

- 2** a 2^2 b 2^{-2} c 2^3 d 2^{-3} e 2^5 f 2^{-5}
 g 2^1 h 2^{-1} i 2^6 j 2^{-6} k 2^7 l 2^{-7}
- 3** a 3^2 b 3^{-2} c 3^3 d 3^{-3} e 3^1 f 3^{-1}
 g 3^4 h 3^{-4} i 3^0 j 3^5 k 3^{-5}
- 4** a 2^{a+1} b 2^{b+2} c 2^{t+3} d 2^{2x+2} e 2^{n-1}
 f 2^{c-2} g 2^{2m} h 2^{n+1} i 2^1 j 2^{3x-1}
- 5** a 3^{p+2} b 3^{3a} c 3^{2n+1} d 3^{d+3} e 3^{3t+2}
 f 3^{y-1} g 3^{1-y} h 3^{2-3t} i 3^{3a-1} j 3^3
- 6** a $4a^2$ b $27b^3$ c a^4b^4 d p^3q^3 e $\frac{m^2}{n^2}$
 f $\frac{a^3}{27}$ g $\frac{b^4}{c^4}$ h $1, b \neq 0$ i $\frac{m^4}{81n^4}$ j $\frac{x^3y^3}{8}$
- 7** a $4a^2$ b $36b^4$ c $-8a^3$ d $-27m^6n^6$
 e $16a^4b^{16}$ f $\frac{-8a^6}{b^6}$ g $\frac{16a^6}{b^2}$ h $\frac{9p^4}{q^6}$
- 8** a $\frac{a}{b^2}$ b $\frac{1}{a^2b^2}$ c $\frac{4a^2}{b^2}$ d $\frac{9b^2}{a^4}$ e $\frac{a^2}{bc^2}$
 f $\frac{a^2c^2}{b}$ g a^3 h $\frac{b^3}{a^2}$ i $\frac{2}{ad^2}$ j $12am^3$
- 9** a a^{-n} b b^n c 3^{n-2} d $a^n b^m$ e a^{-2n-2}
- 10** a 1 b $\frac{4}{7}$ c 6 d 27 e $\frac{9}{16}$ f $\frac{5}{2}$
 g $\frac{27}{125}$ h $\frac{151}{5}$
- 11** a 3^{-2} b 2^{-4} c 5^{-3} d $3^1 \times 5^{-1}$ e $2^2 \times 3^{-3}$
 f $2c^{-3} \times 3^{-2}$ g $3^{2k} \times 2^{-1} \times 5^{-1}$ h $2p \times 3^{p-1} \times 5^{-2}$
- 12** a $5^3 = 21 + 23 + 25 + 27 + 29$
 b $7^3 = 43 + 45 + 47 + 49 + 51 + 53 + 55$
 c $12^3 = 133 + 135 + 137 + 139 + 141 + 143 + 145 + 147 + 149 + 151 + 153 + 155$

EXERCISE 3C

- 1** a $2^{\frac{1}{5}}$ b $2^{-\frac{1}{5}}$ c $2^{\frac{3}{2}}$ d $2^{\frac{5}{2}}$ e $2^{-\frac{1}{3}}$
 f $2^{\frac{4}{3}}$ g $2^{\frac{3}{2}}$ h $2^{\frac{3}{2}}$ i $2^{-\frac{4}{3}}$ j $2^{-\frac{3}{2}}$
- 2** a $3^{\frac{1}{3}}$ b $3^{-\frac{1}{3}}$ c $3^{\frac{1}{4}}$ d $3^{\frac{3}{2}}$ e $3^{-\frac{5}{2}}$
- 3** a $7^{\frac{1}{3}}$ b $3^{\frac{3}{4}}$ c $2^{\frac{4}{5}}$ d $2^{\frac{5}{3}}$ e $7^{\frac{2}{7}}$
 f $7^{-\frac{1}{3}}$ g $3^{-\frac{3}{4}}$ h $2^{-\frac{4}{5}}$ i $2^{-\frac{5}{3}}$ j $7^{-\frac{2}{7}}$
- 4** a 2.28 b 1.83 c 0.794 d 0.435 e 1.68
 f 1.93 g 0.523
- 5** a 8 b 32 c 8 d 125 e 4
 f $\frac{1}{2}$ g $\frac{1}{27}$ h $\frac{1}{16}$ i $\frac{1}{81}$ j $\frac{1}{25}$

EXERCISE 3D.1

- 1** a $x^5 + 2x^4 + x^2$ b $4x + 2x$ c $x + 1$
 d $49x + 2(7^x)$ e $2(3^x) - 1$ f $x^2 + 2x + 3$
 g $1 + 5(2^{-x})$ h $5^x + 1$ i $x^{\frac{3}{2}} + x^{\frac{1}{2}} + 1$
- 2** a $4^x + 2^{x+1} - 3$ b $9^x + 7(3^x) + 10$
 c $25^x - 6(5^x) + 8$ d $4^x + 6(2^x) + 9$
 e $9^x - 2(3^x) + 1$ f $16^x + 14(4^x) + 49$
 g $x - 4$ h $4^x - 9$ i $x - x^{-1}$ j $x^2 + 4 + \frac{4}{x^2}$
 k $7^{2x} - 2 + 7^{-2x}$ l $25 - 10(2^{-x}) + 4^{-x}$

EXERCISE 3D.2

- 1** a $5^x(5^x + 1)$ b $10(3^n)$ c $7^n(1 + 7^{2n})$
 d $5(5^n - 1)$ e $6(6^{n+1} - 1)$ f $16(4^n - 1)$
- 2** a $(3^x+2)(3^x-2)$ b $(2^x+5)(2^x-5)$ c $(4+3^x)(4-3^x)$
 d $(5+2^x)(5-2^x)$ e $(3^x+2^x)(3^x-2^x)$ f $(2^x+3)^2$
 g $(3^x+5)^2$ h $(2^x-7)^2$ i $(5^x-2)^2$
- 3** a $(2^x+3)(2^x+6)$ b $(2^x+4)(2^x-5)$
 c $(3^x+2)(3^x+7)$ d $(3^x+5)(3^x-1)$
 e $(5^x+2)(5^x-1)$ f $(7^x-4)(7^x-3)$
- 4** a 2^n b 10^a c 3^b d $\frac{1}{5^n}$ e 5^x
 f $(\frac{3}{4})^a$ g 5 h 5^n
- 5** a $3^m + 1$ b $1 + 6^n$ c $4^n + 2^n$ d $4^x - 1$
 e 6^n f 5^n g 4 h $2^n - 1$ i $\frac{1}{2}$
- 6** a n^{2n+1} b -3^{n-1}

EXERCISE 3E

- 1** a $x = 3$ b $x = 2$ c $x = 4$ d $x = 0$
 e $x = -1$ f $x = \frac{1}{2}$ g $x = -3$ h $x = 2$
 i $x = -3$ j $x = -4$ k $x = 2$ l $x = 1$
- 2** a $x = \frac{5}{3}$ b $x = -\frac{3}{2}$ c $x = -\frac{3}{2}$ d $x = -\frac{1}{2}$
 e $x = -\frac{2}{3}$ f $x = -\frac{5}{4}$ g $x = \frac{3}{2}$ h $x = \frac{5}{2}$
 i $x = \frac{1}{8}$ j $x = \frac{9}{2}$ k $x = -4$ l $x = -4$
 m $x = 0$ n $x = \frac{7}{2}$ o $x = -2$ p $x = -6$
- 3** a $x = \frac{1}{7}$ b has no solutions c $x = 2\frac{1}{2}$
- 4** a $x = 3$ b $x = 3$ c $x = 2$
 d $x = 2$ e $x = -2$ f $x = -2$
- 5** a $x = 1$ or 2 b $x = 1$ c $x = 1$ or 2
 d $x = 1$ e $x = 2$ f $x = 0$

EXERCISE 3F

- 1** a 1.4 b 1.7 c 2.8 d 0.4
2 a $x \approx 1.6$ b $x \approx -0.7$
3 $y = 2^x$ has a horizontal asymptote of $y = 0$

