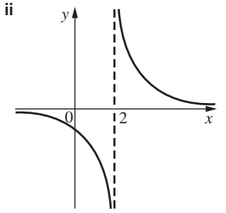

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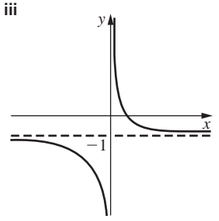

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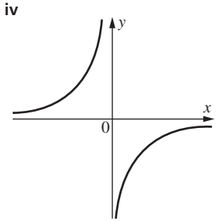

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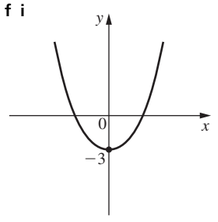

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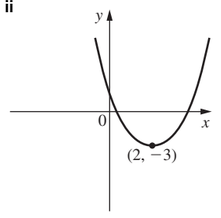

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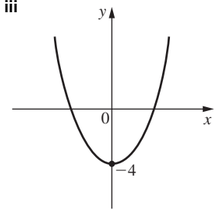

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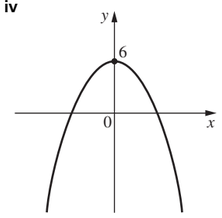

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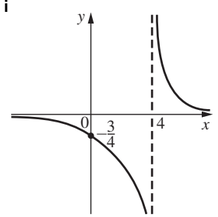

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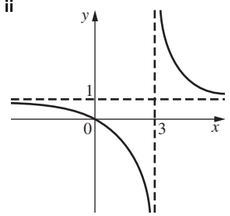

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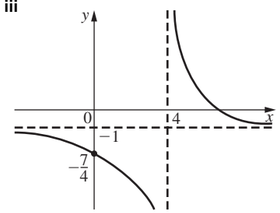

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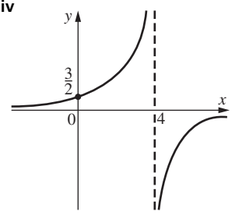

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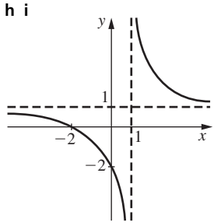

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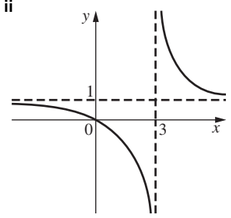

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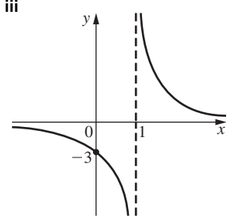

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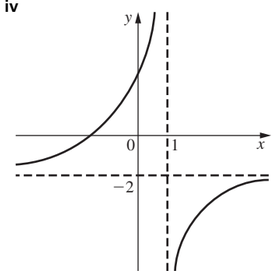
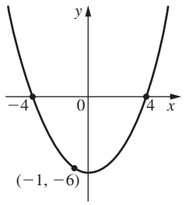


4 a $1 - 2x - x^2$ **b** $1 - 3x - 3x^2 - x^3$ **c** $-3x - 1$ **d** $x - 1$ **e** $\frac{2x + 1}{x + 1}$ **f** $4 - 2x - x^2$ **g** $\frac{2x - 9}{x - 3}$ **h** $\frac{x - 3}{x}$

5 a i



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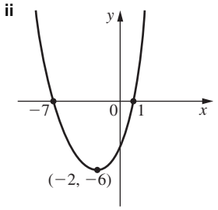

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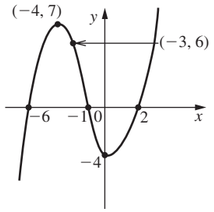

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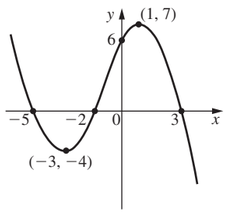

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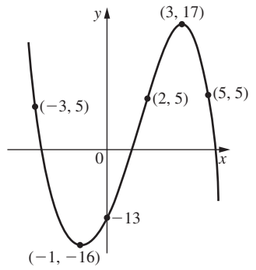

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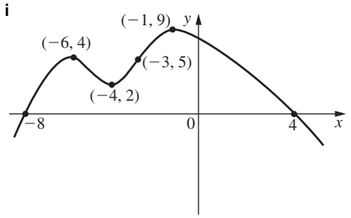

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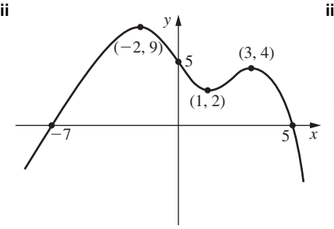

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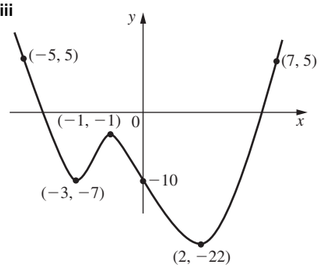

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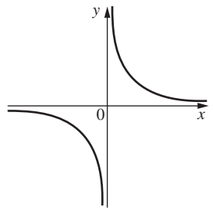

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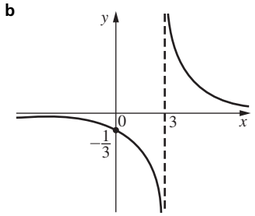

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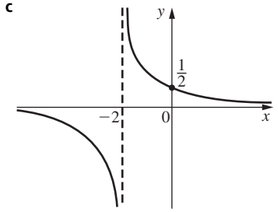

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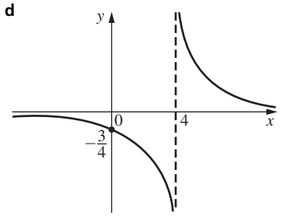

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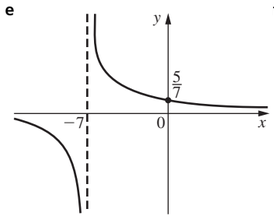

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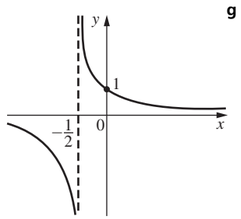

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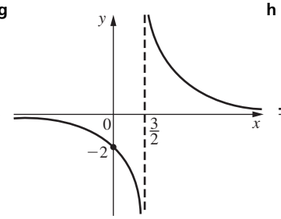

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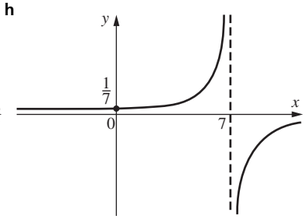

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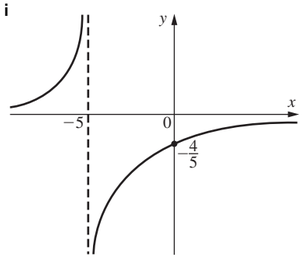

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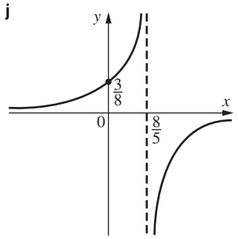

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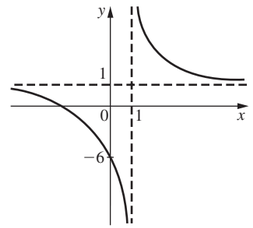

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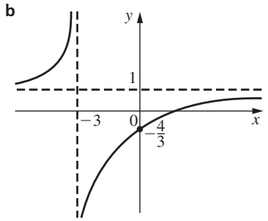

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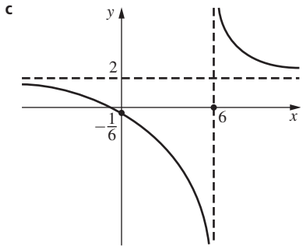

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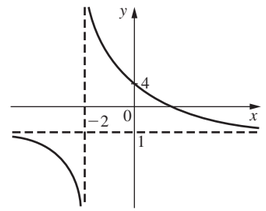

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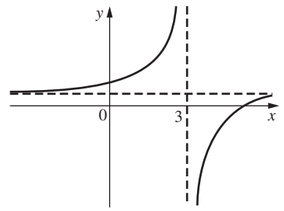

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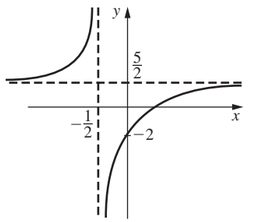

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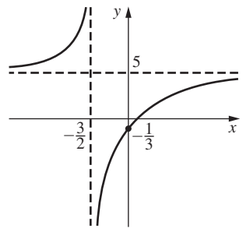

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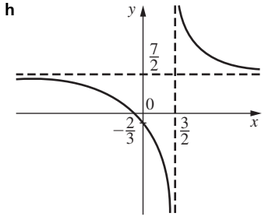
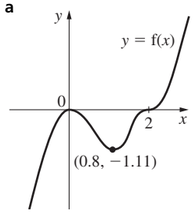


8 a $x = \frac{1}{2}$ **b** $x = \frac{10}{3}$ **c** $x = -\frac{1}{5}$ **d** $x = \frac{2}{3}$ **e** $x = \frac{37}{8}$

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** $x > \frac{3}{2}$

10 a



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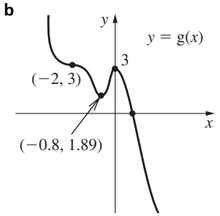

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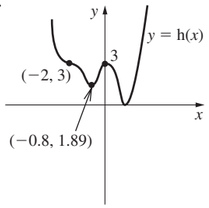

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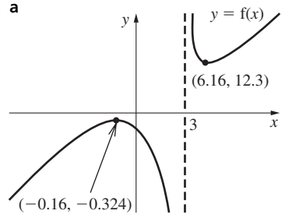

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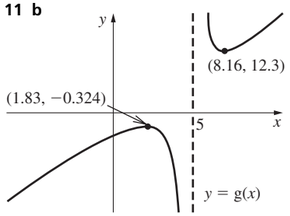

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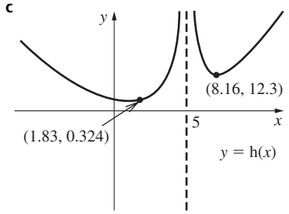

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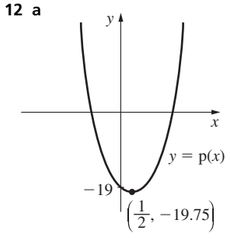

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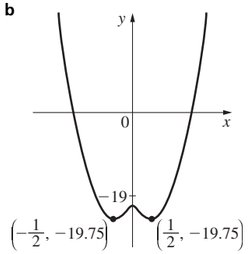
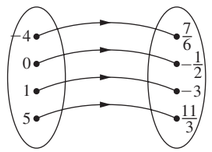


Chapter 3 Review Exercise

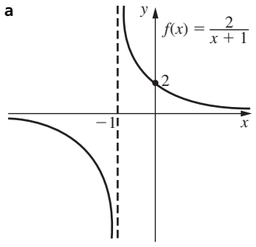
1 $\frac{7}{2}$ **2** $\left\{\frac{7}{6}, -\frac{1}{2}, -3, \frac{11}{3}\right\}$



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** $x \neq -\frac{3}{2}$, $f^{-1}(x) = \frac{7 - 3x}{2x}$

6 a



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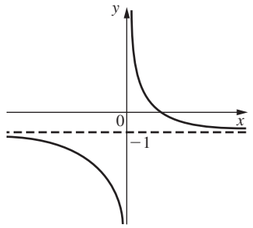

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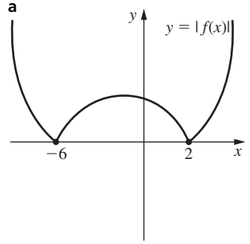

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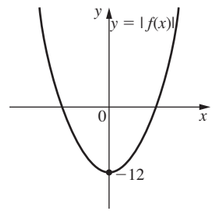
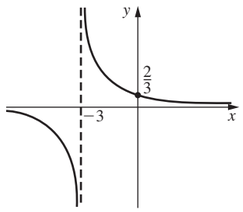


8 $x = -8, x = -1$ **9** $\frac{4}{5} < x < 2$

10



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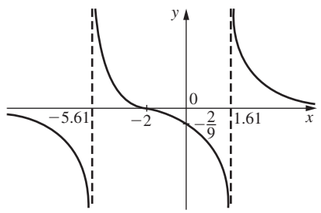

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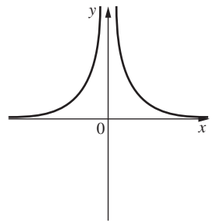

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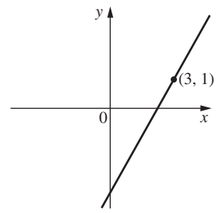

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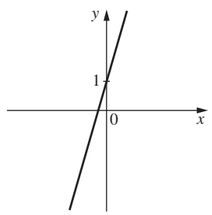

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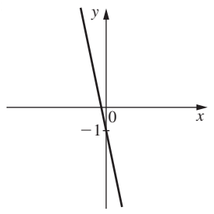

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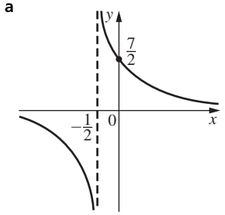

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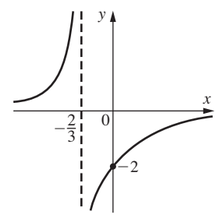

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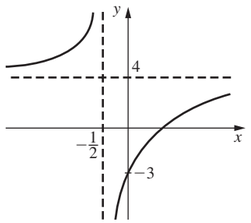
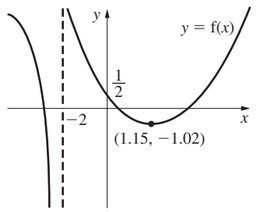
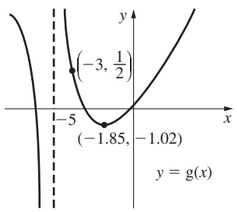
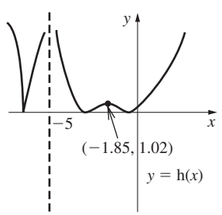


15 $x = \frac{19}{15}$ **16** $x > 0$

17







18 a $0 < y < 2$ **b** $f^{-1}(x) = \frac{-2x-1}{x-2}$ **19** $-3 \le x \le \frac{1}{3}$ **20** $f^{-1}(x) = \sqrt{\frac{-x-1}{x-1}}$

21 a $-\frac{1}{4} \le x \le \frac{1}{4}$ **b** $0 \le y < \infty$ **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** $Q(x) = \frac{x^2}{2} - \frac{x}{4} - \frac{27}{8}, R = \frac{99}{8}$ **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** $x = 3, x = 5$ **9 a** $k = 83$ **b** $x = \frac{1}{2}, x = 7$

10 a $1 \le x \le 7$ **b** $2 \le x \le 5$ **c** $0 \le x \le 1$ **d** $3 \le x \le 7$ **e** $\frac{1}{2} \le x \le \frac{10}{3}$ **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** $x < -0.303$ and $1 < x < 3.30$ **b** $-3.42 < a < 1.27$

15 a $-0.961 < x < 1.63$ and $x < 3.83$ **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** $x = 6.59, x = 2.38, x = -1.97$

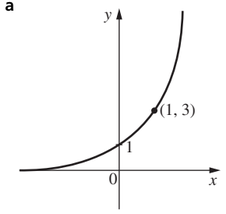
13 $\frac{x^2}{2} - \frac{11x}{4} + \frac{35}{8} - \frac{67}{8(2x-1)}$ **14** $x^2 - 5 + \frac{3x}{x^2+1}$ **15** $a = -\frac{4}{5}, b = -\frac{6}{5}$ **16** $a = -6$ **17** $a = 4$ **18** $k = 6$

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** $6m^{-\frac{1}{3}}$ **f** $12x^5 + 15x$ **g** $2x + 1$ **h** $x + 2 + x^{-1}$

4 a



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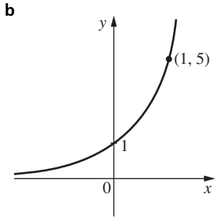

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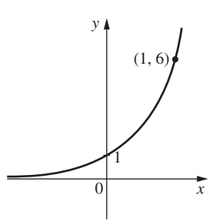

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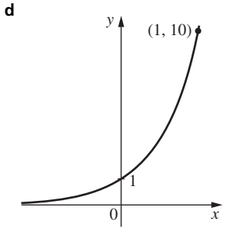

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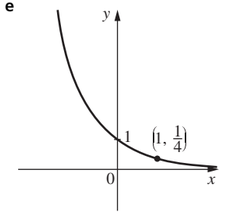

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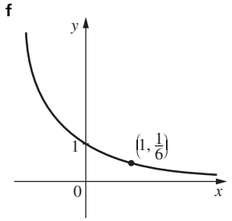

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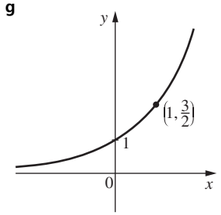

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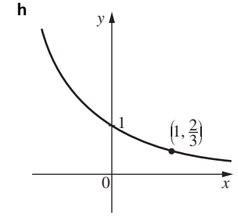
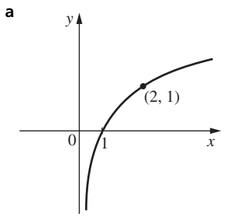


Chapter 5 Exercise 2

1 a



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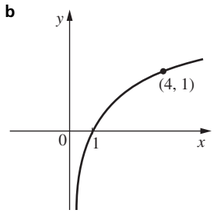

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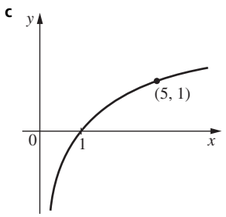

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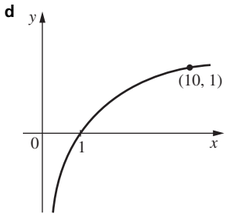

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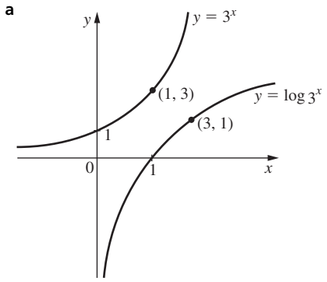

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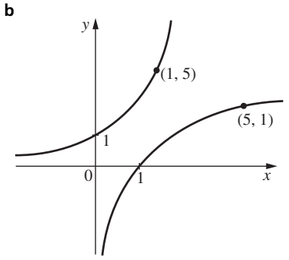


3 a 2 **b** 2 **c** 2 **d** 3 **e** 3 **f** 5

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

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** $x = 15$ **e** $x = \frac{26}{3}$ **f** $x = 10$ **12** $S_1 = 400$

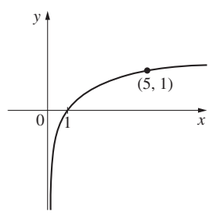
Chapter 5 Exercise 4

1 a 3 **b** 0.903 **c** 1.41 **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** 2.24 **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



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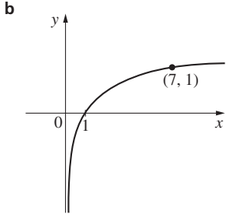

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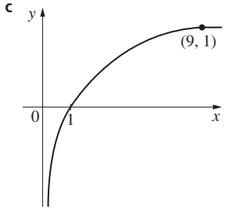


5 a $x = 0, x = 1024$ **b** $x = 8$

5 c $x = 117649$

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

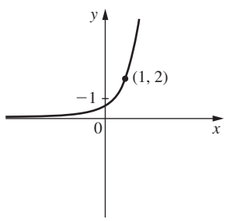
8 a 2100g **b** 1650g **c** 57.8 years **9 a** 20100 km **b** 22.7 years **10 a** 220 **b** 57 **c** 2027

11 a $k = 0.0133$ **b** 67.2 hours **c** 9.6 hours longer **12 a** $k = 0.0114$ **b** 60.8 years **13** $\frac{\ln 12}{\ln 5}$ **14** $\frac{\ln 2}{\ln 6}$ **15** $\frac{\ln\frac{2}{5}}{\ln 80}$ **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



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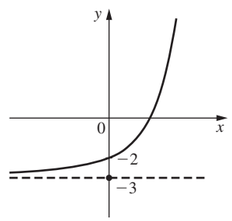

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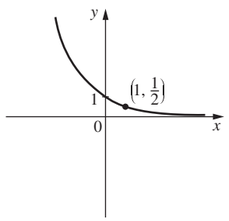

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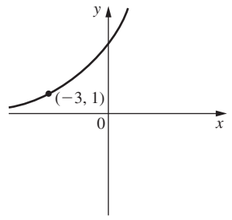

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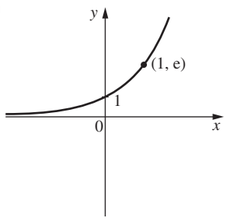

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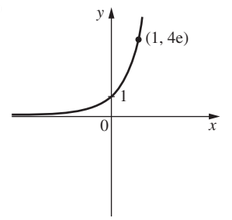

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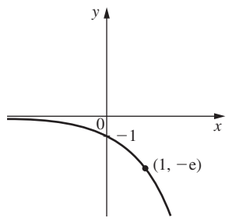

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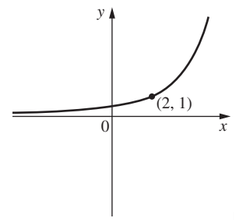
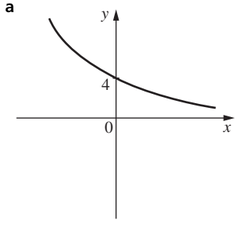


3 a



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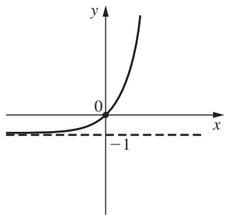

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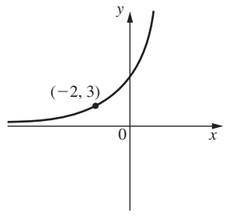

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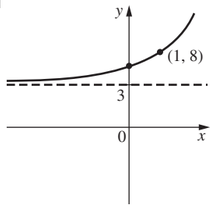

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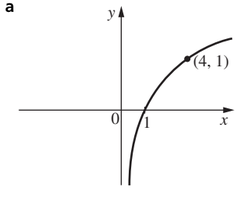

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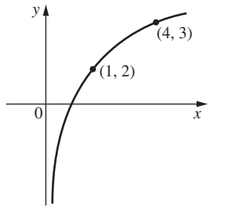

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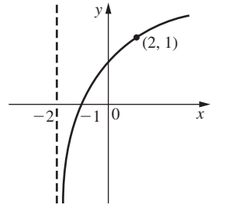

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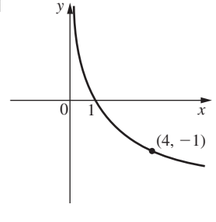

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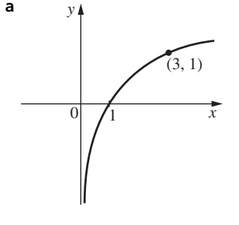

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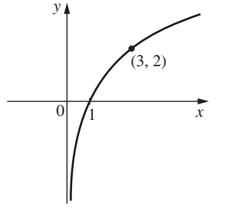

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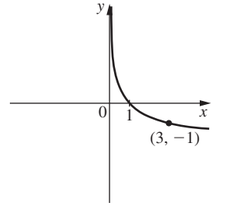

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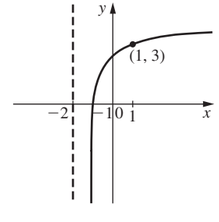
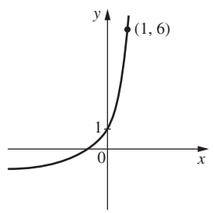


6 $k = 5$ **7** $k = 2, p = 3$ **8** $a = 3$ **9** $a = 4, p = 3$ **10** $p = 3, a = 6$

Chapter 5 Review Exercise

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

2 a



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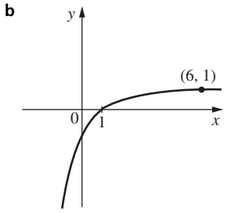


3 a 5 **b** 3 **c** $\frac{1}{3}$ **d** -2 **4 a** $\log_a 48$ **b** $\log_p 2$ **c** $\log_a 25a$

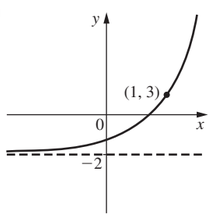
5 a $\log_3 8x$ **b** 1 **6 a** $x = 9$ **b** $x = 81$ **c** $x = 3$ **d** $\frac{11}{8}$

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

11 a



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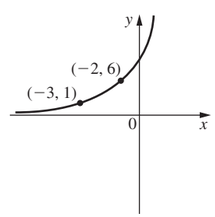

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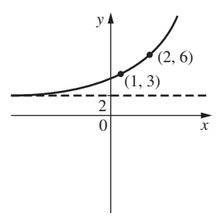

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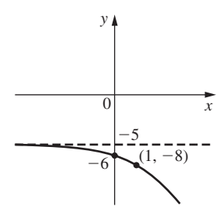
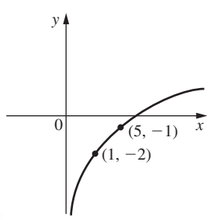
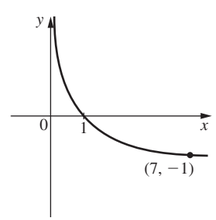


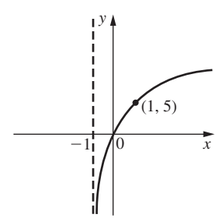
12 a



b



c



13 $k = 7$ **14** $p = 3, q = 5$ **15 a** $k = 0.0633$ **b** Yes as it will be ok for 8.07 hours **16** $x = \pm 6$ **17** $\frac{\ln 9}{\ln 8}$ **18** $-1 + \log_5 3$

19 $x = 4, y = 4$ **20** $x = 1, y = 0$ **21** $x = \frac{15}{7}, y = \frac{10}{7}$ **22 a** $x < -\frac{2}{3}, x > \frac{3}{2}, x \in \mathbb{R}$ **b** $y \geq 0, y \in \mathbb{R}$ **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** 4, 10, 16 **13** $n = 16$ **14** $n = 6$ **15** 1344 **16 a** $d = 2$ **b** 308

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** 20 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** 19068840 **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** 58 **b** −1392 **c** −243 **d** 5

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** 7688 **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 1,9 **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** $u_n = 15(4)^{n-1}$

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** $k = \frac{36}{p^3}$ **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 $\sin\theta$ **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** $-\frac{15}{65}$ **11** 0.951 **12** $-\frac{7}{2}$ **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** $3\cos^5\theta + 4\cos^4\theta - 4\cos^3\theta - 3\cos^2\theta$

6 $2\cos\theta[16\sin^5\theta - 16\sin^3\theta + 3\sin\theta]$ **7** $-\frac{119}{169}$

Chapter 7 Exercise 4

3 $\frac{\sqrt{3}+1}{2\sqrt{2}}$ **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** 120°, 240° **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, 1.82, 4.46

Chapter 7 Exercise 5

1 a $10\cos(x - 53.1)°$ **b** $13\cos(x - 67.4)°$ **c** $\sqrt{10}\cos(x - 288.4)°$ **d** $\sqrt{5}\cos(x - 153.4)°$ **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** $17\cos(x + 28.1)°$ **b** $\frac{5}{2}\cos(x + 36.9)°$ **4 a** $2\sin\left(\theta + \frac{2\pi}{3}\right)$ **b** $\sqrt{2}\sin\left(\theta + \frac{3\pi}{4}\right)$

5 a $\sqrt{10}\sin(x - 108.4)°$ **b** $2\sin(x - 240)°$ **6 a** $\sqrt{2}\cos(2x - 45)°$ **b** $2\cos(3x - 300)°$ **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 $(135°, -5\sqrt{2})$ Maximum $(315°, 5\sqrt{2})$ **b** Minimum (150°, 3) Maximum (330°, 7)

7 c Minimum (157.5°, −8.90), (337.5°, −8.90) Maximum (67.5°, 10.9), (247.5°, 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** $\frac{\pi}{3}, \frac{\pi}{2}, \frac{5\pi}{6}, \pi, \frac{4\pi}{3}, \frac{3\pi}{2}, \frac{11\pi}{6}$ **10 a** 102.4°, 195.7° **b** 7.3°, 34.0°, 127.3°, 154.0°, 247.3°, 274.0°

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°, 22.5°, 56.25°, 67.5° **17 b** $\alpha = 0.464$, $k = -0.559$, $p = 0.5$ **c** $A = 1.059$, $\theta = 1.80$

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** $\frac{120}{7}$

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** $\left(\frac{4}{3}, \frac{256}{27}\right)$ 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 $\left(1, -\frac{8}{3}\right)$ Maximum Turning Point and $(3, -4)$ Minimum Turning Point **b** $\left(\frac{5}{2}, 0\right)$ Minimum Turning Point **c** $\left(-\frac{1}{2}, -12\right)$ 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 $\left(-2, \frac{224}{3}\right)$ Non-Stationary, (0,0) Stationary, $\left(2, -\frac{224}{3}\right)$ Non-Stationary **2** $(-1, 15)$ Non-Stationary **3 a** None **b** None

3 c None Quadratic functions have no points of inflexion **4 a** (0,0) Stationary **b** $(1, -3)$ Non-Stationary **c** $(-2, -35)$ Non-Stationary

4 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

5 $(-1, 3)$ Non-Stationary and (1, 3) Non-Stationary **6** $\left(\frac{1}{6}, 4.11\right)$ Non-Stationary and $(-1, -9)$ Non-Stationary

7 (0,0) Stationary **8** No points of inflexion, $(0, -3)$ is a minimum turning point. **9** $y = -21x + 36$ **10** $\sqrt{1312} \simeq 36.2$

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 $y = 2x + 9$

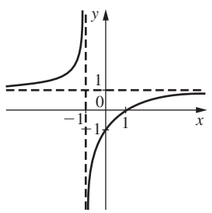
7 Vertical: None, Oblique $y = x - 2$ **8** Vertical: None, Oblique $y = x$ **9** Vertical: $x = -1$ and $x = 4$, Horizontal $y = 0$

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 $y = 4x + 4$

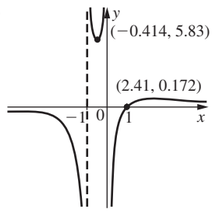
Graphs of the following functions, including asymptotes, stationary points and intercepts:

13



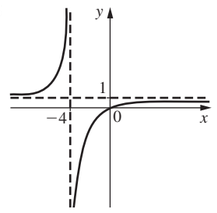
$y = \frac{x - 1}{x + 1}$

14



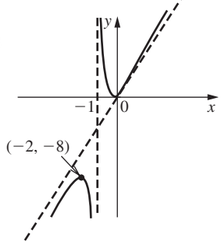
$y = \frac{x - 1}{x(x + 1)}$

15



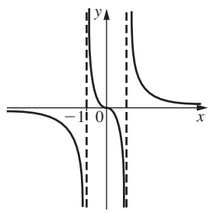
$y = \frac{x}{x + 4}$

16



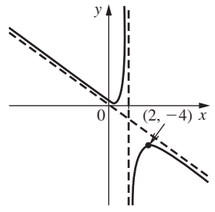
$y = \frac{2x^2}{x + 1}$

17



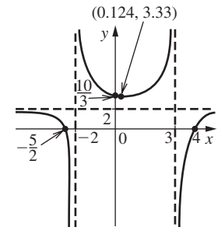
$y = \frac{x}{x^2 - 1}$

18



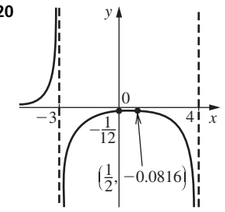
$y = \frac{x^2}{1 - x}$

19



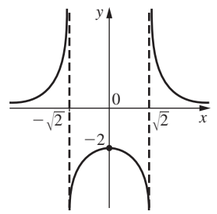
$y = \frac{(2x + 5)(x - 4)}{(x + 2)(x - 3)}$

20



$y = \frac{1}{x^2 - x - 12}$

21



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

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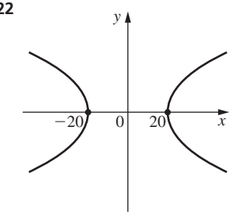
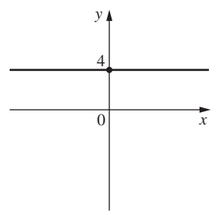


$\frac{x^2}{16} - \frac{y^2}{9} = 25$

Chapter 8 Exercise 7

1 a



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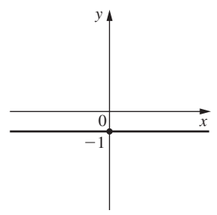

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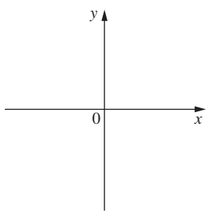

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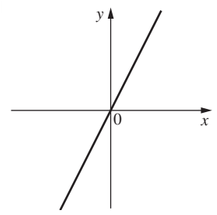

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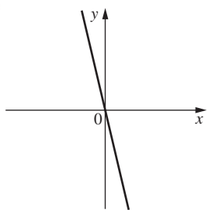

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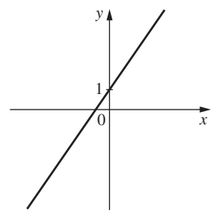

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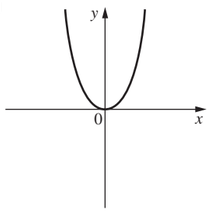

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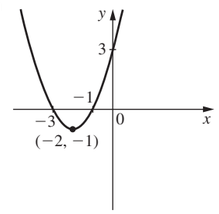

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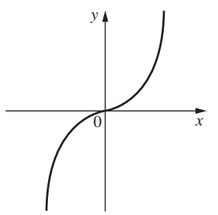

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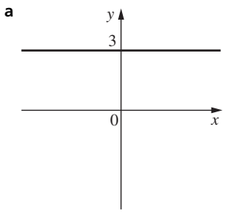

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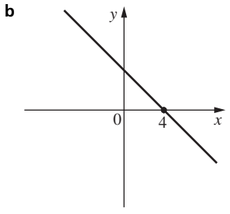

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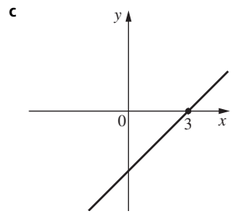

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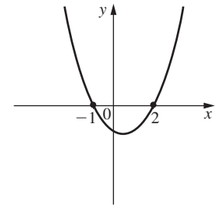

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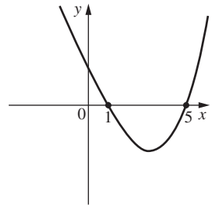

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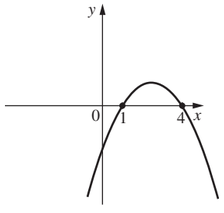

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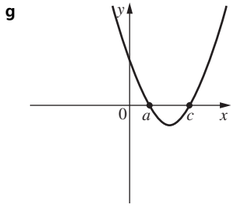

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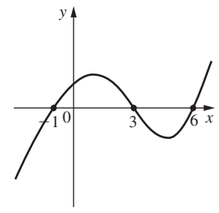

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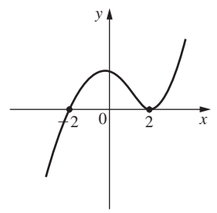

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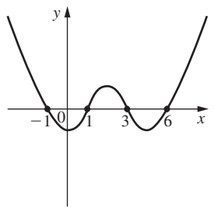

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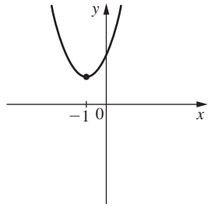

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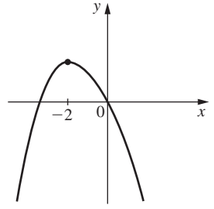

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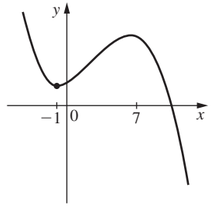

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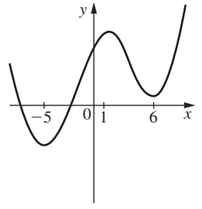

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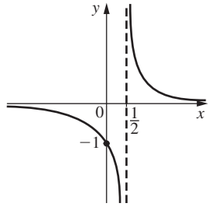

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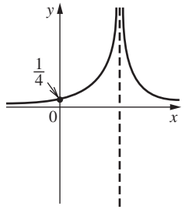

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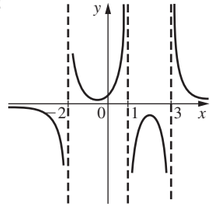

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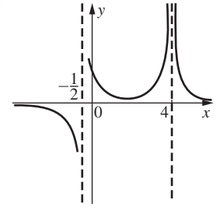

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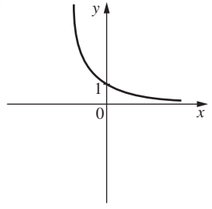

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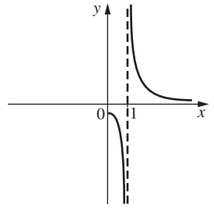

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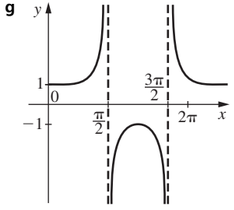

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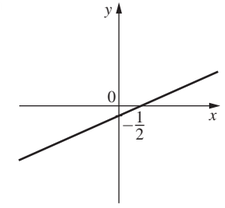

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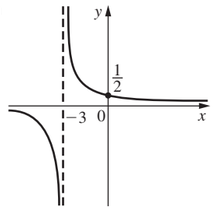

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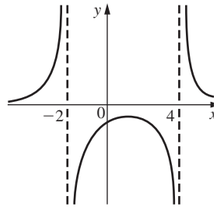

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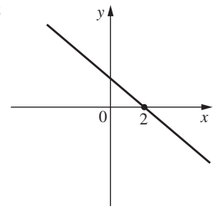

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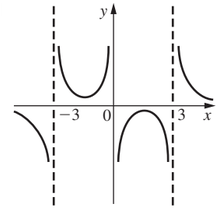

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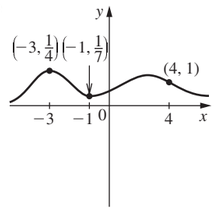

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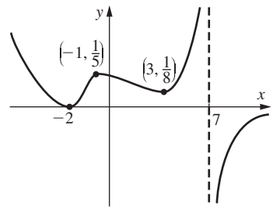
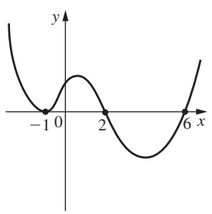


Chapter 8 Review Exercise

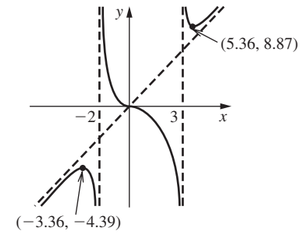
1 $f'(x) = 3x^2 - 4$ **2** $\frac{1}{16}$ **3** $\frac{dy}{dx} = \frac{3}{4}x^{-\frac{1}{2}} - \frac{17}{4}x^{\frac{15}{2}}$ **4** $x > 4$ **5** $h(x) = 45x^2 + 60x + 19$, $h'(x) = 90x + 60$ **6** $y = -6x + 16$

7



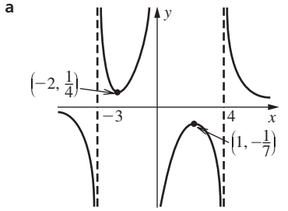
8 $\left(-\frac{1}{2}, \frac{9}{2}\right)$ max TP, $\left(\frac{2}{3}, -\frac{50}{27}\right)$ min TP **9** $y = 5x + 1$, $y = \frac{1}{2}x + \frac{17}{2}, \left(\frac{5}{3}, \frac{28}{3}\right)$

10



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

13 a



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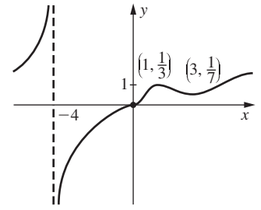


Chapter 9 Exercise 1

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** $\frac{dy}{dx} = \frac{10}{3}(2x - 9)^{\frac{3}{2}}$ **11** $\frac{dy}{dx} = 2(6x - 5)^{-\frac{3}{2}}$

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** $\frac{dN}{dp} = \frac{75}{2}(8 - 5p)^{-\frac{5}{2}}$

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** $\frac{dy}{dx} = 5 \cos 5x + 30(3x + 4)^{-\frac{7}{2}}$ **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** $\frac{dy}{dx} = (x + 1)^{-\frac{1}{2}} \sec^2(\sqrt{x + 1})$

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** $\frac{dy}{dx} = x^2(x - 2)^3(3 + 4x)$

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

1 $f'(x) = \dfrac{e^x(\cos x + \sin x)}{\cos^2 x}$ **2** $f'(x) = \dfrac{6x(x+6)}{(x+3)^2}$ **3** $f'(x) = \dfrac{7\tan x - 7x\sec^2 x}{\tan^2 x}$ **4** $f'(x) = \dfrac{1 - \ln x}{4x^2}$ **5** $f'(x) = \dfrac{e^x(x-5)}{(x-4)^2}$

6 $f'(x) = \dfrac{-6}{(x-3)^2}$ **7** $f'(x) = \dfrac{-3(x+12)}{2x^3\sqrt{x+9}}$ **8** $f'(x) = \dfrac{4^x(2x\ln 4 - 1)}{2x^{\frac{3}{2}}}$ **9** $f'(x) = \dfrac{x-2}{(x-1)^{\frac{3}{2}}}$ **10** $\dfrac{dy}{dx} = \dfrac{e^{3x}(3x-2)}{9x^3}$

11 $\dfrac{dy}{dx} = \dfrac{\frac{1}{x\ln 6}(x+6) - \log_6 x}{(x+6)^2}$ **12** $\dfrac{dy}{dx} = \dfrac{\frac{1}{x}\ln(x-4) - \frac{1}{x-4}\ln x}{(\ln(x-4))^2}$ **13** $\dfrac{dy}{dx} = \dfrac{-2}{(e^x - e^{-x})^2}$ **14** $\dfrac{dy}{dx} = \dfrac{2(\cos 2x - 3\sin 2x)}{e^{6x}}$

15 $\dfrac{dy}{dx} = \dfrac{12(3x-2)^4(4x+19)}{(2x+3)^4}$ **16** $\dfrac{dy}{dx} = \dfrac{(x+1)\sin x + x\cos x}{e^x}$ **17** $\dfrac{dy}{dx} = \dfrac{xe^{3x}(3x^2+15x+10)}{(x+5)^2}$ **18** $\dfrac{dy}{dx} = \dfrac{\tan\left(x+\frac{\pi}{4}\right) - 2}{e^{2x}\cos\left(x+\frac{\pi}{4}\right)}$

19 $\dfrac{dy}{dx} = \dfrac{-2\operatorname{cosec}^2 x\left(2x - \frac{\pi}{3}\right)\ln(3x-1) - \frac{3}{3x+1}\cot\left(2x-\frac{\pi}{3}\right)}{(\ln(3x+1))^2}$

Chapter 9 Exercise 6

1 $\dfrac{dy}{dx} = \dfrac{-3x^2 - y}{x}$ **2** $\dfrac{dy}{dx} = \dfrac{-4x}{y}$ **3** $\dfrac{dy}{dx} = \dfrac{1}{6\sqrt{xy^2}}$ **4** $\dfrac{dy}{dx} = \dfrac{1 - xy - 2x}{x(x+3)}$ **5** $\dfrac{dy}{dx} = \dfrac{y}{2y - x}$ **6** $\dfrac{dy}{dx} = \dfrac{2(x-y)}{e^y + 2x - 2y}$

7 $\dfrac{dy}{dx} = \dfrac{-(3\cos 3x + 2e^{2x}y^3)}{3e^{2x}y^2}$ **8** $\dfrac{dy}{dx} = \dfrac{-\sin(x+y)}{1 + \sin(x+y)}$ **9** $\dfrac{dy}{dx} = \dfrac{4x^3}{1 + \ln y}$ **10** $\dfrac{dy}{dx} = \dfrac{-3(x+y)^2}{3(x+y)^2 - e^y}$ **11** $\dfrac{dy}{dx} = \dfrac{y^2(8 - e^x) - 4y(x+y)^3}{(x+y)^3(3y - x)}$

12 $\dfrac{dy}{dx} = \dfrac{x}{2+3y}$ $\dfrac{d^2y}{dx^2} = \dfrac{(2+3y)^2 - 3x(2+3y) - x^2}{(2+3y)^3}$ **13** $\dfrac{dy}{dx} = \dfrac{\cos x - 4y}{4x+1}$ $\dfrac{d^2y}{dx^2} = \dfrac{(4x+1)\left(-\sin x - 4\frac{dy}{dx}\right) - 4(\cos x - 4y)}{(4x+1)^2}$

14 $\dfrac{dy}{dx} = -\dfrac{1}{x}$ $\dfrac{d^2y}{dx^2} = \dfrac{1}{x^2}$ **15** $y = \dfrac{3}{2}x - \dfrac{5}{2}, y = \dfrac{1}{2}x + \dfrac{5}{2}$ **16** -19. Answers given

Chapter 9 Exercise 7

1 $\dfrac{dy}{dx} = \dfrac{1}{\sqrt{25 - x^2}}$ **2** $\dfrac{dy}{dx} = \dfrac{-1}{\sqrt{64 - x^2}}$ **3** $\dfrac{dy}{dx} = \dfrac{10}{100 + x^2}$ **4** $\dfrac{dy}{dx} = \dfrac{2}{\sqrt{9 - 4x^2}}$ **5** $\dfrac{dy}{dx} = \dfrac{-3}{\sqrt{1 - 9x^2}}$ **6** $\dfrac{dy}{dx} = \dfrac{2e^x}{4 + e^{2x}}$

7 $\dfrac{dy}{dx} = \dfrac{-1}{2\sqrt{-(x+4)(x+3)}}$ **8** $\dfrac{dy}{dx} = \dfrac{1}{2x^2 - 2x + 1}$ **9** $\dfrac{dy}{dx} = \dfrac{1}{x\sqrt{1 - (\ln 5x)^2}}$

Chapter 9 Exercise 8

1 $f'(x) = 2x - 5$ **2** $\dfrac{dy}{dx} = 6(2x-7)^2$ **3** $f'(x) = -8\sin 8x - \dfrac{3}{2}x^{-\frac{1}{2}}$ **4** $\dfrac{dy}{dx} = \sec x\tan x - 5e^{5x}$ **5** $f'(x) = x^2e^{-4x}(3 - 4x)$

6 $\dfrac{dy}{dx} = x(2\ln x + 1)$ **7** $f'(x) = \dfrac{3\cos 3x - \sin 3x}{e^x}$ **8** $\dfrac{dy}{dx} = \dfrac{\sin x - 4x\sin x + x\cos x}{e^{4x}}$ **9** $f'(x) = 3^x(\ln 3 \cdot \sin x + \cos x)$

10 $\dfrac{dy}{dx} = \dfrac{\frac{x-4}{x\ln 2} - 3\log_2 x}{(x-4)^4}$ **11** $\dfrac{dy}{dx} = \dfrac{x\ln x(x+18) + x(x+9)}{(x+9)^2}$ **12** $\dfrac{dy}{dx} = -6(\sin 2x\sin 4x + 2\cos 2x\cos 4x)$ **13** $\dfrac{dy}{dx} = \dfrac{12}{\sqrt{1 - 4x^2}}$

14 $f'(x) = \dfrac{-\left(\frac{x}{\sqrt{1-x^2}} + 2\cos^{-1}x\right)}{3x^3}$ **15** $\dfrac{dy}{dx} = \sin x(\ln x + 1) + x\ln x\cos x$ **16** $\dfrac{dy}{dx} = \dfrac{-(\sec x\operatorname{cosec} x + \ln(\cot x))}{e^x}$ **17** $f'(2) = -\dfrac{20}{3}$

18 $f'(4) = \dfrac{-\pi + 2}{64}$ **19** $\dfrac{dy}{dx} = \dfrac{-y(2x + e^xy)}{x^2 + 2e^xy}$ **20** $\dfrac{dy}{dx} = \dfrac{y(4x^3y^2 - \cos x)}{(\sin x - 3x^4y^2)}$

Chapter 9 Exercise 9

1 $\dfrac{3}{4}$ **2** 0 **3** $\dfrac{4\ln 4 - 3}{e^2}$ **4** $y = -\dfrac{7}{5}x + \dfrac{17}{5}, y = -\dfrac{3}{5}x + \dfrac{13}{5}$ **6** $\dfrac{2 - 2\pi}{e^\pi}$ **7** (0,0) and $\left(2, \dfrac{4}{e^2}\right)$ **8** (0, 0) and $\left(e^{-\frac{1}{2}}, \dfrac{-2}{e}\right)$

9 (0, 0) rising point of inflexion and $\left(3, \dfrac{27}{e^3}\right)$ max TP

Chapter 9 Review Exercise

1 a $60(3x-2)^3$ **b** $14x(3 - 2x^2)^{-\frac{3}{2}}$ **c** $6 - 3\tan 3t\sec 3t$ **d** $48e^{8x}$ **e** $\dfrac{1}{x} - 3^x\ln 3$ **2 a** $4e^{4x}\sin 3x + 3e^{4x}\cos 3x$ **b** $\dfrac{1}{x} + \cot x$

2 c $\dfrac{e^{5x}}{\sqrt{x+4}}\left(5 - \dfrac{1}{2(x+4)}\right)$ **d** $\dfrac{3}{3x+4} - \dfrac{2}{2x-1}$ **e** $\dfrac{1}{\ln 10}\left(2 - 3\tan 3x - \dfrac{2}{x+4}\right)$ **3 a** $\dfrac{6xy}{8y - 3x^2}$ **b** $\dfrac{3x^2}{\ln x} - \dfrac{y}{x\ln x}$

4 $\dfrac{2\sin x + 4x\cos x - 2x\sin x - x^2(\cos x + \sin x)}{e^x} - \dfrac{2x\sin x - x^2\cos x}{e^{2x}} + y$ **5** $\dfrac{-2(1 + \csc x\cot x + \cot^2 x)}{1 + \left(\frac{1+\cos x}{\sin x}\right)^2}$ **6** $-\dfrac{16\sqrt{x} - 4\pi\sqrt{x}}{\pi^2}$ **7** $-\dfrac{3}{4}$

8 $-\dfrac{1}{3}$ **9** $\dfrac{4}{3}$ **10** $x = 0$ **11** 2.533 **12** $y = \dfrac{x}{4} - \dfrac{5}{2}$ **13** . $-2(2x-1)^{-2}$ **14 a** $6\sec 2t\tan 2t + 5$ **b i** $3 + 5\pi$ **ii** 5 **15 a** -1 **b** $\dfrac{4}{5}$

Chapter 10 Exercise 1

1 $v = \sqrt{500}ms^{-1}$ **2** All three sides are $\sqrt{50}cm$ **3** $6.83cm$ **4** $5.62cm$, $4.22cm$, $16.9cm$ **5** $4.16cm$, $6.56cm$ **6** $3.66cm^2$ **7** 78.5 **8** b $\dfrac{4r}{3}$

9 $x = y = 75cm$. It is a maximum value. **10 b** $V = 60\left(\dfrac{450x - 60x^3}{13}\right)$ **10 c** $x = 1.58cm$. It is a maximum value.

11 $t = 6.29$ seconds, $t = 12.6$ seconds **12** 11100 **13** 12.5 Yen, $24.1Kmh^{-1}$ **14** 20 **15 a** $\dfrac{7-x}{7} = \dfrac{y}{24}$ **b** $A = \dfrac{168x - 24x^2}{7}$ **c** $42cm^2$

Chapter 10 Exercise 2

1 $128\pi cm^2s^{-1}$ **2** $\dfrac{15}{32\pi}$ **3** $\dfrac{2}{h}$ **4** $1640N_0$ **5** $216cm^3s^{-1}$ **6** $0.954ms^{-1}$ **7** $1.49cm^2s^{-1}$ **8** $0.283cms^{-1}$ **9** $-\dfrac{5}{3}$

10 a $(a\theta - a\sin\theta, a - a\cos\theta)$ **11** $100cm^3s^{-1}$ **13 a** $\dfrac{2}{9}cms^{-1}$ **b** $\dfrac{4\pi}{3}cm^2s^{-1}$

Chapter 10 Exercise 3

1 $v = 3\dfrac{1}{4}ms^{-1}$ $a = -3ms^{-2}$ $t = \dfrac{2\sqrt{3}}{3}$seconds **2 a** $8ms^{-1}$ **b** $16 - 12t$ **c** $-20ms^{-2}$ **3 a** $-4(1-2t)$ **b** $t = \dfrac{1}{2}$second **c** $0ms^{-2}$

4 a $v = \dfrac{t^2\cos t - t\cos t - \sin t}{(t-1)^2}$ **b** $-1.74ms^{-1}$ **c** $a = \dfrac{t^3\sin t + 2t^2\sin t - 2t\cos t + 2\cos t - t\sin t + 2\sin t}{(t-1)^3}$ **7** Period $= \pi$

8 a $s = \dfrac{e^{2t}(t^2 - 2t - 1)}{(t^2-1)^2}$ **b** $v = \dfrac{-e^4}{9}$ **c** $a = \dfrac{2e^{2t}(t^4 - 6t^3 + 4t^2 + 6t - 1)}{(t^2-1)^3}$ **d** $a = \dfrac{-10e^4}{9}$ **10 a** $v = 3k\cos(kt + c)$

10 b $t = \dfrac{\pi - 2c}{2k}$ **c** $a = 0.0213ms^{-2}$ **11 a** $k = \dfrac{1}{100}\ln 300$ **b**. $v = e^{\frac{\ln 300}{100}t^2}\left(1 + \dfrac{\ln 300}{50}t^2\right)$ **c** $a = \dfrac{\ln 300}{50}e^{\frac{\ln 300}{100}t^2}\left(3t + \dfrac{\ln 300}{50}t^2\right)$ **d** 0.629

12 a Min is (2,1.39) **b** $v = \dfrac{2}{t} - \dfrac{1}{t-1}$ $t \geq 2$ **c** $a = -\dfrac{2}{t^2} - \dfrac{1}{(t-1)^2}$ $t \geq 2$ **d** $v = \dfrac{4}{45}ms^{-1}$ $a = -\dfrac{31}{4050}ms^{-2}$

13 a $v = \dfrac{2t - s}{t + s}$ **b** $a = \dfrac{3(s^2 + 2st - 2t^2)}{(t+s)^3}$ **c** $s = t(-1 \mp \sqrt{3})$

Chapter 10 Review Exercise

1 240 kmh^{-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** $\dfrac{1}{2\pi}cms^{-1}$ **4** $a = 26.2$ cm $b = 22.7$ cm **5** -1.6

6 a $A = 2\pi rh + \pi r^2$ **b** 4.30 cm **c** 1120 cm^2 **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 $units^2$ **9** $\dfrac{\pi}{3}cm^2\ s^{-1}$ **10** $-\dfrac{56}{27}ms^{-2}$ **11 a** 6.28 hours. **b** 6.28 hours. **12** $\dfrac{704}{3}cm^3\ s^{-1}$ **13 a** $BC = 2(x - h\csc\theta)$

13 b $2xh + h^2(\cot\theta - 2\csc\theta)$ **c** $h(2x - h\sqrt{3})$ **14 a** $t = 2$ minutes **b** $\dfrac{112t^3}{(8+t^4)^2}cm\ min^{-1}$ **c** 27.7 $cm^2\ min^{-1}$ **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** $AB = \begin{pmatrix} 12700 \\ 20800 \end{pmatrix}$

Total number of calories consumed on day 1 and day 2. **d i** (33500). 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 women 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** $X = \begin{pmatrix} 1 & -\frac{3}{14} \\ -1 & \frac{5}{14} \end{pmatrix}$ $Y = \begin{pmatrix} \frac{5}{2} & \frac{1}{2} \\ 7 & 5 \end{pmatrix}$ $Z = \begin{pmatrix} \frac{43}{18} & \frac{31}{18} \\ \frac{19}{18} & -\frac{11}{18} \end{pmatrix}$ **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 units^2 **5 b** 4 units^2 **c** 20 units^2 **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** $x = y = 1$ **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** $a = \frac{19}{11}$, 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** $x = \frac{31-33k}{3k^2+2k-5}, y = \frac{5k-6}{3k^2+2k-5}, k \neq -\frac{5}{3}, 1$ **4 a** Unique solution **b** Unique solution

4 c No unique solution **d** No unique solution **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** $x = \frac{5-24\lambda}{2}, y = \lambda, z = \frac{2\lambda-3}{4}$ **b** $x = -\frac{2}{15}, y = \frac{4}{15}, z = \frac{4}{3}$

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 $a = \frac{2-4b}{b+20}$ **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 R 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** $a = 4, b = -1$ $y_1 = 16z_1 + 36z_2 - 58z_3$

17 $y_2 = -18z_1 + 11z_2 - 3z_3$ $y_3 = 13z_1 + 12z_2 - 17z_3$

Chapter 12 Exercise 1

1 a $a = 1$ $b = \frac{1}{2}$ $c = 6$ **b** $a = \frac{1}{3}$ $b = 0, \frac{1}{2}$ $c = -8$ **c** $a = \frac{4}{7}$ $b = -3$ **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** $\begin{pmatrix} \frac{-5}{\sqrt{62}} \\ \frac{-6}{\sqrt{62}} \\ \frac{1}{\sqrt{62}} \end{pmatrix}$ **10 a** Not parallel **b** Not parallel **c** Parallel

11 $PQ = \begin{pmatrix}2\\3\end{pmatrix}$ $QR = \begin{pmatrix}-4\\-6\end{pmatrix}$ $PR = \begin{pmatrix}-2\\-3\end{pmatrix}$ $|PQ| = \sqrt{13}$ $|QR| = \sqrt{21}$ $|QR| = \sqrt{52}$ $|PR| = \sqrt{13}$ **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 f $PQ = \begin{pmatrix}\frac{4}{\sqrt{21}}\\-\frac{2}{\sqrt{21}}\\\frac{-1}{\sqrt{21}}\end{pmatrix}$ $QR = \begin{pmatrix}\frac{-1}{\sqrt{21}}\\\frac{4}{\sqrt{21}}\\\frac{2}{\sqrt{2}}\end{pmatrix}$ $SR = \begin{pmatrix}\frac{4}{\sqrt{21}}\\-\frac{2}{\sqrt{21}}\\\frac{-1}{\sqrt{21}}\end{pmatrix}$ $RP = \begin{pmatrix}\frac{-3}{\sqrt{14}}\\\frac{-2}{\sqrt{14}}\\\frac{-1}{\sqrt{14}}\end{pmatrix}$

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** $17i - 21j - 16k$ **e** $-3i - 6j + 49k$ **f** $20i - 25j - 84k$

1 g $-5mi + 27mj + 17mk$ **2 a** $17i + 16j$ **b** $\sqrt{421}$ **c** 43.0° **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** $\begin{pmatrix}-\frac{5}{2}\\10\end{pmatrix}$ **d** $\begin{pmatrix}-2\\8\end{pmatrix}$ **6 a** $\begin{pmatrix}6\\10\end{pmatrix}$ **b** $\sqrt{136}$ **c** $\begin{pmatrix}3\\5\end{pmatrix}$ **d** $\begin{pmatrix}\frac{3}{4}\\\frac{5}{4}\end{pmatrix}$

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** $AC = \begin{pmatrix}6k\\4c\end{pmatrix}$ **c** $BX = \begin{pmatrix}-2k\\3c\end{pmatrix}$

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** $DG = d - a - b$

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** $\mathbf{p} \cdot \mathbf{q} = 14$, $\cos\theta = \sqrt{\frac{7}{19}}$ **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° **16** It is a rectangle since $A\hat{B}C$ 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** 24

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** $\sqrt{756}$ 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 ii $\sqrt{378}$ units² **iii** $-10.8i + 9.6j - 1.2k$ **iv** 29.6° **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** 0.702**10** $\alpha = \frac{\pi}{2} - 2\theta$ **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** $r = \begin{pmatrix}-3\\-2\\3\end{pmatrix} + \lambda\begin{pmatrix}4\\-7\\3\end{pmatrix}$ $x = 1 + 3\lambda, y = -2 + \lambda, z = -4 - 5\lambda$ $\frac{x - 1}{3} = y + 2 = \frac{z + 4}{-5}$

3 b $r = i - 2j - 4k + \lambda(3i + j - 5k)$ $x = -3 + 4\lambda, y = -2 - 7\lambda, z = 3 + 3\lambda$ $\frac{x + 3}{4} = \frac{y + 2}{-7} = \frac{z - 3}{3}$

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

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 $\begin{pmatrix}6\\\frac{5}{2}\\0\end{pmatrix}$

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

10 a $r = 2i - j + 5k + \lambda(3i - j + k)$ Crosses the xy plane at $(-13, 4, 0)$ Crosses the yz plane at $\left(0, -\frac{1}{3}, \frac{13}{3}\right)$ 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 $\left(-\frac{29}{15}, \frac{14}{5}, 0\right)$ Crosses the yz plane at $\left(0, \frac{17}{4}, -\frac{29}{12}\right)$ Crosses the xz plane at $\left(-\frac{17}{3}, 0, \frac{14}{3}\right)$

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 $\frac{\sqrt{26}}{2}$ **b** $\frac{\sqrt{393}}{3}$ **c** 1 **d** $\frac{\sqrt{154}}{2}$ **e** Lies on line. **f** $\frac{2\sqrt{35}}{7}$

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** $p = 34$

Chapter 13 Exercise 3

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

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

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

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

3 a $x-2y+7z=9$ **b** $4x-y=-6$ **c** $15x+13y-8z=-38$ **d** $-4x+3y+8z=21$ **4** $r.\begin{pmatrix}-1\\ -3\\ 7\end{pmatrix}=10$

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

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

9 b $r.(i+5j+k)=1$ **c** Distance of π_1 to origin is $\frac{8}{\sqrt{27}}$ units Distance of π_2 to origin is $\frac{1}{\sqrt{27}}$ units Distance between π_1 and π_2 is $\frac{7}{\sqrt{27}}$ units

10 Distance of P_1 to origin is $\frac{41}{\sqrt{65}}$ units Distance of P_2 to origin is $\frac{14}{\sqrt{65}}$ units Distance between P_1 and P_2 is $\frac{55}{\sqrt{65}}$ units

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

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

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

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

16 a The line and the plane intersect. **b** The line and the plane are parallel. **c** The line is contained in the plane. **d** The line and the plane intersect.

Chapter 13 Exercise 4

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

2 a 45.0° **b** 23.2° **c** 11.0° **d** 64.5° **e** 90° **f** 55.9° **3 a** 11.7° **b** 57.8° **c** 17.6° **d** 32.5° **e** 34.1° **f** 5.51°

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

4 e $r=(8i+14j)+\lambda(-37i+61j+10k)$ **f** $r=\left(\frac{56}{25}i+\frac{29}{25}j\right)+\lambda(36i-26j-25k)$ **6** 48.5° **7 a** $r=\begin{pmatrix}1\\ 2\\ -3\end{pmatrix}+\lambda\begin{pmatrix}3\\ 1\\ -3\end{pmatrix}$ **b** $(-2,1,0)$

8 a $a=-3$ **b** 74.2° **c** 13.9 units.

Chapter 13 Review Exercise

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

2 iv AD has equation $x-1=\frac{1-y}{3}=\frac{1-z}{4}$ BD has equation $2x-4=\frac{4+2y}{-9}=\frac{6+2z}{-7}$ **v** 16.4° **3 b** $3x-2y+z=5$

3 c $r=\begin{pmatrix}2\\ 1\\ 1\end{pmatrix}+\lambda\begin{pmatrix}-1\\ -2\\ -1\end{pmatrix}$ **4 ii** $\left(\frac{2}{21},\frac{-4}{21},\frac{-8}{21}\right)$ **iii** $r.\begin{pmatrix}4\\ -8\\ 5\end{pmatrix}=0$ **iv** $\left(-33,\frac{-51}{2},4\right)$ **5 i** $\left(1,-\frac{13}{5},\frac{12}{5}\right)$ **ii** $(6,-1,4)$ **iii** $r=\begin{pmatrix}6\\ -1\\ 4\end{pmatrix}+\lambda\begin{pmatrix}25\\ 8\\ 6\end{pmatrix}$

5 iv 116° **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** $r=\begin{pmatrix}-1\\ -3\\ 0\end{pmatrix}+\lambda\begin{pmatrix}-1\\ 1\\ 1\end{pmatrix}$ **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** $r.\begin{pmatrix}-1\\ 1\\ 2\end{pmatrix}=3$ **e** $x=2-\lambda$ $y=-1+\lambda$ $z=-6+2\lambda$ **f** $3\sqrt{6}$ **g** $\frac{-i}{\sqrt{6}}+\frac{j}{\sqrt{6}}+\frac{2k}{\sqrt{6}}$ **h** $(-4,5,6)$

9 i A lies in the plane. B does not lie in the plane **ii** $\frac{2-x}{2}=\frac{y+3}{4}=z-8$ **iii** 43.6° **iv** 3.16 units. **v** $r.(i+3j-10k)=-87$

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 i $r=(2i+j+4k)+\lambda(3i+j)$ **ii** $(-4,-1,4)$ **iii** 0.716 **iv** $(0,-13,18)$ **v** $\left(-\frac{13}{3},0,\frac{28}{3}\right)$ **vi** $r=\begin{pmatrix}0\\ -13\\ 18\end{pmatrix}+\lambda\begin{pmatrix}-\frac{13}{3}\\ 13\\ -\frac{26}{3}\end{pmatrix}$

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** $r.(i+4j+2k)=-9$ **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)

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 $\frac{2}{3}x^{\frac{3}{2}}+c$ **10** $3x^{\frac{1}{3}}+c$ **11** $7x+2x^{-2}+c$ **12** $2x^{\frac{1}{2}}+c$ **13** $\frac{2}{7}x^7-x^5+c$ **14** $2x^{\frac{5}{2}}+2x^{-2}+c$ **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** $y=\frac{2}{3}x^{\frac{3}{2}}-2x^{\frac{1}{2}}+c$ **20** $y=8x-\frac{9}{2}x^{\frac{1}{3}}+c$ **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** $y=\frac{14}{19}x^{\frac{19}{4}}-2x^{\frac{3}{2}}+c$

27 $y=-6p^{-2}+c$ **28** $y=\frac{32}{9}k^{\frac{9}{4}}+c$ **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** $Q=\frac{2}{21}p^{\frac{7}{2}}-\frac{8}{33}p^{\frac{3}{2}}+2$

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** $-\frac{1}{4}\cos p - 3p^2 + \frac{1}{4}$ **23** $2\ln|2k + 1|$

Chapter 14 Exercise 7

1 32 **2** $\frac{343}{6}$ **3** 50 **4** $\frac{85}{4}$ **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** $-\frac{1}{2}e^{-2p} + \frac{1}{3}p^3$ **23** $k = 4$ **24** $a = 1$

Chapter 14 Exercise 8

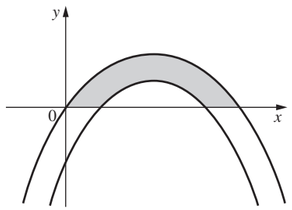
1 $\frac{64}{3}$ **2** 61 **3** 16 **4** $\frac{85}{4}$ **5** $\frac{253}{12}$ **6** $\frac{2401}{16}$ **7** $\frac{863}{6}$ **8** 22.1 **9** $\frac{71}{3}$ **10** 408 **11** $\frac{21}{4}$ **12** 2 **13** 6 **14** 15.3

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** 7.45 **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 $y = \frac{3}{8}t^2 - \frac{1}{2}t^{\frac{1}{2}} + c$ **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** $\frac{4x^{\frac{5}{2}}}{5} + \frac{3}{x} + c$

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** $\frac{1}{21}(1 - 3\cos 2x)^{\frac{7}{2}} + c$ **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 $\frac{2}{\sqrt{11}}\tan^{-1}\left(\frac{2x + 3}{\sqrt{7}}\right) + c$ **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** $\frac{1}{6}\tan^3 3x + \frac{1}{3}\ln|\cos 3x| + c$

10 $\frac{1}{64}(8x - \sin 4x) + c$ **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** $2e^{1-\cot\frac{x}{2}} + c$

23 $\frac{1}{12}(1 + x^3)^8 + c$ **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** $\frac{1}{32}(48x - 4\sin 4x + \sin 8x) + c$

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** $\frac{2(3x - 4)^{\frac{3}{2}}(9x + 38)}{13} + c$ **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** $\frac{3}{4}[\sin^{-1} x + 2x\sqrt{1 - x^2}] + c$ **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** $\frac{75}{32}\left[\tan^{-1}\frac{4}{25}\left(5\tan\frac{p}{2} + 3\right)\right] - \frac{75}{32}\tan^{-1}\frac{12}{25}$

22 $\frac{-16}{1 + \tan 2x} + c$ **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** $\frac{(p + 1)^{10}}{110}(p - 10) - \frac{1}{11}$

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** $x\sin^{-1}x + (1-x^2)^{\frac{1}{2}} + c$ **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 $\frac{1}{4(n+1)^2}[(2p+1)^{n+1}(2np-1) - 2n + 1]$

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** $2(-x^2-6x-4)^{\frac{1}{2}} + \sin^{-1}\left(\frac{x+3}{\sqrt{5}}\right) + c$ **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** $\frac{1}{(n+1)\cos^{-n-1}x} + c$ **9** $\tan^{-1}2(x+1) + c$ **10** $2\sin^{-1}\left(\frac{x+4}{5}\right) + c$ **11** $\frac{(1-x)^8}{36}(7-8x) + c$

12 $x + \frac{25}{x+5} - 10\ln|x+5| - \frac{25}{x+5} + c$ **13** $\frac{4(3x-4)^{\frac{3}{2}}}{135}(9x+8) + c$ **14** $\frac{-(5p+1)}{10(p-3)^5} + \frac{1}{80}$ **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** $\frac{3}{16}\left(2x + 4\sin\frac{x}{3} + \sin\frac{2x}{3}\right) + c$ **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** $\frac{x^3}{4} + \frac{x}{4} + \frac{13\ln|2x-1|}{8} + c$

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** $\frac{12x^{\frac{7}{2}}}{7} - \frac{192x^{\frac{23}{12}}}{23} + \frac{32x^{\frac{3}{2}}}{3} + c$ **5** $-\text{cosec}\,4x + c$ **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** 2.10 **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** $\frac{1}{4}(4-x^2)^{\frac{1}{2}}$ **7** $0.227a^2$ **10** $\frac{4-e^3}{2}$ **11** $\frac{(2a-1)^{\frac{3}{2}}(3a+1) - 4}{15}$ **12** 5.66 **13** 11.7 **14** 3.03

Chapter 15 Review Exercise

1 $e - e^k + 1$ **2** $\frac{4}{15}\left(\frac{x+2}{2}\right)^{\frac{3}{2}}\left(\frac{3x-4}{30}\right) + k$ **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** $y = \frac{3}{2k}e^{\frac{2kx}{3}}\left[1 - \frac{3}{2k}\right] + c$ **7** $y = -\frac{1}{3}(1-15x^2)^{\frac{1}{2}} + k$ **8** $y = \frac{1}{8}(4x - \sin 4x) + k$ **9** $y = \frac{4}{45}(3x+2)^{\frac{5}{2}} + kx + c$

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

15 $y = \frac{(2x-1)^6}{120} + 2x + \frac{239}{240}$ **16** $y = 2x\tan^{-1}x - \ln|1+x^2| + x + 5$

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** $e^{-y} = -\left(\frac{5}{6}\ln x - k\right)$ **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 $3y^3 = \frac{(3x-1)^{11}}{11} + \frac{(3x-1)^2}{2} + k$ **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** $\frac{3}{2}y^{\frac{2}{3}} = \frac{-e^{-2x}}{2} + \frac{3}{2} + \frac{1}{2e^2}$ **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** $\frac{1}{3}\sin^{-1}3s = \frac{t^2}{2} - \frac{1}{2}$

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 $\frac{dz}{dx} = 1 + \frac{dy}{dx}$ $\tan^{-1}z = x + k$ **6 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 $v = \frac{4t^3}{3} + t \quad s = \frac{t^4}{3} + \frac{t^2}{2}$ **2 a** $v = \frac{-3t^4}{2} + 10$ **2 b** $-6134\ \text{ms}^{-1}$ **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** $\frac{\pi}{3}$ssconds **5** $s = -\frac{t^2}{2} - t - 2\ln|\,l - 1\,| + 14$ **6** $v = \pm\sqrt{2 - 2\cos\left(s + \frac{\pi}{4}\right)}$

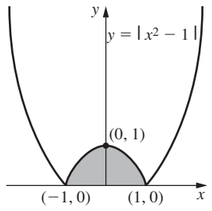
7 $v = \pm\sqrt{\frac{2se^{2s} - e^{2s} + 9}{2}}$ **8** $v = \pm\sqrt{\frac{(2s-1)^5 + 223}{5}}$ **9 a** $7\frac{3}{4}\text{ms}^{-1}$ **10 b** $\frac{e^8 - 137}{4}$ **11 a** 2.60 **11 b** $v = 220e^{-2.60t}$ **c** 108m

12 a $v = \frac{2}{\omega}$ **12 b** $\frac{2\pi}{\omega}$ **13** $v = \frac{g}{k} - \frac{g}{ke^{kt}}$, Yes $v \to \frac{g}{k}$

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** $\frac{2\pi a^5}{5}$ **4** 145 **5** 1940 **6** 84.2 **7** 5cm, 196 cm^2 **8**



9 $\frac{49\pi}{16}$ **10** $\pi^2 b^2$ **11** $-4n\cos(n+1)\pi$

12 a $\frac{1}{4}(2\sin^{-1}x + 2x\sqrt{1-x^2}) + k$ **b.** $\frac{\pi}{4}(\pi - 2\sin^{-1}a + 2a\sqrt{1-a^2})$

3.35 , $\frac{\pi}{2}$

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** $13+2i$ **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 $m(m^2-3n^2)+i(3m-n)$ **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** $\mathrm{Re}(z)=27, \mathrm{Im}(z)=-8$ **b** $\mathrm{Re}(z)=-\frac{53}{185}, \mathrm{Im}(z)=-\frac{89}{185}$ **c** $\mathrm{Re}(z)=\frac{117}{145}, \mathrm{Im}(z)=\frac{41}{145}$

7 d $\mathrm{Re}(z)=\frac{72}{65}, \mathrm{Im}(z)=-\frac{61}{65}$ **e** $\mathrm{Re}(z)=\frac{2a}{4+b^2}-\frac{12}{16+a^2}, \mathrm{Im}(z)=-\frac{ab}{4+b^2}-\frac{3a}{16+a^2}$ **f** $\mathrm{Re}(z)=0, \mathrm{Im}(z)=-\frac{2xy}{x^2+y^2}$

7 g $\mathrm{Re}(z)=-597, \mathrm{Im}(z)=122$ **h** $\mathrm{Re}(z)=\cos\frac{2\pi}{3}, \mathrm{Im}(z)=\sin\frac{2\pi}{3}$ **i** $\mathrm{Re}(z)=-128, \mathrm{Im}(z)=-128\sqrt{3}$

7 j $\mathrm{Re}(z)=\frac{x}{1+y^2}+\frac{12}{25}, \mathrm{Im}(z)=-\frac{xy}{1+y^2}+\frac{9x}{25}$ **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** $x^4-10x^3+20x^2+90x-261=0$

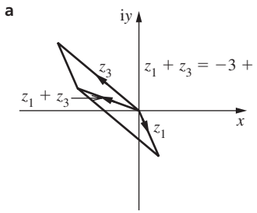
11 a $x^2-4x+53=0$ **b** $x^2-8x+25=0$ **c** $x^2-14x+85=0$ **d** $x^2-2ax+a^2+b^2=0$ **12** $x^4-10x^3+42x^2-82x+65=0$

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** $\frac{348-115i}{13}$

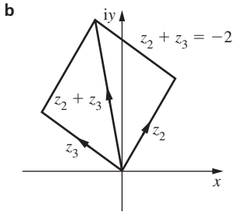
18 $z_1=\frac{26-2i}{17}, z_2=\frac{21+i}{17}$ **19** $\frac{3-i\sqrt{3}}{2}$ **20** $p=-\frac{3}{5}, q=\frac{9}{5}$ **21** $\frac{88-966i}{25}$

Chapter 17 Exercise 3

1 a



b



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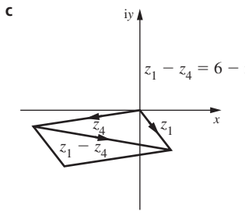

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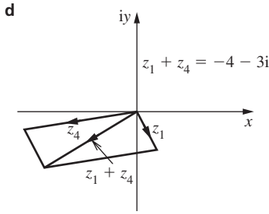

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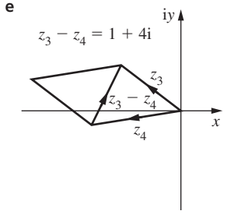


2 a $2\left(\cos\frac{\pi}{3}+i\sin\frac{\pi}{3}\right)$ **b** $\sqrt{8}\left[\cos\left(-\frac{3\pi}{4}\right)+i\sin\left(-\frac{3\pi}{4}\right)\right]$ **c** $\sqrt{26}[\cos(2.94)+i\sin(2.94)]$

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** $2e^{i\frac{\pi}{2}}$

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** $r=\sqrt{370}, \theta=0.487$ **d** $r=4\frac{\sqrt{370}}{5}, \theta=1.41$

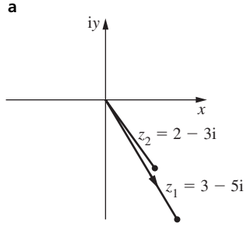
6 a Root 1 $r=2.65, \theta=2.17$ Root 2 $r=2.65, \theta=-2.17$ **b** Root 1 $r=\sqrt{5}, \theta=1.11$ Root 2 $r=\sqrt{5}, \theta=-1.11$

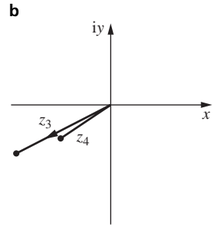
6 c Root 1 $r=\sqrt{7}, \theta=0.714$ Root 2 $r=\sqrt{7}, \theta=-0.714$ **7 a i** $z_1=13e^{-1.18i}$ **ii** $z_2=5e^{2.21i}$ **iii** $z_3=25e^{-0.284i}$ **iv** $z_4=2e^{i\frac{\pi}{3}}$

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** $r=7.5, \theta=-2.22$

7 vii $r=2.5, \theta=-1.33$ **viii** $r=150, \theta=0.763$

8 a and **b**



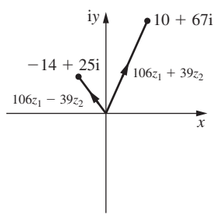


c Rotation of $\frac{\pi}{2}$ radians clockwise.

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 $|z_1z_2|=\sqrt{14}, \arg(z_1z_2)=-3.07, \left|\frac{z_1}{z_2}\right|=\sqrt{\frac{7}{2}}, \arg\left(\frac{z_1}{z_2}\right)=1.64$

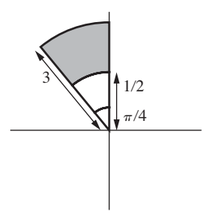
10 $z_1=-\frac{1}{53}+\frac{23}{53}i, z_2=\frac{4}{13}+\frac{7}{13}i$



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** $(\cos\theta + i\sin\theta)^{-\frac{1}{6}}$

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** $0.644 - 1.55i, -0.644 + 1.55i$

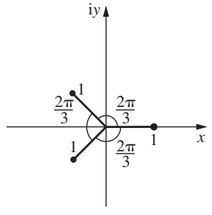
4 c $2^{\frac{1}{2}}\left[\cos\left(-\frac{3\pi}{4}\right) + i\sin\left(-\frac{3\pi}{4}\right)\right], 2^{\frac{1}{2}}\left[\cos\left(-\frac{\pi}{12}\right) + i\sin\left(-\frac{\pi}{12}\right)\right], 2^{\frac{1}{2}}\left[\cos\left(\frac{7\pi}{12}\right) + i\sin\left(\frac{7\pi}{12}\right)\right]$ **d**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

4 e $1.45 + 0.354i, -0.354 + 1.45i, 0.354 - 1.45i, -1.45 - 0.354i$ **f** $1.54 - 0.640i, 1.09 + 1.27i, -0.872 + 1.42i,$

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

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



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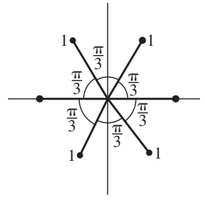

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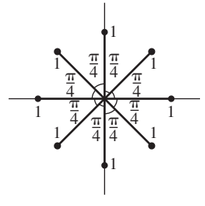
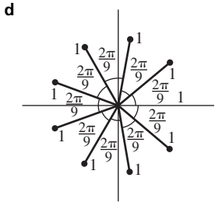


d



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** $2\left[\cos\left(\frac{\pi}{3}\right) + i\sin\left(\frac{\pi}{3}\right)\right]$

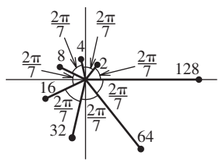
7 b Real part is 2^{15}. Imaginary part is $-2^{15}\sqrt{3}$ **9 b** $\tan\left(-\frac{15\pi}{16}\right), \tan\left(-\frac{7\pi}{16}\right), \tan\left(\frac{\pi}{16}\right), \tan\left(\frac{9\pi}{16}\right)$ **10** $-\frac{1}{2} - i\frac{\sqrt{3}}{2}$

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

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

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** $\cos\left(-\frac{2\pi}{3}\right) + i\sin\left(-\frac{2\pi}{3}\right)$

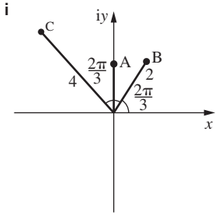
17 c $z^6 + 6z^4 + 15z^2 + 20 + \frac{15}{z^2} + \frac{6}{z^4} + \frac{1}{z^6}$ **d** $a = \frac{1}{32}, b = \frac{3}{16}, c = \frac{15}{32}, d = \frac{5}{16}$

Chapter 17 Review Exercise

1 $r = \sqrt{14.8}, \theta = 2.06$ **2** $k = -2$ **3** $a = -2, b = 5$ **4** 4 **5 b** 4294967296 **6** $x = -\frac{47}{65}, y = -\frac{1}{65}$ **7** $x^3 - 5x^2 + 10x - 12 = 0$

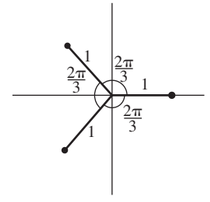
8 Real part $= \frac{x^3 + xy^2 + x}{x^2 + y^2}$, Imaginary part $= \frac{x^2y + y^3 - y}{x^2 + y^2}$ **9** $\sqrt{3}$ **10 a** $|z| = 2, \arg(z) = \frac{\pi}{3}$ **b** $|z^2| = 4, \arg(z^2) = \frac{2\pi}{3}$

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

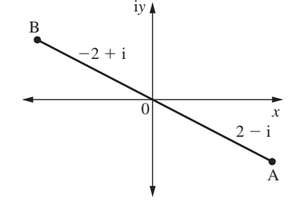


11 d Each side has length $\sqrt{3}$. Area of triangle $= \frac{3\sqrt{3}}{4}$ **12 a** $a = -\frac{5}{3}, b = \frac{16}{9}$ **b** $a = -\frac{17}{4} - \frac{31i}{4}, b = -\frac{17}{4} + \frac{31i}{4}$

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** $|z| \leq 5, \frac{\pi}{3} \leq \arg(z) \leq 1.98, -2 \leq \mathrm{Re}(z) \leq \frac{5}{2}$ **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 $(\sqrt{3}, 2\sqrt{3}), (-\sqrt{3}, -2\sqrt{3})$

Answers are given when asked to form a conjecture

Chapter 18 Exercise 3

1 $D^n = \begin{pmatrix} 1 & 2^n - 1 \\ 0 & 2^n \end{pmatrix}$ **2** $\sum_{r=1}^{n} 3r + 2 = \frac{1}{2}n(7n + 3)$ **3** $\sum_{r=1}^{n} 4r - 7 = n(2n - 5)$ **4** Any value $\geq 21p$

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

Chapter 18 Review Exercise

8 $(n + 1)! - 1$ **16** $M^n = \begin{pmatrix} n + 1 & -n \\ n & 1 - n \end{pmatrix}$

Chapter 19 Exercise 1

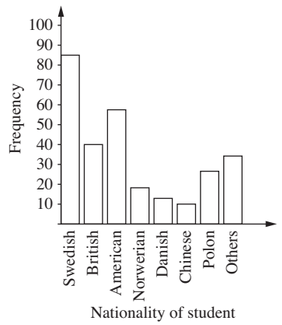
1 a Continuous **b** Discrete **c** Continuous **d** Continuous **2** mode = 4., median = 4, mean = 4.15 **3** mode = Blue

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

1



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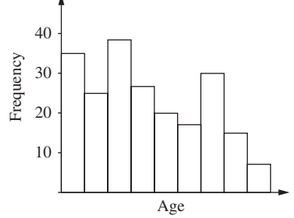

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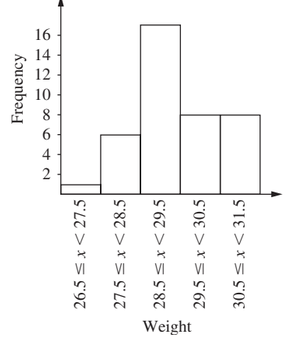

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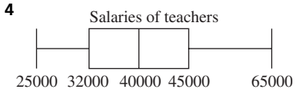

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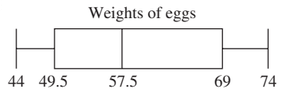
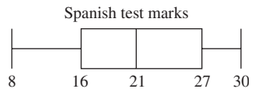
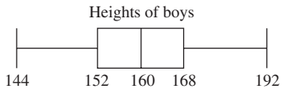


6 a



b 21.0

7



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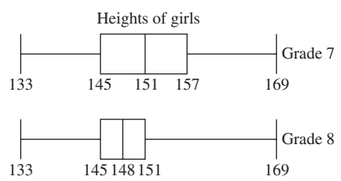
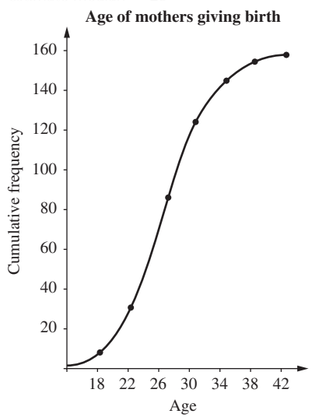


9 median = 13,

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^{th} percentile = 19

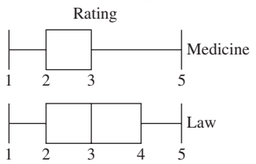
13 estimate $Q_1 = 35m$, $Q_2 = 42m$, $Q_3 = 48m$, 35^{th} percentile = $38m$, 95^{th} percentile = $54m$

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, median = 2. Law IQ = 2, 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** 6.31 **6** $\bar{x} = 501$, variance = 2.61

7 a $Q_2 = 105$, $IQ = 28$ **b** $\bar{x} = 110$, $s = 16.2$

Chapter 19 Exercise 4

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

1 iii a $Q_1 = 34000$, $Q_2 = 45500$, $Q_3 = 57250$ **b** $\bar{x} = 44500$, $s = 14300$ **iv a** $Q_1 = 0.62$, $Q_2 = 0.755$, $Q_3 = 0.845$ **b** $\bar{x} = 0.724$, $s = 0.189$

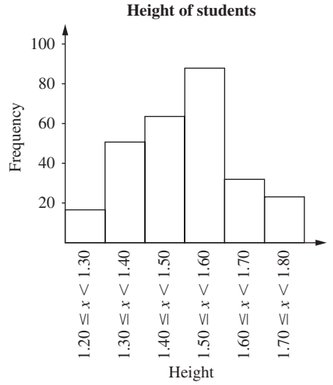
2 Graph IQ = 3 **3** Daniel Graph, median = 185.5, range = 167 Paul Graph, median = 198.5, range = 71

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

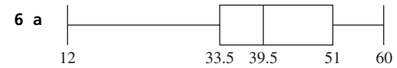
Chapter 19 Review Exercise

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

5



6 a



b 17.5 **c** 40.9

7 estimate $Q_1 = 16$, $Q_2 = 23$, $Q_3 = 27$ **8 a** $Q_2 = 1$, $IQ = 1$ **b** $\bar{x} = 1.63$, $s = 1.51$

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

10 a 29.9 **b** 0.0336 **11 a** median = 135 **b** IQ = 11 **12 a** 31.3 **b** 9.84

13 a 156 **b** $x = 44$ minutes

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** $\frac{1}{8}$ 8 **a** $\frac{1}{5}$ **b** $\frac{9}{15}$

7 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** $\frac{1}{4}$ **d** $\frac{4}{9}$ **e** $\frac{1}{3}$

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** $\frac{1}{2}$ **c 1** The events are mutually exclusive because it is not possible to have an even number that is prime.

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.

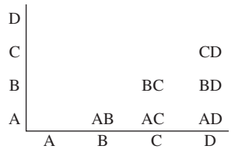
19 0.15 **20 a** $\frac{83}{500}$ **b** $\frac{1}{25}$

Chapter 20 Exercise 2

1 a $\frac{5}{42}$ **b** $\frac{3}{7}$ **2 a** $\frac{9}{15}$ **b** $\frac{4}{21}$ **c** $\frac{1}{2}$ **3 a** $\frac{7}{16}$ **b** $\frac{1}{4}$ **c** $\frac{2}{7}$ **d** $\frac{1}{2}$

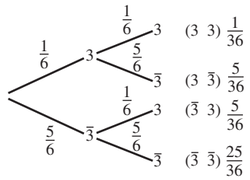
4 a $\frac{1}{14}$ **b** $\frac{1}{6}$ **c** $\frac{2}{7}$ **5 a** $\frac{2}{5}$ **b** $\frac{1}{2}$ **c** $\frac{1}{2}$ **6** 0.0768 **7 a** $\frac{181}{208}$

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

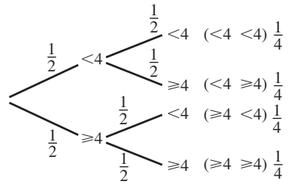


Chapter 20 Exercise 3

1 a 0.3 **b** 0.5 **2 a**

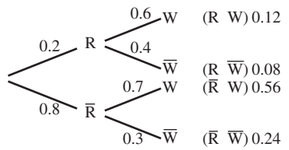


b $\frac{1}{36}$ **c** $\frac{25}{36}$ **d**



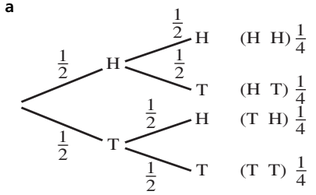
e $\frac{1}{2}$ **f** $\frac{3}{4}$

3 a



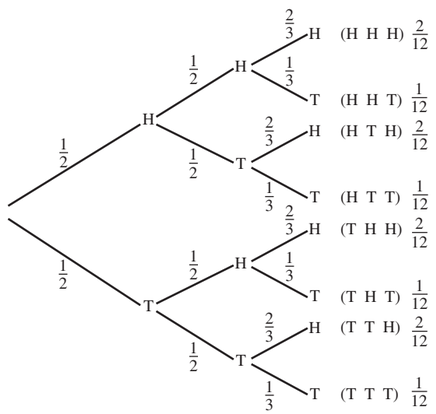
b 0.12 **c** 0.32 **d** 0.3 **e** 0.118 **4 a** $\frac{1}{8}$ **b** $\frac{3}{8}$ **c** $\frac{1}{4}$ **d** $\frac{7}{8}$

5 a

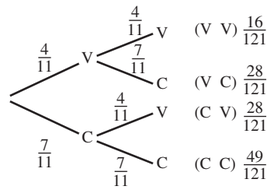


b $\frac{3}{4}$

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** $\frac{21}{55}$ **d** 0 **e** $\frac{27}{64}$ **f** $\frac{17}{110}$

8 a $\frac{108}{455}$ **b** $\frac{128}{455}$ **c** 0.628 **9 a** $\frac{2}{15}$ **b** $\frac{4}{15}$

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** 0.12 **b** 0.36

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** 0.821 **4** $\frac{3}{4}$ **5** $\frac{2}{3}$ **6** $\frac{45}{53}$ **7** $\frac{8}{11}$ **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** 7 **11 a** 0.00103 **b** 0.479 **c** 0.524 **d** 0.561 **12 a** 0.3 **b** 0.35 **c** 0.075 **d** 0.3

13 a $\frac{1}{64}$ **b** $\frac{1}{64}$ **c** 19 **14 a** 0.0191 **b** 0.00459 **c** 0.164 **15 a** $\frac{1}{27000}$ **b** 90 **c** $\frac{1}{900}$

Chapter 20 Exercise 5

1 720 **2** 16065 **3** 24 **4** 60 **5** 10080 **6** 604800 **7** 241920 **8** 201600 **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** 2520 **13 a** 4989600 **b** 1270080 **14 a** 5040 **b** 4320 **c** 720 **15 a** 42 **b** 10 **16 a** 9000000

16 b Increases by 16000000 **17 a** 831600 **b** 176400 **c** 151200 **18** 119 **19** 1 **20 a** 4 **b** 16 **c** 24 **d** 62 **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** 33

Chapter 20 Exercise 6

1 a 100 **b** $\frac{3}{4}$ **c** $\frac{1}{5}$ **d** $\frac{1}{5}$ **2 a** 362880 **b i** $\frac{1}{9}$ **ii** $\frac{8}{9}$ **c** $\frac{1}{189}$ **3 a** 15 **b** $\frac{1}{15}$ **4 a** 360 **b** $\frac{2}{3}$ **c** $\frac{2}{3}$ **5 a** 3838380

5 b $\frac{3}{20}$ **c** $\frac{5}{39}$ **6 a** 10440 **b** $\frac{12}{29}$ **c** $\frac{1}{10}$ **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** $\frac{1}{35}$

Chapter 20 Review Exercise

1 a $\frac{1}{6}$ **b** Events are not independent since $P(Black) \times P(Brown) = \frac{1}{3}$ and $P(Black \cap Brown) = \frac{1}{6}$

Events are not mutually exclusive because $P(Black \cap Brown) \neq 0$ Events are exhaustive since $P(Black \cup Brown) = 1$

2 a 0.995 **b** 3 **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** 30240 **b** 30238 **c** 126 **d** 32 **12** $\frac{4}{5}$ **13 a** 360

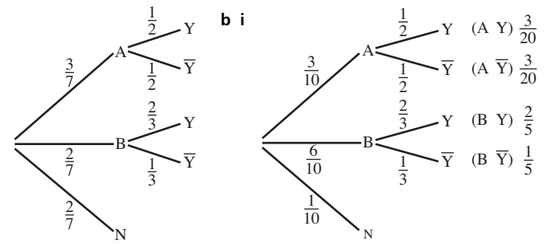
13 b 216 **14** 0.048 **15 a** 20160 **b** $\frac{1}{4}$ **c** $\frac{1}{56}$ **16 a** $\frac{17}{42}, \frac{9}{17}$

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** 0.369 **c** 0.439

21 a 0.581 **b** 0.0918 **c** 0.0663

b i



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
$P(Y = y)$	$\frac{1}{167}$	$\frac{8}{167}$	$\frac{27}{167}$	$\frac{64}{167}$	$\frac{125}{167}$

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 $E(Y) = \frac{28}{15}$, $Var(Y) = 0.780$

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, 3, 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** $\frac{25}{81}$

21 a $\frac{1}{14}$ **b** $E(X) = \frac{4}{7}$, $Var(X) = 0.816$ **c** $\frac{3}{196}$ **d** $E(Y) = \frac{8}{7}$, $Var(Y) = 1.63$

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** 0.998 **d** 0.24 **e** 0.978 **14 a** 10 **b** 2.74 **c** 0.416 **15 a** $\frac{4}{7}$ **b** 16 **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** 0.042 **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 0.0108

Chapter 21 Exercise 4

1 a 0.244 **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** 0.404 **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** 0.119 **e** 0.173 **13 a** 0.0149 **b** 0.223

14 a 0.0183 **b** 0.215 **c** 0.975 **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 i a 0.345 **b** 0.753 **c** Mean = 42 Variance = 42 **d** 41 or 42 **ii** 0.111 **17 a** 0.195 **b** 0.785 **c** 0.152 **d** 0.166 **e** 8

18 a 0.0486 **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 0.0173 **b** 22 **11 a i** $\frac{1}{9}$ **ii** $\frac{1}{81}$ **b i** $\frac{73}{648}$ **ii** $\frac{575}{1296}$ **c ii**

x	3	4	5
$P(X = x)$	$\frac{65}{1296}$	$\frac{175}{1296}$	$\frac{369}{1296}$

iii $\frac{6797}{1296}$

12 a 0.0105 **b** 0.0226 **c** 1 **d** 10 **e** 0.00116 **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** 0.994 **v** $\frac{{}^4C_j\theta^j(1-\theta)^{4-j}}{6\theta^2(1-\theta)^2 + 4\theta^4(1-\theta) + \theta^4}$

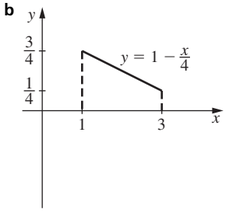
15 e vi 0.545, 0.0488 **vii** 0.969 **16 a**

Amount received in Euros X	30	25	15	12	18	25	40
$P(X = x)$	0.00137	0.0165	0.0823	0.248	0.329	0.263	0.0878

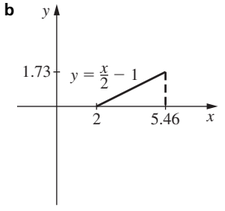
16 b Gain of 20.3 Euros **c** 59.5 **d** 305 **17** $\alpha = \frac{1}{7}$, $E(X) = \frac{123}{49}$ **18** $P(X = r) = {}^nC_r\left(\frac{1}{2}\right)^n$ Mean $= \frac{n}{2}$ Standard deviation $= \sqrt{\frac{n}{4}}$ **b i** $\frac{5}{8}$ **ii** $\frac{8}{11}$

Chapter 22 Exercise 1

1 a $k = 1$ **b**

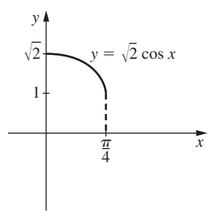


c $\frac{1}{2}$ **d** $\frac{27}{32}$ **2 a** $c = 5.46$ **b**

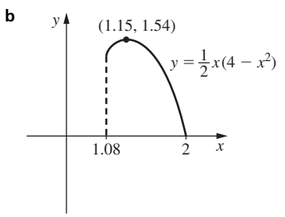


c 0.0625 **d** 0.9975

3 a $k = \sqrt{2}$ **b**

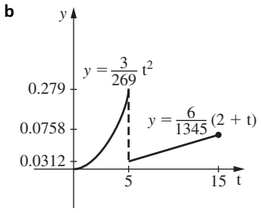


c 0.707 **d** 0.634 **4 a** $k = 1.08$ **b**



c 0.306 **d** 0.621

5 a $\frac{3}{269}$ **b**



c 0.494 **d** 0.375

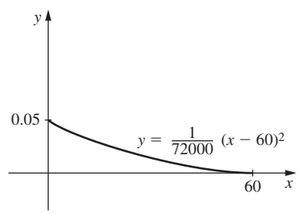
Chapter 22 Exercise 2

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** $c = \frac{1}{e}$ **b** 0.368 **7 a** $k = 1$ **b** 0.571 **c** 0.141 **d** $\frac{\pi}{6}$ **e** 0.830

8 a $k = 1.56$ **b** 0.616 **c** 0.178 **d** 0.546 **e** 0.384 **9 a** $-2 < x < 2$ **b** $0 < x < 0.421$ **c** 0.115 **d** 0.0209 **10 a** 1 **b** 0

10 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** $\frac{2}{\sqrt{3}}$ **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
3 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** 0.125 **5 a** 0.106 **b** 0.809 **c** 0.998 **d** 0.101 **e** 0.0964 **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** 0.0443
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** $\left(\mu - \sigma, \frac{1}{\sigma\sqrt{2e\pi}}\right), \left(\mu + \sigma, \frac{1}{\sigma\sqrt{2e\pi}}\right)$ **7** 0.886 **8 a** 5 **b** 57.4 **9 a** 7.93 **b** 48.9

9 c 7 **10** $\mu = 74.6, \sigma = 11.4$ **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

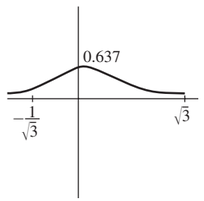
15 a $194 \leq X \leq 303$ **b** 0.423 **16 a** $\mu = 28.5, \sigma = \sqrt{1.49}$ **b** 0.587 **17 a** 126 **b** 280g **18 a** 1.43 **b** 0.0146 **19** 4.14

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** $q = 140$ cm, $r = 180$ cm **d** 0.121 **e** 0.332 **3 a** 0.946 **b** 0.798

3 c 0.000109 **d** 0.99989 **4** $2\frac{1}{2}$ **5 a** 89.6% **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** $E(X) = \pi$, $Var(X) = 2.93$ **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** $e^{\frac{1}{4}} - e^{\frac{1}{2}} + \frac{1}{4}e$ **c** $E(X) = \frac{e}{2} - 1$, $Var(X) = 1 + \frac{e}{3} - \frac{e^2}{4}$ **d** 0.290 **e** 0.0243 **f** 0.179